The Financial Embargo of 1986-1991 on South Africa

Dynamic Analysis

by

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in partial fulfillment of
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Abstract

The Structure of the main analysis of this thesis is to examine the effects of a financial embargo on the time path of the economic growth rate of South Africa. In this study I examine a simple open economy version of the Ramsey growth model. In addition, I undertake a linear intervention analysis to examine the effect of the financial embargo on the time path of the economic growth rate of South Africa. Based on both the theoretical and the empirical analyses, I conclude that the financial embargo of 1986-1991 on South Africa had a temporary negative effect on the time path of the economic growth rate of the country.

The thesis is extended to present a simple open economy version of Ramsey's model within a political context, taking into consideration the main elements of the apartheid system that was in effect in South Africa for a long time. This is in response to the question of the extent of the effectiveness of the international financial embargo in achieving its desired goal. This study concludes that there was an inverse relationship between the degrees of the response of the financial sanction as an international reaction to the human rights violations of the apartheid system on the one hand, and on the interest rate on the other. This provides a new interpretation for the outflow of capital from South Africa during the economic blockades. In line with the assumptions of the model, whites – the group with the capital – were the most affected by the blockade, with their income being directly affected by the imposition of the financial embargo. This indicates that the financial embargo was effective in achieving its desired goal, namely the exertion of pressure on the economic sector to lift the apartheid system. In addition, this analysis presents a simplified empirical study that concludes by reiterating the results of the theoretical study: that the

multilateral financial embargo on South Africa was effective in achieving its desired goal.

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Chapter 1

Introduction

Economic blockades have occupied an enduring place in South Africa's history. The first direct blockade against the country was undertaken by India after World War II, and was in response to South Africa's execution of apartheid laws against its Indian minority. In 1959, in objection to its apartheid system, the International Confederation Free Trade Union imposed economic blockades on South Africa. The horrors of the apartheid were highlighted to the world through various incidents, the most glaring of which was the 1960 Sharpeville slaughter, during which the police fired into resistance fighters. It was at this time that the South African government abolished the African National Congress (ANC) and most of the African political parties, and exiled their members.

The worst of these bloody incidents was one that took place against students at the New African School, and which became known as the Soweto uprising (1976). The government closed down most of the new African political organizations, leading to an outcry on the part of human rights activists worldwide, and ensuing attempts to impose economic blockades against the South African government. These increased in some years and decreased in others, according to the economic benefits derived from foreign investment in the country. But the global conscience refused to be silenced once it had been incited by the 1984 South African imposition of a new constitution that stated the existence of three parliaments for whites, Indians, and coloureds, but prohibited most Africans from entry into them.

With the exception of a few countries, the world united to impose a full economic blockade on the South African government, with the intent of bringing the apartheid system to an end. There types were many. The most obvious were the trade embargoes on both the imports and exports of South Africa, disinvestments including halting new foreign investments, the removal of existing foreign investments, and a financial embargo that encompassed denying new loans to the South African government or any organizations that it owned.

In this thesis, I focus on the study of this last element (the financial embargo) in two separate studies. The main study deals with the effect of this financial embargo on the trajectory of South African economic growth, while also considering the dynamics of the financial embargo on the economic growth rate over time. I begin the study with a theoretical examination of the simple open economy version of the Ramsey growth model. Second, I present an empirical examination of the results of the theoretical analysis of the financial embargo on South Africa between 1986 and 1991, and the effects of that embargo on the rate of economic growth over the years in the country. Despite the breadth of this research, my empirical study directly correlates with the goals of my theoretical study. Just as I examined the external impact of the financial embargo in my theoretical analysis, so I considered in my empirical data the role of the financial embargo as an intervention dummy variable. Likewise, just as I theoretically studied the effects of the financial embargo on the course of the economic growth rate over time, so I explored the effects of this embargo on South Africa's economic growth rate over time, using a time series intervention analysis that captures the dynamic effect of this impact on the time path of the economic growth rate.

For these reasons, I believe that my study here is the first of its kind, theoretically examining the dynamics of the effects of the 1986-1991 financial embargoes on South Africa's economic growth, by using the Ramsey growth model, and also through the assessment of the results of the embargo, utilizing a time series intervention analysis. My work is also the first of its kind to connect the simple open economy version of the Ramsey growth model, with the analysis of the financial embargo (defined as complete sanctions with regard to foreign borrowings) on South Africa.

I have highlighted the problem of the study, as represented in the response to the question of whether an open economic version is capable – in its simple form – of forecasting the effects of the 1986-1991 financial embargoes on South Africa's growth rate. My theoretical study responds to this and my empirical study tests the results of the study through the use of actual data on the economic growth rate in South Africa.

For the purposes of coherence, I have divided the first study in the following way. In chapter 2, I present the theoretical model, analyzing the effects of the financial embargo on the economic growth rate over time and I apply my theoretical findings to the case of South Africa. In chapter 3, I present my empirical study, analyzing the effects of the 1986-1991 financial embargo on South Africa's economic growth rate, through a time series intervention analysis. Finally, I present the main conclusion of the first study.

The findings of this study are that the financial embargo only had an effect on South Africa's economic growth rate in the short run. The long run economic growth rate was not be affected by this embargo. This result is because of the assumption of the stability in the analysis of the selected exogenous growth model. This may elicit some questions from the reader. For example, if the negative effects of the sanctions on the

economic growth rate were limited, then how did this tactic have the power to bring the apartheid system to such a rapid end, with rule transferring to the hands of a black government under Nelson Mandela?

In reality, while my study is unique in its previously explained methodological approach, it is not the only one that establishes the limited results of the financial embargo on South Africa. Analysts have differed in their views on the detrimental effects of the financial and capital embargoes on South Africa. Many – the foremost being Khan (1989) – view such an embargo as an illusion with no place in practical reality. But there was to a large extent an international collusion in definitively imposing sanctions. Others such as Walt & Wet (1993) and Jenkins (1989) believe that such an embargo did have an effect on South Africa's economic growth rate, in short and long terms. They base this point of view on the premise that, before the sanctions, South Africa relied in large part on the outpouring of foreign capital to close its saving investment gap, in order to reach its average growth rates as planned. Any interruption in this foreign capital would have had a significant effect on the country's economic growth. But these previous authors did not present a dynamic study to support this argument, and to elucidate that this kind of embargo does have an effect on economic growth in the long run. Furthermore, many political analysts have not viewed this embargo as a central reason for the termination of apartheid in South Africa. Rather, they believe that there were several internal factors that led to its end and occurred simultaneously with the imposition of the international blockade. As a result, the blockade appeared to be the main reason for the end of apartheid in South Africa. Others see the economic blockade as the central agent in ending apartheid, with the view that the financial embargo was more effective than other

weapons, and therefore it should be considered as a crucial element in bringing apartheid to an end.

Many economic theorists have set up empirical examples within a political context to study another question: whether the financial and capital embargoes were a factor in bringing apartheid to an end. Their results also differed, and I found that I had to add another study in order to try and answer this question. In the second study, I place the example of Ramsey in its major simple form within the political context, keeping in mind the political environment of the apartheid system and its connection with the financial embargo, as has been carried out in previous studies such as those by Kaempfer & Lowenberg (1992) and Lundahl (1993). This second study then enabled me to generate a response to the question of the effectiveness of the financial embargo on the apartheid system in South Africa, a response that was in support of those that believe that the embargo should be considered an effective factor in ending apartheid. I confirmed this through another simple empirical analysis. My analysis builds on important previous works by offering a new study of the financial embargo on South Africa.

The final question that remains is how such a financial embargo can have a limited term effect on economic growth, while at the same time serving as a factor in realizing the desired goal? To this question I do not have difficulty in finding a response. The goal of the embargo was to bring apartheid to an end. It was never intended to destroy the economy of the targeted country; the goal was to exert political pressure rather than to declare an all-encompassing economic war against a hostile financial system. As a result, its effects ended when its goal was met, thereby confirming its

suitability as an effective economic weapon in accomplishing a political goal in a peaceful manner.

The remainder of the second research is divided into 2 main chapters. Chapter 4 presents the theoretical analysis that deals with the effectiveness of the embargo by using a simple open economy version of the Ramsey model in a political framework. Chapter 5 presents an empirical study that examines the findings of chapter 4. Finally, the conclusion of the second research is at the end chapter 5. In chapter 6, I present the summary and the main conclusion of the thesis.

First Part

Does the 1986-1991 Financial Embargo Affect the Long Run Economic Growth Rate of South Africa?

The effects of a financial embargo on the time path of the economic growth rate of South Africa are analyzed.

I examine a simple open economy version of the Ramsey growth model. In addition, I undertake a linear intervention analysis to examine the effect of the financial embargo on the time path of the economic growth rate of South Africa. Based on both the theoretical and the empirical models, I conclude that the financial embargo of 1986-1991 on South Africa had a temporary negative effect on the time path of the economic growth rate of the country.¹

¹ Mohamed, Ghada (2004), External shocks and sustainable development, WSTRD, London, UK

Introduction

In this research, I will focus on the study of the effect of the multilateral 1986-1991 financial embargoes on the time path of the economic growth rate of South Africa. I will begin the study with a theoretical examination of the simple open economy version of the Ramsey growth model. Second, I will use an intervention analysis to examine empirically the effect of this embargo on the time path of the economic growth rate of South Africa.

I have highlighted the problem of the study, as represented in the response to the question of whether an open economic version is capable – in its simple form – of forecasting the effects of the 1986-1991 financial embargoes on South Africa's growth rate. My theoretical study responds to this and my empirical study tests the results of the theoretical study through the use of actual data on the economic growth rate in South Africa.

The remainder of the research is divided as follows: In chapter 2, I present the theoretical study, analyzing the effects of the financial embargo on the economic growth rate over time and predicting theoretically for the effect of the 1986-1991 financial embargo on the economic growth rate of South Africa over time. In chapter 3, I present my empirical study, analyzing the effects of the 1986-1991 financial embargoes on South Africa's economic growth rate, through a time series intervention analysis. Finally, a summary and a conclusion will be presented in chapter 4.

Chapter 2

The Transitional Dynamics of a Financial Embargo in A Simple Open Economy Version of the Ramsey Growth Model

This chapter examines the effect of the financial embargo on the time path of the economic growth rate as predicted in a simple open-economy version of the Ramsey model. The chapter is structured as follows:

Section 2.2: The framework of the open economy version of the Ramsey model.

Section 2.3: The optimal solutions and the steady state equilibrium.

Section 2.4: The effect of the financial embargo on the economic growth rate of the country. Section 2.4 focuses on the following points: 2.4.1: The effect of an unanticipated permanent total interruption of foreign borrowings. 2.4.2: The effect of a fully anticipated permanent total interruption of foreign borrowings. 2.4.3: The effect of a temporary total interruption of foreign borrowings.

Analyzing the effect of a permanent financial embargo is important as a departure analysis for the effect of the temporary shock of the financial embargo on the economic growth rate of South Africa, which is the main goal of my work.

Section 2.5: A theoretical prediction of the effect of the financial embargo imposed on South Africa from 1986 to 1991 on the time path of the economic growth rate of South Africa.

Section 2.6: The main conclusion of chapter 2.

2.2 The Framework of the Model:

Firms produce a single commodity Y by means of capital K and labour N , the technology is Cobb-Douglas with constant return to scale.²

$$Y_t = K_t^\alpha N_t^{1-\alpha}. \quad (2-1)^3$$

Normalizing $N = 1$.⁴

Domestic output is devoted to consumption C , investment I , and net exports X .

$$Y_t = C_t + I_t + X_t. \quad (2-2)$$

Where, t applies to time.

Let D be the country's debt and $r_w D$ is the interest outflow assuming that the country in question is a debtor country.

Let B be the current account deficit.

$$B_t = -X_t + r_w D_t \quad (2-3)$$

Where r_w is the interest rate paid on foreign debt. The r_w is constant as a result of the

² This is to simplify the analysis and to maintain the main features of a neoclassical growth model such as the Solow model and the Ramsey growth model. See for more detail the Wikipedia: Neo-classical growth models.

³ Neglecting the productivity growth in terms of effective labor is also to simplify the analysis. If we assume a non-zero productivity growth in terms of effective labor, the analysis will be more complicated in terms of the number of notations but the main findings still hold. See both Wikipedia: Neo-classical growth models, and the history of economic thought website for more detail. *See references for the quoted websites.*

⁴ This is to save notations and to simplify the analysis. In this case, the growth rate of N ; n equals zero. I use here same assumptions in Blanchard & Fischer (1996). Carlberg (1997) assumed that $n > 0$. This assumption does not affect my main results because of the stability condition in equation (2-9) in the model. If $n > 0$, the stability condition will include the effect of the positive population growth rate yet the whole model still be bounded by same condition which guarantees convergence. See Carlberg (1997) for more detail. I rather use the assumption of Blanchard & Fischer of $n = 0$ to save notations. See also Wikipedia: Neo-classical growth models: "Assuming non-zero rates of labor growth complicate matters somewhat, but the logic still applies."

assumption of the smallness. X_t is the net exports.

Current account deficit adds to the foreign debt.

$$\dot{D}_t = B_t \quad (2-4)$$

Investment adds to the stock of capital.

$$\dot{K}_t = I_t \quad (2-5)$$

I assume zero depreciation rates to simplify the analysis.

Household maximizes their utility within an infinite horizon:

$$\max U_0 = \int_0^{\infty} e^{-\rho t} \ln(C_t) dt, \quad (2-6)$$

Subject to:

$$\dot{D}_t = C_t + I_t[1 + T(I_t/K_t)] + r_w D_t - F(K_t, N_t), \quad (2-7)$$

$$\dot{K}_t = I_t \quad (2-5)$$

$$\lim_{t \rightarrow \infty} e^{-\rho t} D_t = 0, \quad (2-8)$$

$$\rho = r_w. \quad (2-9)$$

ρ is the rate of time preference which assumes to be constant for simplicity.

Equation (2-8) is the NPG condition.⁵

Equation (2-9) is the stability condition for the model.⁶

⁵ According to Blanchard & Fischer (1996), "The country should borrow until the marginal utility of consumption is equal to zero and then borrow further to meet interest payments on its debt. However, it is unlikely that lenders would be willing to continue lending if the country's only means of paying off its debt were to borrow more. Accordingly, we impose the No Ponzi Game – NPG-condition." Olivier Jean Blanchard & Stanley Fischer (1996), p.60

Assuming that the installation function $T(.)$ has the properties of the installation function according to Blanchard and Fischer (1996), p. 59.⁷

Using a logarithmic utility function is to simplify the analysis.⁸

In section 2.3, I use lower case letters when discussing the optimal solution of the model and the steady state equilibrium.⁹

⁶ See Carlberg (1997), p.67 and Blanchard & Fischer (1996), p. 30. If the growth rate of N , n is higher than zero, then the n will be added to the stability condition. Its effect on the optimal variables is trivial and it will not affect the main findings of the model. See the appendix for more explanation.

⁷ “The installation cost is nonnegative and convex, with a minimum value of zero when investment is equal to zero: both investment and disinvestments are costly.” Blanchard and Fischer (1996), p.59

⁸ The model can be represented in lower case letters which denote per capita variables (e.g., $y = Y/N$). Where, i_t/k_t is the per capita investment ratio. However, with $N = I$, all lower case letters will equal their relevant higher case letters.

⁹ I use same notations as Blanchard & Fischer (1996).

2.3. Optimal Solution and Steady State Equilibrium:

Necessary and sufficient conditions for a maximum are:

$$(i) \quad u'(c_t) = \mu_t, \quad (\text{from } \partial H_t / \partial c_t = 0), \quad (2-17)$$

The shadow cost of foreign debt μ_t equals the marginal utility of consumption $u'(c_t)$.

$$(ii) \quad q_t = 1 + T(i_t/k_t) + (i_t/k_t)T'(i_t/k_t), \quad (\text{from } \partial H_t / \partial i_t = 0), \quad (2-18)$$

The shadow value of the capital stock is a function of the rate of investment (i_t/k_t) .

According to equation (2-18), if the rate of investment $i_t/k_t = 0$, the installation cost $= 0$ and $q_t = 1$.

Thus, we can re-write equation (2-18) as:

$$q_t = \Psi(i_t/k_t), \quad \Psi' > 0, \quad \Psi(0) = 1, \quad (2-18)'$$

The q_t is monotonically increasing function in i_t/k_t .

And, we can re-write (2-18)' as:

$$i_t/k_t = \Psi^{-1}(q_t) = \phi(q_t), \quad \phi' > 0, \quad \phi(1) = 0, \quad (2-18)''$$

Where $\Psi^{-1}(q_t)$ is the inverse function of $\Psi(q_t)$.

From (2-18)', we can determine q_t :

$$q_t = \int_t^{\infty} e^{-\rho(\tau-t)} [f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)] d\tau. \quad (2-19)$$

Where:

$\tau-t$: is the dummy variable of integration.

$f'(k_t)$: is the marginal product of capital.

$(i_t/k_t)^2 T'(i_t/k_t)$: is the marginal reduction in the installation cost from higher capital.

According to equation (2-19), the shadow price of capital stock q_t equals the present discount value of future marginal products.¹⁰ Thus q_t and thus i_t/k_t does not depend on the level of debt or the characteristics of the utility function.¹¹

$$(iii) \quad \partial(-\mu_t e^{-\rho t}) / \partial t = \mu_t \rho e^{-\rho t} \quad (\text{from } -\partial H_t / \partial d_t), \quad (2-20)$$

ρ is the rate of time preference and μ_t is the shadow cost of foreign debts.

$$(iv) \quad \partial(\mu_t q_t e^{-\rho t}) / \partial t = -\partial H_t / \partial k_t = -\mu_t e^{-\rho t} [f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)]. \quad (2-21)$$

$f'(k_t)$ is the marginal product of capital.

The optimal path exhibits constant consumption over time.

¹⁰ According to Blanchard and Fischer (1996), p.p. 62-63, "The marginal product is the sum of the marginal product of capital in production and the reduction in the marginal cost of installing a given flow of investment due to the increase in the capital stock. The higher the current or future expected marginal products or the lower the discount rate, the higher are q_t and the rate of investment."

¹¹ Since they are not included in their equations, see also Blanchard and Fischer (1996).

$$c = c^* \quad (2-22)^{12}$$

To obtain the level of consumption, the flow budget constraint is integrated and yields:

$$\int_0^{\infty} e^{-\rho t} c_t dt = \int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t[.J]\} dt - d_0, \quad (2-23)$$

Where $\int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t[.J]\} dt$ is the present value of net output and $i_t[.J]$ is $i_t[i_t + T(i_t/k_t)]$.

If we put,

$$v_0 = \int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t[.J]\} dt - d_0, \quad (2-24)$$

Equation (2-23) becomes,

$$\int_0^{\infty} e^{-\rho t} c_t dt = v_0. \quad (2-25)$$

Since consumption is constant, we can linearly using the budget constraint to figure out:

$$c = \rho v_0. \quad (2-26)$$

According to (2-26), consumers depend on the annuity value of wealth. The marginal

¹² This is the result of imposing the stability condition in the solution.

propensity to consume out of wealth is constant and equals the foreign interest rate.

Accordingly, the optimal saving becomes:

$$s_t = f(k_t) - \rho \int_0^{\infty} e^{-\rho(\tau-t)} \{f(k_t) - i_t[\cdot]\} d\tau. \quad (2-27)$$

According to equation (2-27):

- (i) Saving is high when current output is high relative to future expected output.
- (ii) Saving is independent of the level of debt since the increase in debt leads to a reduction in income of $\rho \cdot d(d)^{13}$ and a reduction in consumption of $\rho \cdot d(v) = \rho \cdot d(d)$. Thus, the change in saving equals zero.

Since, $\dot{d}_t - \rho d_t = c_t + i_t[\cdot] - f(k_t)$, thus,

$$\dot{d}_t = i_t[\cdot] - s_t. \quad (2-28)$$

The current account deficit equals investment minus saving. Neither investment nor saving is affected by the stock of debt. The current account is also independent of the stock of debt.

¹³ First d is the sign of the differentiation.

Steady State and dynamics of consumption, net output, trade and current accounts:

Figure (2-1) shows the path of net output $f(k_t) - i_t[.]$ increases over time as the capital stock increases to its steady state level.

Figure 2-1: Steady state per capita debt d^* is positive and such that ρd^* is equal to AB . The present discount value of current and future trade surpluses is zero. The discount values of the two areas DCN and ANB must be equal and opposite in sign.

According to figure (2-1), the per capita net output $[f(k_t) - i_t(1 + \tau(i_t/k_t))]$ ray increases by diminishing rate. If net output is less than consumption, the country will borrow to finance the gap. Debt accumulates during this phase. On the other hand, if net output exceeds consumption, the trade balance shows surplus and the country will offset the trade surplus by interest payments.

The steady state level of per capita debt d^* is positive,

$$\rho d^* = AB = x. \quad (2-29)$$

Where, x is the trade surplus.

Steady state and dynamics of investment and capital:

$$\rho = f'(k_t) + q_t \quad (2-30)$$

Equation (2–30) is the capital market equilibrium condition.

ρ is the return on asset, $f'(k_t)$ is the dividends on the ownership of capital, and q_t is the capital gain.

When $q_t = 0$, then,

$$\rho = f'(k_t) \quad (2-31)$$

Equation (2-31) is just the static condition. For optimal capital stock, marginal product of capital equals interest rate.

To linearize this system of equations,¹⁴ we take first order Taylor series approximation of $k_t(q_t, k_t)$ and $q_t(q_t, k_t)$.¹⁵ This leads to:

¹⁴ See the Appendix for more detail.

¹⁵ See the Appendix for more detail.

$$k_t(q_t, k_t) = k^* \phi'(q^*) (q_t - q^*), \quad \phi'(q^*) > 0, \quad (q_t - q^*) > 0. \quad (2-32)^{16}$$

and,

$$q_t(q_t, k_t) = \rho(q_t - q^*) - f'(k^*)(k_t - k^*), \quad f'(k^*) < 0, \quad (k_t - k^*) > 0. \quad (2-33)^{17}$$

In the steady state both $\dot{k}_t = 0$ and $\dot{q}_t = 0$.

Figure (2-2) shows the phase diagram that summarizes this mechanism:

Figure 2-2: Dynamics of investment and capital and the saddle path.¹⁸

In the steady state, $\dot{k}_t = 0$. When we move to the right of the horizontal axis, the movement is positive as long as the shadow value of the capital stock is higher than the

¹⁶ When $(dk_t/dt = 0)$, then $q_t = q^* = 1$.

¹⁷ When $(dq_t/dt = 0)$, $\rho(q_t - q^*) = f'(k^*)(k_t - k^*)$. This equation leads to: $\rho q_t - \rho q^* = f'(k^*)(k_t - k^*)$, $q^* = 1$. Thus, $q_t = (1/\rho) [f'(k^*)(k_t - k^*)] + 1$. Thus, $dq_t/dk_t = (1/\rho)f'(k^*)$, $f'(k^*)$ is negative. See Appendix 4 for a numerical solution for q_t .

¹⁸ At E, both $dk_t/dt = 0$ and $dq_t/dt = 0$, $q_t = q^* = 1$. From, $q_t = (1/\rho)(f'(k^*)k_t - (1/\rho)(f'(k^*)k^* + 1)$, thus, $(1/\rho)(f'(k^*)k_t = (1/\rho)(f'(k^*)k^* + 1)$, thus, $k_t = k^*$. Again, at E, $q_t = q^* = 1$ and $k_t = k^*$.

purchase price of the capital stock. We move in the opposite direction if the shadow value of the capital stock q_t is less than the purchase price of the capital stock.¹⁹

The existence of the installation cost for investment guarantees this movement because with no installation cost for investment, the shadow value of the capital stock will equal just the purchase price of the capital stock, whether in the momentary equilibrium or in the steady state.²⁰ On the other hand, the movement will be in different directions for k_t when the movement in the shadow value of the capital stock q_t equals zero in the steady state. Thus, the saddle path ss is a saddle arm.

¹⁹ From $(q_t - 1) = (1/\rho) f''(k^*) (k_t - k^*)$, where q_t is the shadow value of capital stock while 1 is the purchase price of capital stock. $q_t > 1$, $k_t > k^*$. $q_t < 1$, $k_t < k^*$. $q_t = 1 = q^*$, $k_t = k^*$ at E . Numerically speaking, let $\alpha = 1/3$, $\rho = 0.05$, $k^* = 3$ (I use here same numbers as: Mehлум, ISSN: 0801-1117). I try here the following values for k_t [0 1 2 3 4 5 6]. By using those numbers for k_t , and by solving the differential equation (2-33) for q_t , the relevant q_t will take the following values: [3.4 2.6 1.8 1 0.2 -0.6 -1.4]. At E only, $k_t = k^* = 3$ and $q_t = q^* = 1$. See Appendix 4.

²⁰ See appendix 4 for full explanation.

2.4. The Transitional Dynamic of the Financial Embargo:

This section presents the analysis of the financial embargo. It analyzes the effect of both the permanent shock and the temporary shock. I discuss in section 2.4.1 the effect of an unanticipated permanent total interruption of the foreign borrowing. In section, 2.4.2, I discuss the effect of an anticipated permanent total interruption of the foreign borrowing. Finally, I discuss in section 2.4.3, the effect of the transitory total interruption of the foreign borrowing. Last, I apply the theoretical prediction on the case of South Africa in section 2.5. The main conclusion of the chapter will be presented in section 2.6.

2.4.1. The effect of an unanticipated permanent total interruption of foreign borrowings:

In this section, I discuss the effect of an unanticipated permanent total interruption of foreign borrowing assuming a small open economy with perfect capital mobility.

The scenario then will be as following:

Assume at the beginning that the economy is in the stable path. There exists perfect capital mobility. Per capita capital stock and per capita foreign debt are constant. Then, suddenly, lenders impose a financial embargo. More exactly, the foreign borrowing will be zero $b = 0$. In the transitional period, the investment will reduce from

$i_t[1+T(i_t/k_t)] = d + s_t$ to $i_t[1+T(i_t/k_t)] = s_t$. According to figure (2-3), the interruption of the foreign borrowing shifts $(dq_t/dt = 0)$ locus to the left since the shadow price of capital q_t is a function of the rate of investment²¹. The steady state of the economy shifts from E to E' . The new steady state per capita capital stock is lower than the initial steady state per capita capital stock. The new saddle path is SS' . With the initial capital stock given by k^* , the path of adjustment is composed of a jump at time 0 from E to A ²², and a movement over time from A to E' . The rate of investment is negative on the adjustment path²³, returning to zero as the economy moves to the new lower steady state per capita capital stock.

Intuitively speaking, the first jump from E to A is a result of receiving new information of a financial embargo at time 0. The shadow price of capital q_t decreases

²¹ $(dk/dt=0)$ locus is unaffected since the total interruption of foreign borrowing will affect directly the flow budget constraint. The first effect on investment is instantaneous, but the second movement of capital is gradual as a result of imposing the adjustment cost of capital in the analysis. See Blanchard and Fisher, 1996, p. 67. The change in investment does affect the $(dq/dt=0)$ locus, but does not affect the $(dk/dt=0)$ one.

²² This is because the interruption of the foreign borrowing will shift the economy to a new saddle path since $dd/dt = 0$ after imposing the embargo.

²³ Since $i_t=0$ when $q_t=1$. Thus, $i_t<0$, when $q_t<1$. The installation cost is equal to zero at $q_t=1$.

from E to A , investment ratio becomes negative. Capital decumulates since $k_t = i_t$. The marginal product of capital in production increases. At the same time, the marginal cost for disinvestment²⁴ decreases since the installation cost depends on the ratio of investment to capital. As a result, the shadow price of capital q_t increases along the adjustment path until it reaches 1 with the zero investment ratio at a new lower steady state of per capita capital stock.

Figure (2-3): The effect of a sudden permanent financial embargo shock on the dynamics of investment and capital.

Thus, a sudden permanent financial embargo leads to a permanent reduction in per capita capital stock and therefore per capita output must be at lower level in the new steady state.

On the other hand, according to figure (2-1), starting from a steady state, $\rho d = \rho d^*$. After imposing the embargo, the economy will stay at its steady state level of interest payments as long as the embargo is permanent. And since “the Euler equation²⁵ is

²⁴ See q_t equation and its interpretation.

²⁵ See the exposition of figure (3-8). I am using here same notations as Blanchard & Fischer (1996).

²⁵ $c./c = 0$ in this model because $\rho = r_w$.

derived from households' preferences without imposing their lifetime budget constraint²⁶, thus, households' preferences are unchanged by definition.”²⁷

²⁶ Note that the financial embargo affected the lifetime budget constraint.

²⁷ In addition, q_t does not depend on the characteristics of the utility function. Blanchard & Fisher (1995)

2.4.2. The effect of a fully anticipated permanent total interruption of foreign borrowings:

In this section, I discuss the effect of a fully anticipated permanent total interruption of foreign borrowing, assuming a small open economy with perfect capital mobility.

The scenario then will be as following:

The economy is in the stable path. There exists perfect capital mobility. Per capita capital stock and per capita foreign debt are constant. Lenders announce at time 0 that they will impose a permanent financial embargo on the target debtor country starting at time T , $T > 0$. More exactly, the foreign borrowing to the debtor will be fully stopped at time T . Thus, the embargo does not take place until time T .

The announcement will affect the future expected marginal product since it will affect the behaviour of the investors. From equation (2-19), we can figure out that the shadow price of capital q_t is equal to the present discounted value of the future marginal product. The lower the future expected marginal products, the lower are q_t and the rate of investment. The shadow price q_t decreases to the point B ,²⁸ which lies above the new saddle path ss' , and the rate of investment becomes negative. Per capita capital stock decumulates gradually since an installation cost for investment does exist. At time T , a financial embargo does take place with no information being received, since the embargo was announced before at time 0 without a further jump. The stable path subsequently relevant in q_t and k_t beyond time T is the path ss' , which passes through the point $k = k_c$ since the embargo is permanent. The expectation is going up along the new saddle path CE' in figure (2-4), and q_t is rising, until it reaches 1 when the rate of investment reaches zero in the new steady state with lower stock of per capita capital.

²⁸ Note that q_t does not jump directly to the new saddle path, as it did in the case of the sudden permanent shock. In the previous case, the interruption of the foreign borrowings directly affected the investment which reduces from investment = savings + foreign borrowing to investment = saving only, thereby leading to a new equilibrium status. However, in the current case, the effect on investment occurred through the effect on the future expected marginal products. Then, the arrival to a new saddle path will take a lag period and will occur only after the full interruption of foreign borrowings, i.e. at time T .

⁸² This is because the marginal product in capital increases and the adjustment cost decreases. See the mentioned equation.

Thus, a fully anticipated permanent financial embargo leads to a permanent reduction in per capita capital stock. Per capita output must be at a lower level in the new steady state.

Figure (2-4): The effect of a fully anticipated permanent financial embargo shock on the dynamics of investment and capital.

2.4.3. The effect of unanticipated temporary total interruption of foreign borrowings:

In this section, I discuss the effect of a temporary total interruption of foreign borrowing, assuming a small open economy with perfect capital mobility.

The scenario then will be as follows:

At the beginning, the economy is in the stable path. There exists perfect capital mobility. Per capita capital stock and per capita foreign debt are constant. Then, suddenly, lenders impose a financial embargo that is expected to be temporary. More exactly, the foreign borrowing will be zero for a determined period of time, after which targeting lenders will lift the embargo. Agents understand at time 0 that the change is only for the duration of the period $(0, T)$ so that at time $T > 0$, when lenders end the embargo, this action has been fully anticipated and there is no surprise. The analysis will include two types of financial shocks: first, a sudden financial embargo at time 0 for the duration of the period $(0, T)$, second, a fully anticipated lifting of the embargo at time T . As soon as the interruption of the foreign borrowing occurs, $(dq/dt = 0)$ locus shifts to the left since the shadow price of capital q_t is a function of the rate of investment. The stable path SS will also instantaneously and temporarily shift down to SS' . The shadow price q_t decreases to the point B , which lies above SS' .²⁹ The rate of investment becomes negative. Per capita capital stock decumulates and q_t begins to increase. The process follows the path BC in figure (2-5). At time T , when the financial embargo is lifted - with no new information being received since the time of lifting the embargo - no further jump will occur. The stable path relevant for subsequent adjustments in q_t and k_t beyond time T is the path SS , the original stable path. After time T , the q_t and k_t follow the stable path CE in figure (2-

²⁹ The choice of this point is illustrative only because the end of the embargo is controlled by the target's behaviour toward the targeting country's policy.

2.5: A Theoretical Prediction of the Effect of the 1986-1991 Financial Embargo on the Time Path of the Economic Growth Rate of South Africa:

In this section, I apply the theoretical prediction from previous theoretical analysis of the simple open economy version of the Ramsey growth model on the case of South Africa.

South Africa has had a long history with sanctions as a result of the apartheid system against African natives and Asian minorities. Sanctions were first imposed in 1944 by India as a result of apartheid against Indian minorities. In 1959, the International Confederation Free Trade Union imposed other sanctions against South Africa, also because of apartheid. Subsequently, sanctions against South Africa continued increasing in some years and vanishing in others.³¹ Comprehensive international economic embargoes were imposed against South Africa in mid-1985 and took effect in 1986. They were officially lifted in 1990, with the lifting taking effect in 1991.³²

These embargoes against South Africa were of various types, including a trade embargo, disinvestment, and a financial embargo. The trade embargo covered both exports and imports. Disinvestment covered new and existing foreign investment, while the financial embargo covered foreign borrowing to South Africa. The financial embargo on South Africa took the following forms:

- 1- Preventing South Africa from taking on any new debts;
- 2- providing South Africa with no payment assistance on existing debts;
- 3- preventing all international banks from opening transfers credits to the government of South Africa or to any institution associated with, or controlled by, South Africa; and

³¹ Lundahl (1992), pp. 191-195

³² Considering annual data

4- ensuring that all international banks and their affiliates close their branches in South Africa.³³

Disinvestment and the financial embargo are often grouped together under the terms “capital embargo,” which covers all types of foreign capital inflow to South Africa.

According to many researchers, “the embargo is complex and difficult to predict a priori.”³⁴ However, I believe that if we understand its nature, its effect will be more predictable. After reading many studies about South Africa, I can conclude that the embargo was a sudden action, despite having a long history in the country. Interest groups inside and outside South Africa served as an obstacle for collective international action against the government, until this became unavoidable in light of the ongoing campaigns against the country’s human rights violations. It is also considered to be a temporary embargo since the lift of the embargo was a function of changing the government’s behaviour and eliminating the apartheid system. Therefore, the end of the embargo could be predicted year after year. Thus, we can describe the embargo of 1986 to 1991 on South Africa as a sudden temporary embargo.

From figure (2-5) in section (2.4.3), we can derive the potential predicted effect of the temporary embargo of 1986-1991 on the time path of the economic growth rate of South Africa. Figure (2-6) illustrates the potential predicted effect of the embargo on the economic growth rate of South Africa as summarized in figure (2-5).³⁵

³³ Haider Ali Khan, 1989, pp. 66-69

³⁴ Kaempfer & Lowenberg (1986), p. 37

³⁵ See the explanation of the link between both figures (2-5) & (2-6) in Appendix 4.

Figure 2-6: A theoretical prediction of the effect of the temporary financial embargo of 1986- 1991 on the time path of the economic growth rate of South Africa.

Thus, according to the analysis of a sudden temporary embargo from a simple open economy version of the Ramsey growth model, we may predict that the financial embargo of 1986-1991 would have a temporary effect on the economic growth rate of the country. This result will be tested in chapter 3 by using an intervention model that captures the dynamic of the embargo of 1986-1991 on the economic growth rate of South Africa.³⁶

³⁶ I test here only the effect of the period of the multilateral embargo from 1986 to 1991 as an intervention dummy variable on the time path of the economic growth rate of South Africa. I use here a linear intervention analysis that deals with the embargo as an exogenous dummy variable.

2.6. The Main Conclusion of Chapter 2:

In this chapter, I examined the effect of imposing a full interruption of foreign borrowing on the dynamic of the economy by using a simple open economy version of the Ramsey model. The results show that if the financial embargo is permanent – whether it is unanticipated or fully anticipated - per capita capital stock will settle at a lower level in the long run. Per capita output $f(k_t)$ will settle down at lower level in the long run too. However, if the financial embargo is temporary, per capita capital stock and then per capita output will not be affected in the long run. On the other hand, there will not be any effect on the long run economic growth rate whether the shock is permanent or temporary.

We can predict from the above conclusion that the sudden temporary multilateral financial embargo imposed on South Africa from 1986 to 1991 would have affected the economic growth rate of the country in the short run only.

Chapter 3

The Effects of the 1986-1991 Financial Embargo in the Time Path of the Economic Growth Rate of South Africa: An Intervention Analysis

In this chapter, I test the theoretical prediction of the effect of the financial embargo of 1986-1991 on the time path of the economic growth rate of South Africa. I do this through the use of a linear intervention analysis that captures the dynamic features of the effect of the 1986-1991 embargoes as an exogenous intervention variable on the economic growth rate of South Africa.³⁷ My approach is fully parametric and my results indicate an evidence of negative temporary impact of embargoes on South Africa's economic growth. Any impact vanishes after the end of the embargo.

The remaining chapter is organized as follows. Section 3.2 contains data and discussion on attained data. Section 3.3 discusses the model. Section 3.4 presents the specification search and empirical results, and a discussion of the results. The main conclusion is presented in section 3.5.

³⁷ I use here an intervention analysis based on (a single-variable) ARMA model because my main variable is economic growth rate since my main goal is to examine the effect of the embargo on the economic growth rate of South Africa over time.

3.2 Data

I obtained South Africa data from 1960 to 2003 on the gross domestic product (GDP), and GDP deflator etc. from IMF's International Financial Statistics site.³⁸ From this data, I constructed the main variable in concern, *growth*.³⁹ This variable represents the economic growth rate of South Africa. My concern is to examine the effect of the financial embargo imposed on South Africa during the period of 1986 to 1991 on the time path of the economic growth rate of South Africa.

Table 3.2 shows additional detail for these data series and Figure 3.1 shows plots for the constructed variable over time.⁴⁰

³⁸ This is the most updated data, 2005.

³⁹ Y is the actual GDP of South Africa by millions of real Rand.

$growth = \log(y_t) - \log(y_{t-1})$, y is the per capita real GDP of South Africa by millions of real Rand.

⁴⁰ Looking at the time path of the economic growth rate of South Africa in figure 3-1, *growth*, one can observe that the growth rate is very cyclical and it is hard to observe a consistent structural break during the period of the multilateral financial embargo on South Africa. However, the researcher knows in priori that 1986-1991 is a period of multilateral financial embargoes on South Africa. Hence, the study analyzes the effect of this period on the time path of the economic growth rate of South Africa as an external intervention event. The researcher extends the analysis to control for the variability in the data series of *growth* in addition to some other variables that the researcher believes they may correlate with the main intervention variable.

3.3 The Model

In this study, I employ intervention model proposed by Ender, Sandler, and Cauley (1990) to study the impact of financial embargoes on the time path of the economic growth rate of South Africa. The most general model used in the study is given by the following Equation 3.1

$$Y_t = a_0 + A(L) Y_{t-1} + c_0 Z_t + B(L) \varepsilon_t \quad (3.1)$$

In Equation 3.1 Z_t is intervention variable that takes on the value of zero prior to and after the multilateral financial embargo in South Africa and unity during the sample period, and ε_t is white noise disturbance term. In addition, $A(L) [1 + a_1L + a_2L^2 + \dots + a_pL^p]$ and $B(L) [1 + b_1L + b_2L^2 + \dots + b_qL^q]$ are polynomials in lag operator L .

I tested the series of *growth* for possible existence of unit root using Phillips Peron Test. I did not find any evidence of unit root in the series of *growth*. I also tested the series of *growth* for presence of autoregressive conditional heteroskedasticity (ARCH) effects using the LM test for ARCH and the White Test. I did not find any evidence of conditional heteroskedasticity in the series of *growth*.⁴¹

⁴¹ The Correlogram of the series of growth from 1961 to 2003 did not show any evidence of correlation or partial correlation. I consider probability of Q -statistics at Maximum 5%. I am also aware of any evidence of correlation until prob. of Q -statistics 10%. At lag 1 only, the Prob. of Q -statistics is 0.078. I take this evidence in my account in my choice of the best fit intervention model.

3.4. Empirical Results

An extensive specification search was conducted for data series used for each model estimated in this study. I examined all possible parameterizations for ARMA model up to ARMA (3,3) as proposed by Lloyd (1983), but I estimate models beyond this parameterization using both SBC and AIC Criteria. I choose the versions selected by the minimum of both SBC criterion and AIC criterion.⁴²

My empirical analysis comprises of three periods:

- In the first period of my analysis, I use all available observations. Data span is from 1961 to 2003.
- In the second period, I exclude the period from 1961 to 1970 in order to control for any instability in this period.⁴³ The most glaring incident during the period of 1960th was the 1960 Sharpeville slaughter, during which the police fired into resistance fighters. It was at this time that the South African government abolished the African National Congress (ANC) and most of the African political parties, and exiled their members.

⁴² Each estimated model is estimated using least squares (LS). The following criteria were used to identify the best fit intervention model:

- It has the lowest Akaike Info Criterion (AIC) and Schwarz Criterion (SC). (Lloyd, 1993, P. 451),
- It has highest adj R^2 (Lloyd, 1993, P.451),
- It satisfies the following diagnostic checks (Enders, 1995):
 - “All coefficients should be statistically significant at conventional levels and the autoregressive coefficients should imply that the $\{y_t\}$ sequence is convergent.”
 - “The residuals should approximate white noise.”

My search for best-fit intervention model takes all above criteria into account.

⁴³ Different data reports give different results by including this period of analysis. By using the World Development Indicator, the best-fit intervention model gives an evidence that embargo has a negative but insignificant effect on the economic growth rate of the country in the first period of analysis. However, by using data from the IMF's Financial Statistics report, the best-fit intervention model gives an evidence of a negative significant effect of the embargo on the economic growth rate of the country. I have included the results of the second report because its data span is longer and all data checks give better results than the first report. On the other hand, the empirical analysis is extended to control for any instability while I am using the entire data span. The results give same evidence by using both reports that the multilateral financial embargo imposed on South Africa from 1986 to 1991 has negative significant effect on the economic growth rate of the country. All best-fit intervention models exhibit convergence.

- In the third period of the analysis, I include data series starting in 1980. The period before 1980 has economic instability because of economic sanctions as well as Soweto uprising in South Africa.⁴⁴

I estimate all alternative intervention models for the series of growth. In these analyses I examine the effect of the 1986-1991 financial embargoes, as an external dummy variable, on the time path of the data series *growth*. Table (3.2) shows parameter estimates for *growth* by choosing the best fit intervention model in each period of analysis. From the results presented in Table (3.2), it transpires that the financial embargo of 1986-1991 has a negative significant effect on the time path of the economic growth rate of South Africa in all periods of analysis. From the features of the best-fit intervention models in table (3.1), I can conclude that the significant effect of embargo on the economic growth rate of South Africa is temporary since the models exhibits convergence. Figures 3-2, 3-3, and 3-4 illustrate the forecast of the best fit intervention model in each period of analysis.⁴⁵

⁴⁴ In each period of analysis, I checked data series again for data stationary or for any evidence for heteroscedasticity. I did not find any evidence for unit root or heteroscedasticity in any period of analysis.

⁴⁵ By using data series from the World Development Indicator, 2003, when I controlled for the instability period of Soweto uprising only embargo had a negative and significant effect on the time path of the *growth*. The second period of analysis also gave an evidence of a relatively significant effect of the embargo on the economic growth rate of South Africa. In order to confirm my results, I had to extend my analysis in order to control for the instability while I am using the entire data span from 1961 to 2003 IMF's International Financial Statistics which is the longest consistent data I found.

Extension:

I modified the model given in Equation (3-1) to incorporate the effect of 3 more dummy variables; *PINST*, *REACTION*, and *TARGET1* incorporated in an instrument *I*.⁴⁶ This way enables me to use all available observations without excluding unrest periods. In addition, it controls for the effect of other dummy variables correlated with the financial embargo on South Africa. The modified model is presented in Equation (3-2) below.⁴⁷

$$Y_t = a_0 + A(L)Y_{t-1} + c_0 Z_t + d_i I_i + B(L) \varepsilon_t \quad (3-2)$$

Where,

PINST is a dummy variable that takes on the following values:

1. The value one if there are observed political problems or observed political instability.
2. The value two if there is a stable state of political status, and
3. The value three if there is an observed internal political reform.

REACTION is another dummy variable that takes on the following values:

1. The value one if there is any trial for financial circumventions as a reaction of the financial embargo,

⁴⁶ I use here for my regression TSLS and ARMA. See EVIEWS (4.3) for the technical reasons of using this method of regression with the above model (3-2).

⁴⁷ See the appendix for the constructed variables.

2. The value two if there is any trial for other economic circumventions as a reaction to the international economic sanctions, and
3. The value three if there is no internal reaction.

TARGET1 is another dummy variable takes on the following values:

1. The value one if there are comprehensive international sanctions,
2. The value two if there is only a financial embargo, and
3. The value three if there are no sanctions imposed on South Africa.

I constructed these three variables depending on the political economic analysis of Martin (1992).⁴⁸

Incorporating the dummy variable, *PINST* controls for the political instability without excluding the period before 1980. Incorporating the second dummy variable, *REACTION* controls for any internal reaction has been taken by the government of South Africa as a result of imposing international sanctions. Incorporating the third dummy variable *TARGET1* separates the effect of the financial embargo from other types of embargoes.

The result of the best fit intervention model concludes again that the financial embargo has a significant effect on the economic growth rate of South Africa in the short run only. The first model in table (3-3) illustrates this result.

I repeated same analysis by incorporated *TRADESHARE* to the above instrumental list as a proxy for the degree of openness of the country. Where,

⁴⁸ See Martin (1992). She determines in her study the main elements of the cooperation in imposing an international sanction against a target. Her study has a different goal and she uses a different method; however, I use her way of constructing her dummy variables in combination with Lee (1995) in order to construct the model given in equation 5-3.

TRADESHARE is a quantitative variable that measures the real value of South Africa's foreign trade to its real GDP. I also incorporated the economic growth rate of USA *GROWTH_{USA}* (and - or without the foreign lending rate *FOREIGNRATE*)⁴⁹ to the above instrumental list as a proxy for world demands. Having known the fact that the world demand - and the foreign trade in general - is a significant factor in the South African economy, incorporated any of them (or any combination of them) in the above instrumental list may control partially for the cyclical movement in the data series of the economic growth rate of South Africa and isolate - with the rest of variables incorporated in I_t - the effect of the multilateral financial embargo on the time path of the economic growth rate of South Africa.

The result of the best fit intervention model concludes again that the financial embargo has a significant effect on the economic growth rate of South Africa in the short run only. The second model in table (3-3) illustrates this result.

Accordingly, I can conclude that the embargo imposed on South Africa from 1986-1991 has a temporary negative significant effect on the economic growth rate of the country.

⁴⁹ I use here foreign lending as a proxy to world interest rate.

3.5. The Main Conclusion of Chapter 3:

In this study, I am employing intervention analysis in order to examine the effect of the financial embargo of 1986 – 1991 on the time path of the economic growth rate of South Africa.

My results provide strong evidence for the fact that the economic financial embargo on South Africa had a temporary negative effect on its economic growth rate.

Tables and Figures

Table 3-1: Raw data of South Africa's GDP, GDP deflator, and population (1960 – 2003):
IMF's International Financial Statistics Site

	GDP	GDP deflator	Population
1960	5258	1.9	17.4
1961	5535	2	17.85
1962	5898	2	18.32
1963	6539	2	18.81
1964	7197	2.1	19.31
1965	7859	2.1	19.83
1966	8568	2.2	20.37
1967	9559	2.3	20.92
1968	10340	2.4	21.48
1969	11654	2.6	22.06
1970	12791	2.7	22.66
1971	14136	2.8	23.27
1972	15953	3.2	23.89
1973	19740	3.7	24.52
1974	24277	4.3	25.16
1975	27323	4.8	25.8
1976	30848	5.3	26.45
1977	34261	5.9	27.1
1978	39416	6.6	27.75
1979	47100	7.57702	28.43
1980	62730	9.5	29.14
1981	72654	10.4	29.88
1982	82462	11.9	30.65
1983	94350	13.8	31.43
1984	110584	15.4	32.22
1985	127598	17.9994	33
1986	149395	21.1	33.77
1987	174647	24.1	34.52
1988	209613	27.8	35.28
1989	251676	32.6	36.05
1990	289816	37.6	36.85
1991	331980	43.6	37.67
1992	372225	49.9	38.51
1993	426133	56.4406	39.34
1994	482120	61.9	40.16
1995	548100	68.2	40.93
1996	617954	73.7	41.66
1997	685730	79.7	42.33
1998	742424	85.8	42.96
1999	813683	91.9	43.51
2000	922148	100	44
2001	1020010	107.7	44.42
2002	1164940	118.7	44.76
2003	1251470	124.1	45.03

Source: IMF's International Financial Statistics site, 2005

Notes on Table 3-1:

$growth = \ln(y) - \ln(y)_{-1}$, Where growth is the economic growth rate of South Africa

$y = Real\ GDP / Population$, Where y is the per capita real GDP.

$Real\ GDP = (Nominal\ GDP / GDP\ deflator) * 100$, $Year_{2000} = 100$

Data are by millions of Rand and populations are by millions. (All previous studies mentioned in the thesis use data by millions of Rand).

Table 3-2: Parameter Estimates for a Best Fit Intervention Model for *growth* in three different periods of analysis.

	<i>growth (1965-2003)</i>	<i>growth (1975-2003)</i>	<i>growth (1984-2003)</i>
Method of Estimation	LS	LS	LS
Model Parameterization	(2,2)	(4,0)	(4,0)
C	0.004514 (0.0674)	0.004583 (0.1998)	0.008864 (0.0572)
emb_t	-0.022648 (0.0131)	-0.023681 (0.0151)	-0.029490 (0.0062)
$growth_{t-2}$	0.456291 (0.0006)		
$growth_{t-4}$		-0.403625 (0.0194)	-0.398383 (0.0426)
ε_{t-2}	-0.925542 (0.0000)		
Adj R^2	0.325199	0.146405	0.174173
AIC	-4.713476	-4.679373	-4.766489
SC	-4.542854	-4.537929	-4.617129

Notes on Table 3-2:

1. Model 1 is $Y_t = a_0 + A(L)Y_{t-1} + c_0 emb_t + B(L) \varepsilon_t$, where $Y_t = growth$, $growth = \ln(\text{per capita real GDP}_t) - \ln(\text{per capita real GDP}_{t-1})$.

Data span (1965-2003)

2. Model 2 is $Y_t = a_0 + A(L)Y_{t-1} + c_0 emb_t + B(L) \varepsilon_t$, where $Y_t = growth$, $growth = \ln(\text{per capita real GDP}_t) - \ln(\text{per capita real GDP}_{t-1})$.

Data span (1975-2003)

3. Model 3 is $Y_t = a_0 + A(L)Y_{t-1} + c_0 emb_t + B(L) \varepsilon_t$, where $Y_t = growth$, $growth = \ln(\text{per capita real GDP}_t) - \ln(\text{per capita real GDP}_{t-1})$.

Data span (1984-2003)

4. p -Values for each parameter estimate are given in parenthesis below each statistic.

5. Q -statistic tests did not show any evidence for autocorrelation or partial correlation in residuals.

6. Method used for regression: LS for all above models.

Table 3-3: Parameter Estimates for a Best Fit Intervention Model for *growth*. Method of Estimation: TSLS. Sample period: 1965-2003

Model Parameterization	(2,2)	(2,2)
C	0.008 (0.002)	0.008 (0.002)
emb_t	-0.038 (0.001)	-0.037 (0.000)
$growth_{t-2}$	0.425 (0.003)	0.425 (0.003)
ε_{t-2}	-0.919 (0.000)	-0.919 (0.000)
Adj R^2	0.261	0.265

Notes on Table 3-3:

1. Model 4 is $Y_t = a_0 + A(L)Y_{t-1} + c_0 emb_t + d_i I_i + B(L) \varepsilon_t$, where $Y_t = growth$, $growth = \ln(\text{per capita real GDP}_t) - \ln(\text{per capita real GDP}_{t-1})$. Instrument list: *PINST*, *REACTION*, & *Target1*. EViews adds automatically lagged dependent variable and repressors to instrument list. Data span (1965-2003)

2. Model 5 is $Y_t = a_0 + A(L)Y_{t-1} + c_0 emb_t + d_i I_i + B(L) \varepsilon_t$, where $Y_t = growth$, $growth = \ln(\text{per capita real GDP}_t) - \ln(\text{per capita real GDP}_{t-1})$. Instrument list: *PINST*, *REACTION*, *Target*, and *growthUSA*. Adding foreignrate or (and) trade share to the instrumental list didn't have any significant change on the result. Data span (1965-2003)

3. p -Values for each parameter estimate are given in parenthesis below each statistic.

4. Q -statistic tests did not show any evidence for autocorrelation or partial correlation in residuals. I accept prob. at maximum 0.05 to check for all possible lags using Q -statistic tests.

Figure 3-1- a. Plot showing behaviour of the variable *growth* over time. Where, *growth* is the economic growth rate of South Africa.

Data Span (1961-2003) - Raw data are obtained from IMF's Financial World Statistics, 2005

Figure 3-1-b. Plot showing behaviour of the variable $GROWTH_{USA}$ over time. Where, $GROWTH_{USA}$ is the economic growth rate of USA .

Data Span (1961-2003) - Raw data are obtained from IMF's Financial World Statistics, 2005

Notes on Figures 3-1-a & 3-1-b: The cyclicity of the time path of the economic growth rate of South Africa does not show a specific concern regarding the period of the multilateral embargo. However, the author knows in priori that the period of 1986 – 1991 is the period of the multilateral embargo and hence we examine its effect on the entire time path of *growth*. Figure 3-1-b illustrates the time path of the economic growth rate of USA for comparison reasons.

Figure 3-2 Plot showing forecast of best fit intervention model for *growth* over time.
Model 1: Effects of Embargos on Economic Growth: Evidence from South Africa Time Series - Data span (1965-2003)

Figure 3-3 Plot showing forecast of best fit intervention model for *growth* over time:
Model 2: Effects of Embargoes on Economic Growth: Evidence from South Africa Time Series - Data span (1975-2003)

Figure 3-4 Plot showing forecast of best fit intervention model for *growth* over time:
Model 3: Effects of Embargos on Economic Growth: Evidence from South Africa Time Series - Data span (1984-2003)

The Main Conclusion of the First Part

My main goal in this study was to examine the effect of the financial embargo imposed on South Africa during the period 1986-1991 on the time path of the economic growth rate of the country. Theoretically, I have used the simple open economy version of the Ramsey growth model to predict the effect of the 1986-1991 financial embargoes on the time path of the economic growth rate of South Africa. Then I tested this prediction by using a linear intervention analysis that considers the embargo as an exogenous intervention variable.

Both the theoretical analysis and the empirical study consistently examine the shock of the embargo exogenously on the time path of the economic growth rate of South Africa. Both studies conclude that the financial embargo that was imposed on South Africa from 1986 to 1991 had no permanent effect on the economic growth of the country.⁵⁰

⁵⁰ Yet, the pattern of the transitional dynamic of the effect of this shock on the time path of the economic growth rate is inconsistent in both the theoretical and the empirical studies. Consider here the difference in the nature of both studies. See Appendix 4. Yet, the main conclusion in both studies is still that the financial embargo has no permanent effect on the economic growth rate of the country. This result satisfies the reality because time proved that this embargo had no permanent effect on the economic growth rate of South Africa. "Apart from any controversial views, the average of the economic growth rate during the 7-year period of the multilateral sanctions from 1985 to 1991 was 0.03, while the average of the economic growth rate during both the 7-year period preceded and the 7-year period followed the period of the multilateral embargo was 0.12 and 0.11 consequently which proves that the effect of this embargo was temporarily", Mohamed Ghada (April, 2006), the sanctions on South Africa: A successful story, the center for international relations, CIR, VA, USA.

Extension: Second Part

Was the Financial Embargo on South Africa Effective?

This study presents a simple open economy version of Ramsey's model within a political context, taking into consideration the main elements of the apartheid system that was in effect in South Africa for a long time. This is in response to the question of the extent of the effectiveness of the international financial embargo in achieving its desired goal, which was the lifting of the apartheid system. The research concludes that there was an inverse relationship between the degrees of the response of the financial sanction as an international reaction to the human rights violations of the apartheid system on the one hand, and on the interest rate on the other. This provides a new interpretation for the outflow of capital from South Africa during the economic blockades. In line with the assumptions of the model, whites – the group with the capital – were the most affected by the blockade, with their income being directly affected by the imposition of the financial embargo. This indicates that the financial embargo was effective in achieving its desired goal, namely the exertion of pressure on the economic sector to lift the apartheid system. In addition, this research presents a simplified empirical study that concludes by reiterating the results of the theoretical study: that the financial embargo that was imposed on South Africa between 1986 and 1991 was effective in achieving its desired goal.⁵¹

⁵¹ Mohamed, Ghada (2005), Ramsey growth model in a political framework, the global conference of business and economics (GCBE), Oxford, UK (Conference proceeding)

This study is divided into two main chapters. The first presents a theoretical study of the simple open economy version of Ramsey's model within a political context, concluding that whites controlled the economy and were the decision makers, in accordance with Kaempfer and Lowenberg's description of apartheid in South Africa. They were also the holders of capital and skilled labour, since they had available to them levels of education and training that did not exist for the black unskilled workers, who lived in isolated areas according to the laws of apartheid. In response to this political situation with its lack of application of the principles of human rights, the world realized that it was necessary to join forces on an international scale in order to exert economic pressure on the South African government and lift the apartheid system. I will attempt in the following to respond to a question on which researchers have differed: whether the financial embargo of 1986-1991 was successful in ending the apartheid system in South Africa.⁵²

My theoretical analysis is divided into two parts, each focusing on a central assumption. The first analysis assumes as its premise that the financial embargo was a proportional tax on foreign borrowings to South Africa, and concludes that the extent of the effect of the embargo depends on the model variables. As for the second analysis, it takes into account the variable of apartheid, and connects the financial embargo with this variable. It assumes that the embargo is a constant tax on foreign borrowings to South Africa. This embargo changes according to

⁵² In this research, I try to insert a political variable into a simple dynamic macroeconomic model which is not a new issue itself but the new issue here is interpreting the results in line with the proposed assumptions in the selected model in addition to the new nature of the model. I do not claim here that my model presents exactly the real life in South Africa. I try only to build my assumptions depending on the description of some analysts - I do not manage here to analyze deeply the case of South Africa from any political perspectives. My main contribution here is to add more features to an existing model which can establish a new simple model that may trigger more complicated realistic models in the same topic.

apartheid, so that the extent of its imposition increases as the violations of human rights increase, and decreases and halts as the apartheid system is lifted.⁵³ The analysis concludes that the response of the financial embargo to the apartheid system directly affects the interest rate, seen to be the domain of the capitalist white sector that is affected by the continuation or the lifting of the apartheid system. This relationship between the extent of the embargo and the interest rate is negative, since the interest rate decreases as the extent of the embargo increases. This can then explain the outflow of capital from South Africa through the period of international financial embargo. In short, the analysis concludes that the financial embargo was effective in pressuring the white group; therefore its implement can be considered to have been effective in changing South Africa's behaviour in favour of the nations imposing the blockade.

The second chapter of the research is an empirical study, the goal of which is to respond to the same question of the study: to what extent was the financial embargo effective in realizing its goals? Here I use a LOGIT analysis, in order to study the effect of the surrounding political environment on the strength or weakness of the apartheid system throughout the financial embargo period. Here I am juxtaposing the financial embargo as an external variable on the one hand, and the degree of the observed human rights violation as an internal variable on the other, in order to arrive at the politicization of the financial embargo as an economic variable. I conclude that there was in reality a moral relationship between the degree of the observed human rights violation as a measure of the apartheid variable and the extent of the imposition of the financial embargo on

⁵³ This is an assumption for simplification.

South Africa, which indicates that my assumption is correlated with the political environment of apartheid.

After this, I will study the effect of South Africa's political environment (leading to the imposition of embargoes) on the country's net foreign borrowings, using a time series intervention analysis. My results from this conclude that the lifting of apartheid and the embargo both led to an increase in the inflow of capital to South Africa confirming the results of the theoretical study in this chapter. Just as the theoretical analysis was dynamic, so was the empirical one, as exemplified in the intervention analysis, which captures the dynamic features of apartheid and the embargo on the net foreign borrowing over time.

For this reason, I believe that my study here is an addition to previous writings on the work that deal with this question. My study on the embargo, for example, differs from the theoretical one of Kaempfer & Lowenberg in that it presents a dynamic analysis. By neglecting to take into consideration the role of capital motion in the economy, and dealing only with the short term production function. On the other hand, Kaempfer & Lowenberg's work can be seen to be a more complex study with regard to the political angle, since it deals separately with analyzing the situation of the whites and interest groups, whereas my study does not differentiate between the two, considering them a unified whole for the sake of simplification. But I consider my study to rely on that of Kaempfer & Lowenberg with regard to the main aspects of apartheid. However, my choice of production function differs from that of previous studies on this subject, since I relied in its logic on basic endogenous growth models in the extent that skilled labour is human capital, and I rely in its formula on neoclassical growth models.

In order to examine the subject, I discuss in the second chapter after the introduction the theoretical analysis, then the empirical analysis. This research ends with my conclusions on the subject.

Chapter 4

Theoretical Analysis

A Simple Open Economy Version of Ramsey Growth Model In a Political Framework

In this chapter I discuss the framework of the model, the optimal solution, and discussions on the optimal solutions. I discuss first the model framework in section 4.2. In section 4.3, I discuss the optimal solutions. The main conclusion of the theoretical analysis will be presented in section 4.4.

4.2. The Model Framework:

Assuming that firms produce a single commodity Y by means of human capital; skilled labour; whites N_W , and raw labour; unskilled labour; blacks N_B .

The technology is Cobb-Douglas with constant return to scale:

$$Y = (AK)^\alpha (N_B)^{(1-\alpha)}. \quad (1)$$

Where AK is white labour or human capital N_W , N_B is black labour or unskilled labour, and A is the factor of productivity. I eliminate the subscript t (time) to save notations.

I assume that A is constant for two reasons: 1- to simplify the analysis, 2- to maintain the fundamental features of a neoclassical production function.

Whites own the entire capital in this economy. I also use a strong assumption that each white owns a unit of AK .

In an open economy version, domestic output can be devoted to:

$$Y = C + I + X \quad (2)$$

Where C is consumption, I is domestic investment, and X is net exports.

No depreciation to simplify the analysis. I assume also that there is no adjustment cost for investment to simplify the analysis.

Investment I , adds to the capital stock K , which owns by whites N_W only.

$$\dot{K} = I \quad (3)$$

The dot over the variable denotes time derivative.

Consider a financial embargo in which sanctions M impose on foreign borrowing:

$$M = m B, \quad m < 0 \quad (4)$$

Where m is the degree of the embargo, m equals zero in peace times, equals -1 in war times – which is not our case - and it ranges between zero and -1 in hostility times. The value of m then depends on international relations issues.

Foreign borrowing adds to foreign debt D and the accumulation of foreign debt will be restricted by $(1-m)B$.

$$\dot{D} = B \quad (5)$$

On the other hand, foreign borrowing B equals interest payments on foreign debt $r_w D$ - net exports X ., assuming that the country in question is a debtor country.

$$B = r_w D - X \quad (6)$$

As long as $(1-m)$ of foreign borrowings is only available for the target country to borrow then the whole equation (6) will be also restricted by $(1-m)$.⁵⁴

The apartheid A adds to the sanctions M . More apartheid induces more international interventions to end the apartheid system.

⁵⁴ The restriction on foreign borrowing is added internally to the model. As long as the foreign borrowing is restricted to an economy, this economy will not accumulate same levels of debt over time as in the case with no restrictions and hence it will not accumulate same interest payments as in a case without restrictions on foreign borrowings. For that reason, both equations (5) & (6) are restricted in both sides by $(1-m)$.

$$\dot{M} = A \quad (7)$$

Labour force N includes both black labour and white labour,

$$N = N_W + N_B \quad (8)$$

Black labour grows at constant growth rate n_B ,

$$\dot{N}_B = n_B N_B \quad (9)$$

White labour grows at constant growth rate n_W ,

$$\dot{N}_W = n_W N_W \quad (10)$$

I assume also for simplicity that the total population growth rate is zero to simplify the analysis but the growth rate of each group of labour does not equal zero.

Firms maximize profits under perfect competition.⁵⁵ The marginal product of capital MPK determines the interest rate r , and the marginal product of labour MPN determines the wage rate w .

$$r = MPK = \partial Y / \partial K = \alpha (AK)^{\alpha-1} A N_B^{(1-\alpha)} = \alpha Y/K \quad (11)$$

⁵⁵ Firms maximize profits under perfect competition in terms of its economic perspectives. This assumption does not mean that the competition between black labor and white labor is considered here since both types of labor are considered heterogeneous labor.

And since whites own capital, thus, the return on capital is same as the return on white labour, then,

$$w_W = r \quad (12)$$

$$w_B = \partial Y / \partial N_B = (1 - \alpha) (N_W / N_B)^\alpha \quad (13)$$

Households maximize utility within an infinite horizon assuming that both blacks and whites have same consumption preferences to simplify the analysis while whites are the decision makers since they have the political power according to the apartheid system. The general optimal problem then takes the following formula:

$$\text{Max } U_0 = \int_0^\infty e^{-\rho t} \ln(c_t) \cdot dt \quad (14)$$

Subject to:

$$\dot{D} = C + I + \rho D - f(K) \quad (15)$$

$$M = mB, \quad m < 0 \quad (6)$$

$$\dot{K} = I \quad (3)$$

$$\dot{M} = \text{Apartheid}, \quad (8)$$

$$\lim_{t \rightarrow \infty} e^{-\rho t} D_t = 0 \quad (16)$$

$$\rho = r_w \quad (17)$$

ρ is constant rate of time preference. Equation (16) is the No-Ponzi Game condition, and equation (17) is the stability condition to guarantee a stable consumption path.⁵⁶

We can then express the model in per capita terms by dividing each variable by N .

⁵⁶ See Blanchard & Fischer (1996) and Carlberg (1997).

4.3. The Optimal Solutions

This problem will be solved under two main assumptions:

- 1- First assumption, we suppose that financial embargoes equal mB where m is the degree of the financial embargo. The range of m is from 0 to -1. Thus, sanctions M are considered to be a proportional tax of the foreign borrowings to South Africa.
- 2- Second assumption, we suppose that sanction is a constant tax that will be subtracted from foreign borrowings $(B - M)$, where M is sanction. In this case, I impose the apartheid variable A in the model internally since I assume that sanctions depend on *Apartheid*. More apartheid leads to more sanctions. For simplicity, I assume that this relationship between the apartheid and the sanction is linear; $M = aA$.⁵⁷ When apartheid reduces, M declines by a , where a is a constant factor. Thus, in the second assumption, I linked between an external variable⁵⁸ which is the sanction with an internal political variable which is the apartheid.

First Assumption:

$M_t = mB$, $m < 0$, thus,

$$H_t = [u(c_t) - \lambda_t \{c_t - mc_t + i_t - mi_t + \rho d_t - m\rho d_t - f(k_t) + m f(k_t)\} + \lambda_t q_t i_t] e^{-\rho t} \quad (18)$$

⁵⁷ For convenience, let $M = aA$, and $dM/dt = A$, then $(dM/dt)/M = 1/a$.

⁵⁸ I mean by external variable, a variable that hits the country from outside.

Second Assumption:

$$H_t = [u(c_t) - \lambda_t \{c_t + i_t + \rho d_t - f(k_t) + M_t\} + \lambda_t q_t i_t + \lambda_t g_t A] e^{-\rho t}, \quad (19)$$

The Solutions with assuming the first assumption:

Necessary and sufficient conditions:

$$(i) \partial H_t / \partial c_t = e^{-\rho t} u'(c_t) - \lambda_t e^{-\rho t} (1-m) = 0 \quad (20)$$

Therefore,

$$u'(c_t) = \lambda_t (1-m), \quad (21)$$

The shadow value of foreign debt λ_t less the degree of the financial embargo times the shadow value of foreign debt $m \lambda_t$ equals the marginal utility of consumption $u'(c_t)$.

Thus,

$$c_t = 1 / [\lambda_t (1-m)] \quad (22)$$

$$(ii) \partial H_t / \partial i_t = -e^{-\rho t} \lambda_t \{1-m\} + e^{-\rho t} \lambda_t q_t = 0, \quad (23)$$

This equation leads to equation (24)

$$q_t = (1-m), \quad m < 0 \quad (24)$$

The shadow value of the capital stock q_t equals 1 minus the degree of the financial embargo m . If the degree of the financial embargo is zero then the shadow value of the capital stock will equal 1 and the investment will be zero.

$$(iii) \partial (-\lambda_t e^{-\rho t}) / \partial t = -\partial H_t / \partial t = \lambda_t e^{-\rho t} \rho (1-m) \quad (25)$$

This equation leads to equation (26)

$$\dot{\lambda}_t / \lambda_t = \rho m, \quad m < 0. \quad (26)$$

This is a difference equation. Its solution with combination of equation (22) leads to equation (27):

$$c_t = e^{-(\rho m)t} c_0, \quad m < 0. \quad (27)$$

By integrating the dynamic budget constraint, we get the following intertemporal budget constraint:

$$c_0 (1-m) / \rho = \int_0^{\infty} e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] . dt - d_0, \quad (28)$$

Where $(f(k_t) - i_t)$ is net output. The growth rate of consumption is illustrated in equation (29).

$$\dot{c}_t / c_t = \rho m, \quad m < 0. \quad (29)$$

If the degree of the financial embargo $m = 0$, the growth rate of the consumption will equal zero as well and consumption will be constant. According to equation (29), the degree of the financial embargo times the foreign interest rate affects the growth rate of consumption. I found this result because I imposed the financial embargo directly in the dynamic budget constraint. Then with imposing a financial embargo, consumption grows from by zero rates to ρm rate, $m < 0$. The plausible interpretation

for this result is that consumption is high today because it is cheap to borrow and falls over time.

The optimal saving becomes:

$$S_t/N_t = f(k_t) - \{ e^{-(m\rho)t} \{ [\rho/(1-m)] \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] . dt \} + (\rho m/(1-m)) d_t \} \quad (30)$$

If the degree of the financial embargo is zero, the optimal saving will not depend on the level of the foreign debt in this model and q_t will equal 1 and hence i will equal zero. According to equation (30), the change in the optimal saving with respect to the level of debt will equal $\rho m/(1-m)$. Thus, if d changes by 1, optimal saving will change by $\rho m/(1-m)$, $m < 0$.

$$(v) \partial(\lambda_t q_t e^{\rho t}) / \partial \alpha = -\partial H_t / \partial K_t = -e^{-\rho t} \lambda_t f'(k_t) + e^{-\rho t} \lambda_t m f'(k_t), \quad (31)$$

Equation (31) will lead to equation (32).

$$f'(k_t) = \rho - \rho m, \quad m < 0. \quad (32)$$

If the degree of the financial embargo is zero, the result will be just the static equilibrium condition.

According to equation (32), when the degree of the financial embargo increases, the return on capital decreases and capital outflows of the country.⁵⁹ This result may prove Walt and Wet conclusion that huge capital outflows of South Africa during the period of imposing the embargo. Note also that the wage rate of white people will be affected according to the assumptions of the model since they own the capital stock. Thus, imposing such a financial embargo will affect directly the white's income.

Let us apply now the second assumption:

We will have same optimal solutions as above assuming that $m = 0$. In addition, we will have the following additional equations:

Interest groups will benefit from maximizing the Apartheid since it gives them more power in the economy.⁶⁰

$$(iv) \quad \partial H_t / \partial (A) = -e^{-\rho t} \lambda_t a + e^{-\rho t} \lambda_t g_t = 0 \quad (33)$$

Equation (33) leads to the following result:

$$g_t = a, \quad (34)$$

Where $a = dM / dA$, when apartheid increases, sanctions increase by a . According to (34), the shadow cost of the apartheid g_t equals the responsiveness of sanctions to the apartheid system a . If the responsiveness of the international sanctions to the apartheid is zero, then the shadow cost of the apartheid becomes zero. We assume that a is a constant factor for simplicity.

$$(iiv) \quad \partial (\lambda_t g_t e^{-\rho t}) / \partial t = -\partial H_t / \partial M_t = e^{-\rho t} \lambda_t. \quad (35)$$

⁵⁹ This is because the domestic capital return will be less than the foreign capital return when m increases.

⁶⁰ I assumed in the model that interest groups are the whites for simplicity.

By solving equation (35) with the combination of equation (34) and equation (32) with $m=0^{61}$, we attain the following final result in this model:

$$f'(k_t) = 1/a \quad (36)$$

Equation (36) is a very important result. According to the assumptions of the model, the marginal product of capital $f'(k_t)$ equals the wage rate of whites. According to this result, when the responsiveness of the financial embargo to the apartheid increases (when the cost of the apartheid increases,) the wage rate of whites decreases. On the other hand, the reduction of the capital return inside the country will make the domestic environment less attractive for investment. Capital will outflow of the country. This result proves again that the embargo was very effective weapon since it hit directly white's power or income. It explains also the relationship between the responsiveness of sanctions to Apartheid and the capital outflow during the time of imposing the sanction.

⁶¹ We solve here under the second assumption in which $m = 0$ and sanction is considered a constant tax on foreign borrowings. The solution will lead to that $f'(k_t) = \rho$ in which the interest rate equals marginal product of capital.

4.4. The Main Conclusion of Chapter 4

The analysis concludes that the response of the financial embargo to the apartheid directly affects the interest rate, seen to be the domain of the capitalist white sector that is affected by the continuation or the lifting of the apartheid system. This relationship between the extent of the embargo and the interest rate is negative, since the interest rate decreases as the extent of the embargo increases. This can then explain the outflow of capital from South Africa through the period of international financial embargo. In short, the analysis concludes that the financial embargo was effective in pressuring the decision makers; therefore the embargo can be considered to have been effective in changing South Africa's behaviour in favour of the nations imposing the blockade.

Chapter 5

The effectiveness of the Multilateral Financial Embargo On South Africa: Empirical Investigation

In this chapter I test the following two main hypotheses:

- 1- The first hypothesis is that there is a link between the degree of the observed human rights violations in South Africa and the degree of the embargo.⁶² The first null hypothesis then is that: sanctions are not a function of the degree of the observed human rights violations.
- 2- The second hypothesis is that the financial embargo of 1986-1991 is the main explanation of the capital outflows during the embargo. Thus, the second null hypothesis is that the financial embargo does not have a significant negative effect on the foreign capital flows.

I use two different techniques in order to employ my analysis; LOGIT analysis to test the first hypothesis and an intervention analysis to test the second hypothesis.

I use quarterly data from 1960, 1 to 2004, 1 from the International Financial Statistics (IMF) (2004) on line. I rely in my description for all dummy variables on studies of Levy (1999), Trade Policy Review (1993), Lipton (1988), Hufbauer, Schott, and Elliott (1990), and other on-net sources.

In section 5.2, I discuss the first technique and its results. In section 5.3, I discuss the second technique and its results. Finally, the final conclusion of the chapter and the research will be presented in section 5.4.

⁶² I measure here the apartheid by periods of observed human rights violations.

5.2. The Responsiveness of the Embargo to the observed degree of the human rights' violations:

The main objective in this chapter is to explain the relationship between the embargo as a dependent dummy variable and the degree of the apartheid in South Africa. I measure the degree of the apartheid by the degree of human rights' violations that draw the attention of the international community. Here I consider periods of observed human rights violations that draw the attention of the international community are periods of political instability.⁶³

The main variables are:

- 1- The embargo (*EMBARGO*) which takes on the value 1 during the period of imposing the embargo and takes on the value 0 otherwise.

I considered 3 different measures of *EMBARGO*:

- (i) *EMBARGO1* which takes on the value 1 during the period of imposing the multilateral financial embargo from 1986 to 1991 and takes on the value 0 otherwise.
- (ii) *EMBARGO2* which takes on the value 1 during the periods of imposing any type of financial sanctions on South Africa and takes on the value 0 otherwise.
- (iii) *EMBARGO3* which takes on the value 1 during the periods of imposing any type of comprehensive sanctions on South Africa and takes 0 otherwise.

⁶³ I mean here periods of political instability accompanied the high degrees of human rights violations that draw the attention of the world.

Incorporating these three different measures for *EMBARGO* is to comprise data received from various sources.⁶⁴

2- The variable (*APARTHEID*) that reflects the degree of the observed human rights' violations in South Africa. *APARTHEID* takes on the following values:

- (1) For the highest degree of the observed violation of human rights.
- (2) If there is a stable state of apartheid (Human rights violation does not draw the attention of the international community).
- (3) If there is an internal political reform to reduce the human rights violation. (I consider any trial for political reforms regarding the apartheid).
- (4) For the lift of the apartheid.

According to the theoretical model,

$$EMBARGO = f(APARTHEID),$$

Embargo is a function of the apartheid since the main goal of its imposition is ending the apartheid in South Africa.

I address in my empirical study here the correlation between *EMBARGO* and *APARTHEID* or the effect of *APARTHEID* on imposing *EMBARGO* on South Africa. I use a LOGIT analysis because the dependent variable *EMBARGO* is a binary dummy variable that takes on only two values. Table (5-1) illustrates the result of the estimation by using the three different measures of *EMBARGO*.

According to the three estimated models in Table (5-1), there is a significant negative relationship between *APARTHEID* and *EMBARGO*. The results gave evidence that

⁶⁴ In both the second measure and the third measure of the embargo, the data set was extended with a longer embargo period in order to confirm my argument toward the relationship between embargo periods and periods of political instability accompanied observed periods for human rights violations as measured in the text.

more degrees of human rights violations that draw the attention of the international community increases the embargo and vice versa since higher values of *APARTHEID* means less degree of observed human rights violations or more political stability.⁶⁵

According to all results, I can conclude that the degree of the observed human rights violation that draw the attention of the international community is a main element of imposing the embargo against South Africa and vice versa. The result then can give evidence that the end of the apartheid lead to an end to the embargo against South Africa. Thus, both variables are related. I can then reject the first null-hypothesis and conclude that imposing the international embargo against South Africa was a credible weapon.

⁶⁵ In order to control for the stability of the relationship between *APARTHEID* and *EMBARGO*, I have regressed the first model (the dependent variable is *EMBARGO1*) by including two more variables that should have an impact on the dependent variable. These two variables are the internal circumvention, *REACTION* and the degree of the openness of the country which is represented by trade share in GDP, *TRADESHARE*, where *REACTION* is the internal economic circumvention to the international actions against the government of South Africa. *REACTION* is another dummy variable which takes on the following values:

- (i) The value (1) if there is any trial for financial circumventions.
- (ii) The value (2) if there is any trial for other economic circumventions.
- (iii) The value (3) if there is no internal economic circumvention.

TRADESHARE is a quantitative variable that measures the ratio of trade to the GDP of South Africa as a measure of the degree of the openness of South Africa.

All results are significant. However, these two variables may raise the question of the causality because both variables *REACTION* and *TRADESHARE* themselves partly may be affected by *EMBARGO*, rather than the other way round, which may artificially reduce the significance of *APARTHEID* as an explanatory factor. Yet, the result is still significant with these variables excluded. In both the second and the third models (the dependent variable is *EMBARGO2* and *EMBARGO3* consecutively), I added only the variable *TRADESHARE* to the regression. Adding the other dummy variable *REACTION* is not valid for technical reasons. See applied methods in EVIEWS 4.3. All results are available with the author for validations.

5.3. The Effect of the Embargo on the Net Foreign Borrowing in South Africa:

The main objective of this section is to examine the effect of the financial embargo of 1986-1991 on the net foreign borrowing after I proved that it is a function of the degree of observed human rights violations in South Africa. In this section, I employ an intervention model proposed by Ender, Sandler, and Cauley (1990) to study the impact of the degree of observed human rights violations that have attracted the economic embargo to South Africa on the time path of the net foreign borrowings *REALFB* of South Africa. The model is given by the following Equation (39):

$$REALFB = a_0 + A(L)Y_{t-1} + c_0 APARTHEID + B(L) \varepsilon_t \quad (39)$$

In Equation (39) *APARTHEID* is an intervention variable that represents again the degree of the *observed* human rights violations in South Africa. It takes same values as represented in the previous section, and ε_t is a white noise disturbance term. In addition, $A(L) [1 + a_1L + a_2L^2 + \dots + a_qL^q]$ and $B(L) [1 + b_1L + b_2L^2 + \dots + b_qL^q]$ are polynomials in lag operator L .

I tested the series *REALFB* for possible existence of unit root using Phillips Peron unit root test. I did not find any evidence of unit root in the series of *REALFB*. However, I tested the series for presence of autoregressive conditional heteroskedasticity (ARCH) effects using the correlogram test. I found evidence of conditional heteroskedasticity in the series of *REALFB*. Accordingly, I used ARCH method suggested by Enders (1995) to run the regression. Equation (40) shows the

results of the best-fit intervention model that has the lowest AIC and SC, with 165 observations (1961:1 2002:1) ⁶⁶

$$REALFB_t = -1656.113 + 0.188730 REALFB_{t-2} + 930.1701 APARTHEID_t .$$

$$\begin{array}{ccc} (-2.816464) & (6.219174) & (5.493221) \\ (0.0049) & (0.0000) & (0.0000) \end{array} \quad (40)$$

The first numbers between parentheses are z-statistics, and second numbers between parentheses are *p*-values. According to the best-fit intervention model in Equation (40), there is a significant relationship between the degree of observed human rights violations and the net foreign borrowings in South Africa. Less observed human rights violations lead to capital inflows. The contrary is also true; more observed human rights violations lead to capital outflows (or a reduction in net foreign borrowings). This result may explain the capital outflows that happened during the embargo since we have evidence from the previous section that there is a significant link between the degree of the observed human rights violations and the embargo on South Africa. In addition, we can deduce from equation (40) that the effect of this instability will not last longer. Figure (2) illustrates the forecast of the model described in equation (40) which explains that the net real foreign borrowings increase after the end of the apartheid in 1994. This empirical result proves the theoretical results in the previous chapter. However, this result contradicts some studies such as Khan (1989) who believes that this embargo was an illusion and has no place in practical reality. The main arguments of those studies are that in reality the inflow of foreign capitals and foreign investments increase in times of embargoes. In order to examine those arguments, I had to repeat the analysis after excluding the

⁶⁶ I excluded the rest of observations from 2003, 1 to 2004, 1 because of the observed variability in those quarters that might affect the result. I excluded also observations from 1960, 1 to 1961, 1 in order to have enough lags. I tested all possible ARMA models for *REALFB* until ARMA (5, 5).

entire period of after the official termination of the apartheid system and of after the lift of the embargo. I found that the relationship between high degrees of human rights violations and real net foreign borrowings is positive at probability 9%.⁶⁷ Net foreign borrowings increase in times of high degrees of human rights violations which may confirm the arguments of those studies. However, after including the period of after the official termination of the embargo, this relationship turns to be significantly negative at probability 0%; Net foreign borrowings increase in times of stability because higher degrees of the variable *APARTHEID* means more stability and less degree of human rights violations. The plausible interpretation here is that adding a longer data span clarifies the relationship between degrees of human rights violations and embargoes from one side and net real foreign borrowings from the other side and hence confirms the reliability of the embargo as a credible weapon in eliminating the apartheid system in South Africa. My analysis adds to those previous studies by expanding data span that clarifies the actual relationship between the variability of human rights violations and foreign capital flows to South Africa. In fact, eliminating the apartheid system in South Africa increases the political stability and made the business environment in South Africa more foreseen and hence more attractive to foreign investors. The question here is not only about the relationship between the foreign capital and degrees of human rights violations but the main question should be what would happen if there was no apartheid system led to the multilateral embargo. Adding the period after eliminating the apartheid system gives the right answer and clarifies the relationship between the embargo and foreign capital flows because the significant increase of foreign capital inflows after the end of the apartheid and after

⁶⁷ The best fit intervention model is AR (1) after we exclude the period after the official life of the apartheid.

the lift of the embargo proves the lost opportunity of having more capital inflows if there were neither apartheid nor embargoes in and on South Africa.

5.4. The Main Conclusion of Chapter 5

This chapter presented an empirical study that relies on two different analyses. The first is a LOGIT analysis to determine the relationship between the extent of the degree of human rights' violations that draw the attention of the international community and the extent of the embargo, concluding that the political environment of apartheid was a crucial element in the imposition of the financial embargo, affirming the truth of the goal given for the embargo. The second empirical study relies on the time series intervention analysis, and is an examination of the effect of the imposition of the financial embargo on the net foreign borrowings to and from South Africa, concluding that the political environment that led to the imposition of the embargo had a significant impact on the flow of capital in and out of South Africa.

Tables and Figures

Table (5.1): The results of LOGIT Analysis: The dependent variable is: *EMBARGO*. Number of observations: 177 (1960, 1 – 2004, 1)

The dependent variable	<i>EMBARGO1</i>	<i>EMBARGO2</i>	<i>EMBARGO3</i>
C_0	-0.283190 (-0.392294) (0.6948)	0.199119 (0.321393) (0.7479)	1.244805 (1.813078) (0.0698)
<i>APARTHEID</i>	-0.701304 (-2.124906) (0.0336)	-0.707900 (-2.542827) (0.0110)	-1.104747 (-3.399431) (0.0007)
McFadden R-squared	0.041089	0.046670	(0.094169)
Log Likelihood	-67.36178	-83.90626	-86.54003
Probability (LR stat)	0.016275	0.004154	2.22E-05
Andrews statistic - Prob. Chi-Sq(10)	0.0000	0.000	0.000

Numbers between first parentheses are z-statistics.

Numbers between second parentheses are *P*-Values.

Figure 5.1: Plot showing the behaviour of the variable *REALFB* over time.
 Effectiveness of Embargos on foreign capital flows: Evidence from South Africa Time Series:
 Data span (1960, 1-2000, 4)

Figure 5.2: Plot showing forecast of best fit intervention model for *REALFB* over time.
 Effectiveness of Embargos on foreign capital flows: Evidence from South Africa Time Series:
 Data span (1960, 1-2000, 4)

The Main Conclusion of the Second Part

In this study, I undertook a study of the extent of the success of the financial embargo on South Africa in realizing its intended goal: exerting economic pressure on the government of South Africa in order to bring apartheid to an end. To do this, I divided the research into two main chapters. The first deals with the theoretical study, in which I lay out Ramsey's simple economic version in a simplified political context, relying on the political environment of apartheid that was in place for a long time in South Africa. The first section concludes that the response of the embargo to apartheid had a direct impact on the return of whites in South Africa, which led to the success of the embargo in achieving its desired goal. The second chapter of the research is an empirical study that relies on two different analyses. The first is a LOGIT analysis to determine the relationship between the extent of the degree of human rights' violations that draw the attention of the international community and the extent of the embargo, concluding that the political environment of apartheid was a crucial element in the imposition of the financial embargo, affirming the truth of the goal given for the embargo. The second empirical study relies on the time series intervention analysis, and is an examination of the effect of the imposition of the financial embargo on the net foreign borrowings to and from South Africa, concluding that the political environment that led to the imposition of the embargo had a significant impact on the flow of capital in and out of South Africa. This confirms the results of the theoretical study that connected between the political environment of the embargo and the internal rate of return of capital, providing an explanation for the outflow of capital from South Africa during the period of the imposition of the embargo, and the increase of flow upon the end of apartheid there. In this way, the study sheds light on two important factors: the success of the embargo

in placing economic pressure on special interest groups (The whites) on the one hand, and the clarification of the phenomenon of the correlation between the flow of capital and the political environment of the human rights violations in South Africa – which is directly connected with the imposition of the embargo – on the other.

Chapter 6

Summary and Conclusion

The thesis was divided to two parts. The main goal of the first part was the response to the question: did the financial embargo imposed on South Africa between 1986 and 1991 have a significant impact on the rate of economic growth of the country? I have dedicated 2 main chapters in this study to answer this question. The goal of the second part was a response to another question: was the financial embargo successful in achieving its desired goal, namely exerting economic pressure on interest groups in South Africa in order to lift the apartheid system? I dedicated also 2 main chapters to answering this question.

In order to answer the first question, I undertook an analysis of Ramsey's models in its simple form. I concluded that the financial embargo has a short term effect only, due to the assumption of the stability of the steady state in the long run. After this, I applied the results of my theoretical study on the case of South Africa, highlighting it as a case of imposition of a short term embargo, the continuation of which is related to the continuation of the reason for its imposition (the apartheid system), and the lifting of which would take place with the lifting of apartheid. Furthermore, it is the government that has the choice of maintaining or lifting it, which means that its start may have been a surprise, but its end is predictable. The main result of the theoretical study is that the financial embargo imposed on South Africa from 1986 to 1991 had a short term impact on the country's economic growth rate, ending with the lifting of the embargo.

After this, I attempted to test the results of the theoretical study with an empirical example. I used an intervention analysis, which I deemed to be the closest to the logic of the theoretical study, since it assumes – as I did – that the

embargo is an external influence. Also, it takes into consideration (as does the theoretical study) the dynamism of the impact of the financial embargo on the economic growth rate over time. My conclusion from the empirical study was that its effects disappeared with the lifting of the financial embargo. Thus, the answer to the main question of the study is that the embargo had only a short-term impact on South Africa's economic growth rate.

On another front, I investigated the second question in a second study, which is related to the extent of the success of this embargo in realizing the desired goal, namely exerting pressure on interest groups in order to bring the apartheid system to an end. After all, history has proven its ability to be lifted, with the creation of a black government under Nelson Mandela. For the purposes of this study, I divided my work into two main portions: in the first I undertake a theoretical analysis in which I use the simple open economy version of the Ramsey model, assuming a simplified political context based on the political environment that was in place under apartheid. Here I reached a result at which I was happy to stop, due to my belief that it was a clear response to the question of the study. The result was that there is a direct relationship between the extents of the embargo's responsiveness to the political context of apartheid on the one hand, and the capital rate of return on the other. This would be the rate of return for the whites, according to the assumptions of the study, meaning that the embargo had a direct impact on interest groups (Whites in this research), emphasizing the effectiveness of its imposition on the one hand, as well as explaining the outflow of capital from South Africa during the embargo years (referred to by some studies quoted in Kaempfer & Lowenberg) on the other.

The second part of the last section is an empirical analysis to test the results of this theoretical analysis. In it, I undertook two different analyses:

- 1- A LOGIT analysis to test the relationship between the economic embargo and the political context of the apartheid system. My results here were that the apartheid system that was measured in the research by the observed degrees of human rights' violations was in reality a crucial factor in the imposition of the embargo on South Africa, thereby affirming the truth of the reason that was claimed for its imposition.
- 2- An intervention analysis to study the effects of the political context that brought about the embargo on the outflow of capital from South Africa. Here my results were that this unstable political environment (measured by periods of observing human rights violations) – that brought about the embargo – did have an impact on the flow of capital in and out of South Africa, confirming the results of the theoretical study in the last study. For this reason, I believe that the financial embargo on South Africa was a central factor in bringing apartheid to an end. This does not mean that I am ignoring other internal social factors, which I did not study in this work, but that perhaps I will study them in another future one.

Finally, I hope that my study has benefits to other researchers.

Appendices

Appendix 1: The optimal solution of the optimization problem in the simple open economy version of Ramsey model:

Households maximize their utility within an infinite horizon:

$$\text{Max } U_0 = \int_0^{\infty} e^{-\rho t} \ln(c_t) \cdot dt \quad (1)$$

Subject to:

$$\dot{d}_t = c_t + i_t[1 + T(i_t/k_t)] + \rho d_t - f(k_t), \quad (2)^{68}$$

$$\dot{k}_t = i_t, \quad (3)$$

$$\rho = r_w. \quad (4)^{69}$$

$$\lim_{t \rightarrow \infty} e^{-\rho t} d_t = 0. \quad (5)^{70}$$

$$H_t = [u(c_t) - \mu_t \{c_t + i_t[1 + T(i_t/k_t)] + \rho d_t - f(k_t)\} + \mu_t q_t i_t] e^{-\rho t}. \quad (6)$$

F.O.Cs:

(I):

$$\partial H_t / \partial c_t = [u'(c_t) - \mu_t] e^{-\rho t} = 0$$

$$\Rightarrow \mu_t = u'(c_t) \quad (7)$$

The shadow cost of foreign debt μ_t = Marginal utility of consumption $u'(c_t)$.

(II):

$$\partial H_t / \partial i_t = -\mu_t [1 + i_t \cdot T'(i_t/k_t) \cdot 1/k_t + T(i_t/k_t) \cdot 1] + \mu_t q_t = 0,$$

$$\Rightarrow q_t = [1 + i_t/k_t \cdot T'(i_t/k_t) + T(i_t/k_t)],$$

⁶⁸ Let $n=0$ to simplify discussions.

Note that: According to Blanchard and Fischer (1996), "Costs of installing investment goods take $i[1 + T(\cdot)]$ units of output to increase the capital stock by i unit." Thus, $dk/dy = i/[i[1 + T(\cdot)]] = 1/(1+T(\cdot))$. Thus, $T(\cdot) = dy/dk - 1$ or $T(\cdot) = f'(kt) - 1$. The amount $T(\cdot) = f'(kt) - 1$ per unit of investment is used up in transforming goods into capital. See also the properties of $T(\cdot)$ in Blanchard and Fischer.

⁶⁹ This is a very important condition for the stability of the optimal path, see Carlberg, 1997, p. 67 and Blanchard & Fischer, 1996, p.30

⁷⁰ "The country should borrow until the marginal utility of consumption is equal to zero, and then borrow further to meet interest payments on its debt. It is unlikely that the lenders would be willing to continue lending if the country's only means of paying off its debt were to borrow more. Accordingly, we impose the No Ponzi Game –NPG- condition", Olivier Jean Blanshard & Stanley Fischer, 1996, p. 60.

$$\Rightarrow q_t = 1 + T(i_t/k_t) + (i_t/k_t) T'(i_t/k_t). \quad (8)$$

(III):

$$\partial(-\mu_t e^{-\rho t})/\partial t = -\partial H_t/\partial t = +\mu_t \rho_t e^{-\rho t} \quad (9)$$

$$(IV): \partial[\mu_t q_t e^{-\rho t}]/\partial t = -\partial H_t/\partial k_t = -\mu_t e^{-\rho t} [f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)]. \quad (10)$$

Now, from (III) note that:

$$\partial(-\mu_t e^{-\rho t})/\partial t = \mu_t \rho_t e^{-\rho t} - \dot{\mu}_t e^{-\rho t} = \mu_t \rho_t e^{-\rho t}$$

$$\Rightarrow \dot{\mu}_t = 0.$$

From (I),

$$\mu_t = u'(c_t),$$

Thus, $u''(c_t) = 0$. This may happen only if consumption is constant.

Thus,

$$c_t = c = \text{constant}. \quad (11)$$

This happens because $\rho = r_w$.

Now recall the dynamic budget constraint,

$$\dot{d}_t = c_t + i_t[1 + T(i_t/k_t)] + \rho d_t - f(k_t).$$

This is a first order differential equation. We can solve it to find the intertemporal budget constraint as follows:

$$\dot{d}_t - \rho d_t = c_t + i_t[.] - f(k_t). \quad (12)$$

Where $i_t[.]$ is $i_t[1 + T(i_t/k_t)]$.

Multiply each side of (12) by the integration factor, $e^{-\int \rho t dt} = e^{-\rho t + c}$.⁷¹

$$e^{-\rho t} \dot{d}_t - \rho d_t e^{-\rho t} = e^{-\rho t} c_t + e^{-\rho t} [i_t[.] - f(k_t)], \quad (13)$$

Note that the left hand side of (13) is the derivative with respect to t of the integration factor times d_t , so (13) can be rewritten as:

⁷¹ We can multiply by $e^{-\rho t}$ only since the constant will be cancelled through the steps of the solution.

$$d/dt [e^{-\rho t} d_t] = e^{-\rho t} c_t + e^{-\rho t} [i_t[.] - f(k_t)], \quad (13')$$

Integrate (13') over the interval from 0 to ∞ :

$$\int_0^{\infty} d/dt [e^{-\rho t} d_t] \cdot dt = \int_0^{\infty} e^{-\rho t} c_t \cdot dt + \int_0^{\infty} e^{-\rho t} [i_t[.] - f(k_t)] \cdot dt \quad (14)$$

This leads to,

$$e^{-\rho t} d_t \Big|_0^{\infty} = \int_0^{\infty} e^{-\rho t} c_t \cdot dt + \int_0^{\infty} e^{-\rho t} [i_t[.] - f(k_t)] \cdot dt, \quad (15)$$

Use the No-Ponzi-Game Condition $\lim_{t \rightarrow \infty} e^{-\rho t} d_t = 0$ to obtain:

$$0 - d_0 = \int_0^{\infty} e^{-\rho t} c_t \cdot dt + \int_0^{\infty} e^{-\rho t} [i_t[.] - f(k_t)] \cdot dt, \quad (16)$$

Re-write (16) to find:

$$\int_0^{\infty} e^{-\rho t} c_t \cdot dt = \int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t[.]\} \cdot dt - d_0 \quad (16')$$

Equation (16') is the intertemporal budget constraint.

d_0 is the initial debt.

$\int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t[.]\} \cdot dt$ is the present value of net output.

$$\text{Put } v_0 = \int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t[.]\} \cdot dt - d_0, \quad (17)$$

Then,

$$\int_0^{\infty} e^{-\rho t} c_t \cdot dt = v_0, \quad (18)$$

Since consumption is constant, we can linearly using this budget constraint to figure out that,

$$c \int_0^{\infty} e^{-\rho t} \cdot dt = v_0, \text{ then,}$$

$$c[e^{-\rho t}/-\rho]_0^{\infty} = v_0, \text{ then,}$$

$$c[0 - (-1/\rho)] = v_0, \text{ then,}$$

$$c/\rho = v_0, \text{ then,}$$

$$c = \rho v_0. \quad (19)$$

Thus, this consumer depends on the annuity value of wealth. The marginal propensity to consume out of wealth is constant and equals the foreign interest rate.

To find the optimal saving set,

$$S_t = f(k_t) - c_t - \rho d_t \quad (20)$$

Substitute (17) into (20), then,

$$S_t = f(k_t) - \rho v_t - \rho d_t, \text{ then,}$$

$$S_t = f(k_t) - \rho [v_t + d_t], \quad (21)$$

Substitute (17) into (21), then,

$$S_t = f(k_t) - \rho \int_0^{\infty} e^{-\rho(\tau-t)} \{f(k_t) - i_t[\cdot]\} d\tau \quad (22)$$

Where, τ is the dummy variable of the integration.

According to equation (22),

- (i) Saving is high when current output is high relative to future expected output.
- (ii) Saving is independent of the level of debt since the increase in debt leads to a reduction in income of $\rho \cdot d(d)^{72}$ and a reduction in consumption of $\rho \cdot d(v) = \rho \cdot d(d)$. Thus, the change in saving will equal zero.

Since,

$$d_t - \rho d_t = c_t + i_t[\cdot] - f(k_t). \quad (23)$$

⁷² The first d is the differential.

Thus,

$$\dot{d}_t = i_t[\cdot] - s_t \quad (24)$$

The current account deficit equals investment minus saving. Since neither of these is affected by the stock of debt, the current account is also independent of level of debt.

Appendix 2: Steady state and dynamics in the open economy version of the Ramsey model:

From,

$$q_t = 1 + T(i_t/k_t) + (i_t/k_t) T'(i_t/k_t). \quad (25)$$

It implies implicit function theorem since $T(0) = 0$, if the rate of investment $= 0$, the installation cost $= 0$.

Since, this is true, then, $i_t/k_t = 0$ this means $q = 1$.

We can write,

$$q_t = \psi(i_t/k_t), \quad \psi' > 0, \quad \psi(0) = 1, \quad (26)$$

Thus, q_t is monotonically increasing function in i_t/k_t .

We can re-write (26) to,

$$i_t/k_t = \psi^{-1}(q_t) = \varnothing(q_t), \quad \varnothing' > 0, \quad \varnothing(1) = 0, \quad (27)$$

Where $\psi^{-1}(q_t)$ is the inverse function of $\psi(q_t)$.

To determine q_t , recall the fourth F.O.C,

$$\partial[\mu_t q_t e^{-\rho t}] / \partial t = - \partial H_t / \partial k_t,$$

Thus,

$$\dot{\mu}_t q_t e^{-\rho t} + \mu_t \dot{q}_t e^{-\rho t} - \rho \mu_t q_t e^{-\rho t} = -\mu_t e^{-\rho t} [f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)], \quad (28)$$

Remember that, $\dot{\mu}_t = 0$, then, $\mu_t q_t e^{-\rho t} = 0$. Thus (28) becomes,

$$\dot{q}_t = \rho q_t - [f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)]. \quad (29)$$

Equation (29) is a first order differential equation, we can solve it as the following:

First, rewrite equation (29) to,

$$\dot{q}_t - \rho q_t = - [f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)], \quad (29')$$

Second, multiply by the integration factor, $e^{-\rho t}$, then,

$$e^{-\rho t} [\dot{q}_t - \rho q_t] = e^{-\rho t} [-f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)], \quad (30)$$

We can rewrite (30) to:

$$d [e^{-\rho t} q_t] / dt = - e^{-\rho t} [f'(k_t) + (i_t/k_t)^2 T'(i_t/k_t)], \quad (30')$$

Third, take integration from t to ∞ and substitute $i_t/k_t = \mathcal{O}(q)$ into (41'),

$$\int_t^\infty d [e^{-\rho t} q_t] / dt \cdot dt = - \int_t^\infty e^{-\rho t} [f'(k_t) + (\mathcal{O}(q_t))^2 T'(\mathcal{O}(q_t))] \cdot dt, \quad (31)$$

Then,

$$e^{-\rho t} q_t = - \int_t^\infty e^{-\rho t} [f'(k_t) + (\mathcal{O}(q_t))^2 T'(\mathcal{O}(q_t))] \cdot dt, \quad (32)$$

Forth, impose the No-Ponzi Game condition, $\lim_{t \rightarrow \infty} e^{-\rho t} q_t = 0$, then,

$$0 - q_t = - \int_t^\infty e^{-\rho t} [f'(k_t) + (\mathcal{O}(q_t))^2 T'(\mathcal{O}(q_t))] \cdot dt, \quad (33)$$

Thus,

$$q_t = \int_t^\infty e^{-\rho(\tau-t)} [f'(k_\tau) + (\mathcal{O}(q_\tau))^2 T'(\mathcal{O}(q_\tau))] \cdot d\tau, \quad (34)$$

Where:

τ - t : is the dummy variable of integration.

$f'(k_t)$: is the marginal product of capital.

$(\mathcal{O}(q_t))^2 T'(\mathcal{O}(q_t))$: is the marginal reduction in the installation cost from higher capital.

The interpretation of equation (34) is:

The shadow price of capital equals the present discounted value of future marginal products.

According to equation (34), the q_t and thus i_t/k_t , does not depend on the level of debt or does not depend on the characteristics of the utility function.

To figure out the steady state and dynamics of investment and capital, we need to follow the following steps:

Recall,

$$dk_t/dt = \dot{k}_t = i_t = k_t \cdot \mathcal{O}(q_t), \quad \mathcal{O}'(q_t) > 0, \quad \mathcal{O}(1) = 0,$$

$$dq_t/dt = \dot{q}_t = \rho q_t - f'(k_t) - \mathcal{O}(q_t)^2 T'[\mathcal{O}(q_t)],$$

In the steady state,

$$\dot{k}_t = 0, \quad \dot{q}_t = 0. \quad \text{Thus,}$$

$$\dot{k}_t = i_t = k_t \cdot \mathcal{O}(q_t), \quad \mathcal{O}(q_t) = 0 \text{ if } q_t = 1 \quad (35)$$

Thus,

$$\dot{q}_t = \rho - f'(k_t), \quad (36)$$

Re-write equation (36) to,

$$\rho = f'(k_t) + \dot{q}_t \quad (36')$$

Equation (36') is capital market equilibrium condition.

Where:

ρ : is the return on asset.

$f'(k_t)$: is the dividends on the ownership of capital.

$\dot{q}_t$: is the capital gain.

When $\dot{q}_t = 0$, then,

$$\rho = f'(k_t). \quad (37)$$

Equation (37) is just the static condition. For optimal capital stock, marginal product of capital equals interest rate.

It is obvious that the system of equations we have is not linear. So we have to linearize to get the approximation of linearity.

For the linearization, we take First Order Taylor series approximation as the following:

$$f(x) \approx f(x^*) + f'(x^*)(x-x^*).$$

since we evaluate the function at some neighbourhood point.

Figure (A-1) shows the linearization of $f(x)$ graphically,

Figure (A-1): Linearization of $f(x)$.

Thus,

$$k_t(q_t, k_t) \approx k(q^*, k^*) + \left. \frac{\partial k_t}{\partial q_t} \right|_{q_t=q^*} (q_t - q^*) + \left. \frac{\partial k_t}{\partial k_t} \right|_{k_t=k^*} (k_t - k^*), \quad (38)$$

Note that, $k(q^*, k^*) = 0$, Thus,

$$k_t(q_t, k_t) = k^* \mathcal{O}'(q^*) (q_t - q^*) + \mathcal{O}(q^*) (k_t - k^*), \quad (39)$$

Note that, $\mathcal{O}(q^*) = 0$ since in the steady state, $k = 0$, then $q_t = 1$. Thus,

$$k_t(q_t, k_t) = k^* \mathcal{O}'(q^*) (q_t - q^*). \quad (40)$$

And,

$$q_t(q_t, k_t) \approx q_t(q^*, k^*) + \left. \frac{\partial q_t}{\partial q_t} \right|_{q_t=q^*} (q_t - q^*) + \left. \frac{\partial q_t}{\partial k_t} \right|_{k_t=k^*} (k_t - k^*), \quad (41)$$

Note that,

$$\partial q_t / \partial q_t = \rho - 2 \rho(q_t) \mathcal{O}'(q_t) T'(\mathcal{O}(q_t)) - \rho(q_t)^2 T''(\mathcal{O}(q_t)) \cdot \mathcal{O}'(q_t), \quad (42)$$

Substitute (54) into (53) yields,

$$q_t(q_t, k_t) = (\rho - 2\rho(q^*) \mathcal{O}'(q^*) T'(\mathcal{O}(q^*)) T'(\mathcal{O}(q^*)) (q_t - q^*) - \mathcal{O}(q^*)^2 T''(\mathcal{O}(q^*) \mathcal{O}(q^*)) (q_t - q^*) - f''(k^*) (k_t - k^*)), \quad (43)$$

Note that,

$$\mathcal{O}(q^*) = 0, \text{ thus,}$$

$$q_t(q_t, k_t) = \rho (q_t - q^*) - f''(k^*) (k_t - k^*). \quad (44)$$

Appendix 3: An open economy version of the Ramsey model without imposing an installation cost for investment:

Households maximize their utility within an infinite horizon:

$$\text{Max } U_0 = \int_0^{\infty} e^{-\rho t} \ln(c) \cdot dt, \quad (1)$$

Subject to:

$$\dot{d} = c + i + r_w d - f(k), \quad (2)$$

$$\dot{k} = i, \quad (3)$$

$$\rho = r_w. \quad (4)$$

$$\lim_{t \rightarrow \infty} e^{-\rho t} b = 0. \quad (5)$$

To solve the intertemporal problem, we set up the present value

Hamiltonian:

$$H_t = [u(c_t) - \mu_t \{c_t + i_t + \rho d_t - f(k_t)\} + \mu_t q_t i_t] e^{-\rho t}. \quad (6)$$

Where $-\mu e^{-\rho t}$ is the costate variable on the flow budget constraint (2) and

$\mu q e^{-\rho t}$ is the costate variable on the capital accumulation equation(3).

Necessary and sufficient conditions for a maximum are:

$$u'(c_t) = \mu_t, \quad (\text{from } \partial H_t / \partial c_t = 0), \quad (7)$$

The shadow cost of foreign debt μ_t equals the marginal utility of consumption $u'(c_t)$

$$q_t = 1, \quad (\text{from } \partial H_t / \partial i_t = 0), \quad (8)$$

The shadow value of the capital stock equals 1 ⁷⁴.

$$\partial(-\mu_t e^{-\rho t}) / \partial t = -\partial H_t / \partial d_t = +\mu_t \rho_t e^{-\rho t}, \quad (9)$$

(74) We can simplify discussions by setting $n = 0$. Then we can write,

$\dot{d} = b$ and $\dot{k} = i$.

⁷⁴ Since we have one good in the model, we can normalize the purchase price of the capital stock by 1. Thus, the purchase price of the capital stock equals the shadow value. As long as this is hold, the investment equals zero.

This is because, we do not have adjustment cost in the model.

And,

$$\partial[\mu_t q_t e^{-\rho t}]/\partial t = -\partial H_t/\partial k_t = -\mu_t e^{-\rho t} f'(k_t), \quad (10)$$

Consumption:

The optimal solution for consumption will be:

$$c = 0, \quad (11)$$

Thus, consumption is constant on the optimal path.

$$c = c^*. \quad (12)$$

This is because $\rho = r_w$.

To obtain the level of consumption, we integrate the dynamic budget constraint (2), which yields,

$$\int_0^{\infty} e^{-\rho t} c_t dt = \int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t\} dt - d_0 \quad (13)$$

The present discounted value of consumption $\int_0^{\infty} e^{-\rho t} c_t dt$ is equal to the present

discounted value of net output $\int_0^{\infty} e^{-\rho t} \{f(k_t) - i_t\} dt$ minus the initial level of debt d_0 .

Investment:

From (8), the shadow value of the capital stock equals 1.

And since we have just one good in the model, we can normalize the purchase price of the good by 1. Accordingly, the purchase price equals the

shadow value of the capital stock, thus, i is equal zero and thus k is equal

zero. If this holds, k is constant.⁷⁵

Equation (10) yields the following condition:

$$\rho = f'(k_t), \quad (14)$$

This is just the static capital equilibrium condition. For optimal capital

⁷⁵ This is because there is no adjustment cost in the model.

stock, marginal product of capital equals interest rate. This condition holds in the momentary equilibrium and in the steady state.

Thus, we can solve the equation (13) to find:

$$c^* = f(k^*) - \rho d_0 \quad (15)$$

It is obvious from (15) that d is constant too, thus, $\dot{d} = 0$.⁷⁶

Consumption equals income. The marginal propensity to consume out of income equals 1.

Saving:

$$S = f(k) - c - \rho d = 0,^{77} \quad (16)$$

This is because income equals consumption.

Current Account:

$$b_t = i_t - S_t = 0, \quad (17)^{78}$$

Thus,

$$x = \rho d, \quad (18)$$

Net exports equal debt payment.

⁷⁶ This results because $\rho = r_w$ and there is no adjustment cost in the model.

⁷⁷ Since $S = f(k) - c - \rho d$, $c = f(k) - \rho d$. Thus, $S = 0$.

⁷⁸ This is because both i and S equal zero.

Appendix 4: Mathematical Explanation: The transitional dynamic of the effect of the temporary financial embargo:

At the beginning, the economy is in the stable path. There exists perfect capital mobility. Per capita capital stock and per capita foreign debt are constant. Then, suddenly, lenders impose a financial embargo that is expected to be temporary. More exactly, the foreign borrowing will be zero for a determined period of time, after which targeting lenders will lift the embargo. Agents understand at time 0 that the change is only for the duration of the period $(0, T)$ so that at time $T > 0$, when lenders end the embargo, this action has been fully anticipated and there is no surprise. The analysis will include two types of financial shocks: first, a sudden financial embargo at time 0 for the duration of the period $(0, T)$. Second: a fully anticipated lifting of the embargo at time T . As soon as the interruption of the foreign borrowing occurs, $(dq/dt = 0)$ locus shifts to the left since the shadow price of capital q_t is a function of the rate of investment.

From Linearizations, the following two equations attain:

$$\dot{k}_t(q_t, k_t) = k^* \mathcal{O}'(q^*) (q_t - q^*), \quad \mathcal{O}'(q^*) > 0, \quad (q_t - q^*) > 0. \quad (2-32)$$

and,

$$\dot{q}_t(q_t, k_t) = \rho(q_t - q^*) - f''(k^*)(k_t - k^*), \quad f''(k^*) < 0, \quad (k_t - k^*) > 0. \quad (2-33)$$

In the steady state, both $\dot{k}_t = 0$ and $\dot{q}_t = 0$.

When $(dq_t/dt = 0)$ the following equation attains:

$$\rho(q_t - q^*) = f''(k^*)(k_t - k^*) \quad (2-34)$$

Equation (2-34) with $q^* = 1$ lead to equation (2-35):

$$q_t - 1 = (1/\rho) f''(k^*) (k_t - k^*) \quad (2-35)$$

Note also from (2-18),

$$q_t = \Psi(i_t/k_t), \quad \Psi' > 0, \quad \Psi(0) = 1, \quad (2-18)'$$

Where i_t/k_t is the rate of investment.

From (2-18)' and (2-35) of $(dq_t/dt = 0)$ locus, the rate of investment will be affected by the financial embargo and hence q_t . $(dq_t/dt = 0)$ locus will shift to the left. The stable path SS will also instantaneously and temporarily shift down to SS' .⁷⁹ The shadow price q_t decreases to the point B , which lies above SS' .⁸⁰

Thus, according to both equations, (2-35) and (2-18)',

At E , $q_t = 1$, $k_t = k^*$, and the rate of investment equals zero.

At B , $q_t < 1$, $k_t = k^*$, and the rate of investment is negative. Equation (2-18)'' confirms again this relationship between q_t and the rate of investment.

$$i_t/k_t = \Psi^{-1}(q_t) = \mathcal{Q}(q_t), \quad \mathcal{Q}' > 0, \quad \mathcal{Q}(1) = 0, \quad (2-18)''$$

Where $\Psi^{-1}(q_t)$ is the inverse function of $\Psi(q_t)$.

According to the discussion of the stability of the steady state or the saddle path in the end of section (2.2), per capita capital stock decumulates,⁸¹ and q_t begins to increase (See the relationship between k_t and q_t in both equations (2-18) and (2-18)'). For more explanation, recall equation 18:

$q_t = 1 + T(i_t/k_t) + (i_t/k_t)T'(i_t/k_t)$, (from $\partial H_t/\partial i_t = 0$), then take the derivative of q_t with respect to k_t with taking into consideration all characteristics of the adjustment cost for investment. According to Blanchard and Fischer (1996)

$$"T(0) = 0, \quad T'(\cdot) > 0, \quad 2T'(\cdot) + ((i/k).T''(\cdot)) > 0." \text{ P.59}$$

⁷⁹ The stability of the saddle path is already approved in the text.

⁸⁰ Any point below E and above the new saddle path because the initial reduction will reduce q_t from 1 (on the initial saddle path) to lower than one (below the initial saddle path).

⁸¹ This is because investment adds to the capital stock according to the model.

$$\partial q_t / \partial k_t = -(i_t / k_t^2) [2T'(i_t / k_t) + (i_t / k_t) T''(i_t / k_t)],$$

According to the above characteristics of the adjustment cost for investment, the term $[2T'(i_t / k_t) + (i_t / k_t) T''(i_t / k_t)] > 0$, $(i_t / k_t^2) > 0$, then, $\partial q_t / \partial k_t < 0$. Thus q_t increases with the decumulation of k_t and vice versa and again $q_t = q^* = 1$ when $k_t = k^*$. The process follows the path BC in figure (2-5).⁸² At time T , when the financial embargo is lifted - with no new information being received since the time of its lifting the embargo - no further jump will occur. The stable path relevant for subsequent adjustments in q_t and k_t beyond time T is the path SS , the original stable path. After time T , the q_t and k_t follow the stable path CE in figure (2-5) to the original steady state equilibrium at E .⁸³ At E , the shadow value q_t reverts to 1, but with the same stock of per capita capital because according to the stability of the saddle path when q_t exceeds $q^*=1$, k_t exceeds k^* and hence the direction will go again toward k^* .⁸⁴

⁸² See the discussion of the saddle path.

⁸³ See the discussion of the stability of the saddle path.

⁸⁴ See equation (2-34) of the $(dq/dt = 0)$ locus. In the steady state, $(dk/dt = 0)$ as well. When we move to the right of the horizontal axis, the movement is positive as long as the shadow value of the capital stock is higher than the purchase price of the capital stock. We move in the opposite direction if the shadow value of the capital stock q_t is less than the purchase price of the capital stock.

Thus, the temporary full interruption of foreign borrowing will not affect the per capita capital in the long run.

Figure (2-5): The effect of a sudden temporary financial embargo shock on the dynamics of investment and capital.

From this analysis, we can predict for the direction of the investment capital ratio, i_t/k_t . From the above analysis, $i_t/k_t = 0$ when $q_t = 1$, $k_t = k^*$ and becomes negative when $q_t < 1$. In addition, i_t/k_t becomes positive when $q_t > 1$. See the numerical explanation below. Following the above analysis, figure (2-6) that illustrates the behaviour of the investment rate over time follows.

Figure 2-6: The effect of a sudden temporary embargo on the rate of investment over time.

And since investment adds to capital stock according to the model, then the above figure (2-6) can reflect also the behaviour of the growth rate of the capital stock $(dk_t/dt)/k_t$ over time. It equals zero when $q_t = 1$ and $k_t = k^*$. And from $y_t = f(k_t)$, then the same figure (2-6) can reflect also the behaviour of the economic growth rate over time.

Numerical Explanation

Let's start from the following two equations:

$$k_t(q_t, k_t) = k^* \phi'(q^*) (q_t - q^*), \quad \phi'(q^*) > 0, \quad (q_t - q^*) > 0. \quad (2-32)$$

and,

$$q_t(q_t, k_t) = \rho(q_t - q^*) - f''(k^*)(k_t - k^*), \quad f''(k^*) < 0, \quad (k_t - k^*) > 0. \quad (2-33)$$

In the steady state, both $k_t = 0$ and $q_t = 0$.

When $(dq_t/dt = 0)$, the following equation attains:

$$\rho(q_t - q^*) = f''(k^*)(k_t - k^*) \quad (2-34)$$

Equation (2-34) with $q^* = 1$ lead to equation (2-35):

$$q_t - 1 = (1/\rho) f''(k^*)(k_t - k^*) \quad (2-35)$$

Let $k^* = 3$, $\rho = 0.05$, and $\alpha = 1/3$. (I use here same values as Mehlum – ISSN: 0801-1117).

Thus, $f''(k^*) \approx -0.04$. (This is the second derivative of $f(k_t) = k^\alpha$ evaluated at $k^*=3$.)

Thus, equation (2-35) becomes:

$$(q_t - 1) = -0.8 (k_t - 3) \quad (2-35)'$$

Equation (2-35)' is the $(dq/dt = 0)$ ray.

At each value of k_t , we can easily derive the relevant value of q_t . Also, we can solve the differential equation (2-33) for q_t at each potential value of k_t . The following table illustrates the derived values of q_t at each relevant value of k_t .

Table A4.1: k_t and q_t :

k_t	q_t
0	3.4
1	2.6
2	1.8
3	1
4	0.2
5	-0.6
6	-1.4

Figure (A4-1) shows the phase diagram that summarizes this mechanism:

Figure A4-1: Dynamics of investment and capital and the saddle path.

By choosing a saddle path between both $(dk/dt = 0)$ and $(dq/dt = 0)$, the following saddle path can be attained: (We can just use a graph copy paper)

Table A.2: The initial saddle path:

k_t	q_t	dq/dt
1	1.65	-0.0475
2	1.3	-0.025
3	1	Zero
4	0.70	0.025
5	0.35	0.0475

After imposing the embargo, we can easily derive the new saddle path at a lower steady state by repeating the above steps at relevant parallel saddle path. The new steady state is ss' as illustrated in figure 2-5.

We can now derive the *EBCE* transitional path from numbers in table A-5:

At E : $k_t = 3$, $q_t = 1$, $dk/dt = dq/dt = 0$.

At B : $k_t = 3$, $q_t = (0.5)$ "I select here any plausible point under E ", the relevant $dq/dt = -0.025$. (With an explicit relation between q_t and the investment rate, it will be straightforward to know the exact value of q_t at point B .)

At C : $k_t = 2.4$ "a point between 2 and 3", the relevant $q_t = 1.18$. Then the relevant $dq/dt = -0.015$.

We can also derive any point on the transitional path *EBCE* at each relevant value of k_t .

We can also know the direction of the investment rate ($dk/dt / k$) by knowing all values of the relevant ($q_t - q^*$) on the saddle path. We know already that $\mathcal{O}'(q^*) > 0$. Thus, $i/k_t = (3/k_t) \cdot \mathcal{O}'(q^*)(q_t - 1)$ (from equation (2-32)). Thus, the direction of the investment rate depends on the direction of ($q_t - 1$). If we know precisely the value of $\mathcal{O}'(q^*)$, we can figure out easily the relevant values of the investment rate.

Table A-3: $(q_t - 1)$ on the saddle path.

	q_t	$(q_t - 1)$
1	1.65	0.65
2	1.3	0.3
3	1	1
4	0.65	-0.35
5	0.35	-0.65

We can elicit from table A-3 that if q_t is higher than 1, the investment rate is higher than zero and when q_t is lower than 1, the investment rate is lower than zero, and when $q_t = 1$, the investment rate is zero.

Note that C is a point on the saddle path, thus, by knowing the relevant $\mathcal{O}'(q^*)$, we can easily derive the relevant investment rate but at least we are confident that the investment rate is positive at this point. By using a graph copy paper, we can easily figure out the values of q_t on the transitional path $EBCE$ at each relevant value of k_t as long as we know the values of q_t at $(dq_t/dt = 0)$ locus and the values of both k_t and q_t on the saddle path. Then, we can figure out the direction of the investment rate on the $EBCE$ transitional path. And because, the behaviour of k_t reflects the behaviour of y_t , ($y_t = f(k_t)$), thus, the behaviour of $dk_t/dt / k_t$ can reflect the behaviour of the economic growth rate.

Table A-4: The direction of the investment rate along the *EBCE* transitional path at 14 selected points of time:

<i>Time</i>	h_t	q_t	$(q_t - 1)$
T_0	3	0.5	-0.5
T_1	2.9	0.5	-0.5
T_2	2.8	0.5	-0.5
T_3	2.7	0.5	-0.5
T_4	2.6	0.55	-0.45
T_5	2.5	0.65	-0.35
T_6	2.4	0.75	-0.25
T_7	2.45	0.85	-0.15
T_8	2.4	1.18	0.18
T_9	2.5	1.15	0.15
T_{10}	2.6	1.10	0.10
T_{11}	2.7	1.07	0.07
T_{12}	2.8	1.05	0.05
T_{13}	2.9	1.03	0.03
T_{14}	3	1	Zero

Figure A4-2 illustrates the time path of the $(q_t - 1)$ and thus the direction of the investment rate assuming a discrete time:

Figure A4-2: The time path of the $(q_t - 1)$ and thus the direction of the investment rate assuming a discrete time.

With less and less time intervals, the time path of $(q_t - 1)$ can take the shape in figure A4-3.

Figure A4-3: The time path of $(q_t - 1)$ that reflects the direction of the time path of the investment rate.

With less time intervals and the stability of the saddle path, figure (2-6) is the plausible predicted direction for the investment rate and hence the direction of the growth of y_t because $y_t = f(k_t)$.

Appendix 5: The solution of the first chapter 4:

We will solve this problem under two main assumptions:

First assumption: we suppose that financial embargoes equal $m B$, where m is the degree of the financial embargo. The range of m is from zero to -1. Thus, sanctions M are considered to be a proportional tax of the foreign borrowing.

Second assumption: we suppose that sanction is a constant tax that will be subtracted from foreign borrowing $(B - M)$, where M is sanction. In this case, I impose the apartheid system in the model internally since I assume that sanctions depend on apartheid. More apartheid leads to more sanctions. For simplicity, I assume that this relationship between the apartheid and the sanction is linear. For instance, $M = a \cdot \text{Apartheid}$. When apartheid increases, M increases by a , where a is a constant factor. Thus, in the second assumption, I linked between an external variable,⁸⁵ the sanction, and an internal political variable, the apartheid.

First Assumption:

$M_t = mB$, $m < 0$, thus,

$$H_t = [u(c_t) - \lambda_t \{c_t - mc_t + i_t - mi_t + \rho d_t - m\rho d_t - f(k_t) + m f(k_t)\} + \lambda_t q_t i_t] e^{-\rho t} \quad (1)$$

Second Assumption:

$$H_t = [u(c_t) - \lambda_t \{c_t + i_t + \rho d_t - f(k_t) + M_t + \lambda_t q_t i_t + \lambda_t g_t A\}] e^{-\rho t}, \quad (2)$$

Where, A is the apartheid variable.

Solutions under the first assumption:

Necessary and sufficient conditions:

$$(i) \partial H_t / \partial c_t = e^{-\rho t} u'(c_t) - \lambda_t e^{-\rho t} (1-m) = 0 \quad (3)$$

Therefore,

$$u'(c_t) = \lambda_t (1-m), \quad (4)$$

⁸⁵ By external variable, I mean a variable that hits the country from outside.

The shadow value of foreign debt λ_t less the degree of the financial embargo times the shadow value of foreign debt $\lambda_t m$ equals the marginal utility of consumption $u'(c_t)$.

Thus,

$$c_t = 1/[\lambda_t (1-m)] \quad (5)$$

$$(ii) \partial H_t / \partial i_t = -e^{-\rho t} \lambda_t \{(1-m)\} + e^{-\rho t} \lambda_t q_t = 0, \quad (6)$$

Thus,

$$q_t = (1-m), \quad m < 0 \quad (7)$$

The shadow value of the capital stock q_t equals 1 minus the degree of the financial embargo m .

$$(iii) \partial (-\lambda_t e^{-\rho t}) / \partial t = -\partial H_t / \partial d_t = \lambda_t e^{-\rho t} \rho (1-m) \quad (8)$$

Note that:

$$\partial (-\lambda_t e^{-\rho t}) / \partial t = \dot{\lambda}_t e^{-\rho t} - e^{-\rho t} \dot{\lambda}_t = \dot{\lambda}_t e^{-\rho t} \rho (1-m) \quad (9)$$

This equation will lead to:

$$\dot{\lambda}_t / \lambda_t = \rho m, \quad m < 0 \quad (10)$$

Thus,

$$\dot{\lambda}_t - \rho m \lambda_t = 0 \quad (10)'$$

This is a difference equation.

In order to solve it, we need to multiply both sides by the integrating factor, $e^{-\int(\rho m)t} = e^{-(\rho m)t+C_0}$, Where C_0 is the constant of integration. Therefore,

$$e^{-(\rho m)t} (\dot{\lambda}_t - \rho m \lambda_t) = 0 \quad (11)$$

Note that the left landside of this equation is the derivative of the integration factor times λ_t , so the equation can be rewritten as:

$$d[e^{-(\rho m)t} \lambda_t] = 0 \quad (12)$$

By taking the integration of both sides, equation (12) becomes:

$$\int d[e^{-(\rho m)t} \lambda_t] . dt = \int 0 . dt \quad (12)$$

Then,

$$e^{-(\rho m)t} \lambda_t = C_0, \quad (13)$$

Where, C_0 is the constant of integration.

Thus,

$$\lambda_t = e^{(\rho m)t} C_0, \quad (14)$$

If $t = 0$, then $\lambda_0 = C_0$,

From (5),

$$c_t = e^{-(\rho m)t} \lambda_0^{-1} (1-m)^{-1} \quad (15)$$

When $t = 0$, then,

$$c_0 = \lambda_0^{-1} (1-m)^{-1} \quad (16)$$

Where, c_0 is consumption at time zero.

Thus,

$$c_t = e^{-(\rho m)t} c_0, m < 0 \quad (17)$$

But we need to know c_0 in order to determine the right consumption path. Thus, we need to integrate the dynamic budget constraint to get the intertemporal budget constraint. To do that, we need to follow the following steps:

We re-write first the dynamic budget constraint in the standard form for a linear first-order differential equation as the following:

$$\dot{d}_t - \rho d_t + m \rho d_t = c_t - m c_t + i_t - m i_t - f(k_t) + m f(k_t), \quad (18)$$

$$\dot{d}_t - (1-m)\rho d_t = c_t - m c_t + i_t - m i_t - f(k_t) + m f(k_t), \quad (18)'$$

Multiply both sides of the equation by the integration factor $e^{-\int (1-m)\rho . dt} = e^{-(1-m)\rho t + c_0}$. Thus,

$$e^{-(1-m)\rho t} d_t - e^{-(1-m)\rho t} (1-m) \rho d_t = e^{-(1-m)\rho t} [(1-m) c_t + (1-m) i_t - (1-m)f(k_t)] \quad (19)$$

The left-hand side of the equation is the derivative with respect to t of the integration factor times d_t so we can re-write it to:

$$d[e^{-(1-m)\rho} d_t]/dt = e^{-(1-m)\rho} [(1-m)c_t + (1-m)i_t - (1-m)f(k_t)] \quad (20)$$

Integrate over the interval from 0 to ∞ . Then,

$$[e^{-(1-m)\rho} d_t]_0^\infty = \int_0^\infty e^{-(1-m)\rho t} [(1-m)c_t + (1-m)i_t - (1-m)f(k_t)] .dt \quad (21)$$

Use the transversality condition, $\lim_{T \rightarrow \infty} e^{-(1-m)\rho T} d^T = 0$, to obtain,

$$0 - d_0 = \int_0^\infty e^{-(1-m)\rho t} (1-m)c_t .dt + \int_0^\infty e^{-(1-m)\rho t} (1-m)[i_t - f(k_t)] .dt, \quad (21)$$

$$\int_0^\infty e^{-(1-m)\rho t} (1-m)c_t .dt = \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] .dt - d_0, \quad (21)$$

With (17), then,

$$\int_0^\infty e^{-(1-m)\rho t} (1-m) e^{-(m\rho)t} c_0 .dt = \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] .dt - d_0, \quad (22)$$

Thus,

$$\int_0^\infty e^{\rho t} (1-m)c_0 .dt = \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] .dt - d_0, \quad (23)$$

We can take $(1-m) c_0$ out of the integration since it is constant, therefore,

$$(1-m)c_0 \int_0^\infty e^{\rho t} .dt = \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] .dt - d_0, \quad (24)$$

$$(1-m)c_0 [e^{\rho t} / -\rho]_0^\infty = \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] .dt - d_0, \quad (25)$$

Thus

$$(1-m)c_0 \left[\lim_{T \rightarrow \infty} e^{-\rho T} - (1/\rho) \right] = \int_0^{\infty} e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] . dt - d_0, \quad (26)$$

$$(1-m)c_0 [0 + (1/\rho)] = \int_0^{\infty} e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] . dt - d_0, \quad (27)$$

Thus,

$$c_0 (1-m)/\rho = \int_0^{\infty} e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] . dt - d_0, \quad ((28)$$

Thus,

$$c_0 = [\rho/(1-m)] \int_0^{\infty} e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] . dt - d_0, \quad (29)$$

With (17), then,

$$c_t = e^{-(m\rho)t} \left\{ [\rho/(1-m)] \int_0^{\infty} e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t] . dt - d_0 \right\}, \quad (30)$$

With (10), therefore,

$$\dot{\lambda}_t = d\lambda_t/dt = d[u'(c_t)/(1-m)]/dt = d[1/(1-m)]/dt = [1/(1-m)]$$

$$[u''(c_t) \dot{c}_t]/dt, \quad \dot{c}_t/\dot{\lambda}_t = c_t, \text{ thus,}$$

$$\dot{\lambda}_t = [1/(1-m)] u''(c_t) \dot{c}_t, \quad \lambda_t = [u'(c_t)/(1-m)],$$

Thus,

$$\dot{\lambda}_t/\lambda_t = [u''(c_t)c_t/u'(c_t)] \cdot (\dot{c}_t/c_t), \quad [u''(c_t)c_t/u'(c_t)] = 1 \text{ as long as } u(c_t)$$

$$= \ln(c_t), \quad \text{since } \dot{\lambda}_t/\lambda_t = \rho m, \text{ thus,}$$

$$\dot{c}_t/c_t = \rho m, \quad m < 0 \quad (31)$$

Note that if the degree of the financial embargo $m = 0$, the growth rate of the consumption will also equal zero, and consumption will just be constant.

To find the optimal saving, set:

$$S_t/N_t = f(k_t) - c_t - \rho d_t \quad (32)$$

With, (30), gives:

$$S_t/N_t = f(k_t) - \{ e^{-(m\rho)t} \{ [\rho/(1-m)] \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t]. dt - d_0 \} \} - \rho d_t \quad (33)$$

Thus,

$$S_t/N_t = f(k_t) - \{ e^{-(m\rho)t} \{ [\rho/(1-m)] \int_0^\infty e^{-(1-m)\rho t} (1-m) [f(k_t) - i_t]. dt \} + (\rho m/(1-m)) d_t \} \quad (34)$$

Since,

$$e^{-(m\rho)t} d_0 = dt$$

Note that if the degree of the financial embargo is zero, the optimal saving will not depend on the level of foreign debt in this model and q_t will equal 1. Hence i will equal zero, and saving will equal zero as well. (See the explanation without imposing an installation cost for investment.) The change in optimal saving with respect to the level of debt will equal $\rho m/(1-m)$. Thus, if d changes by 1, optimal saving will changes by $\rho m/(1-m)$, $m < 0$.

$$(v) \partial(\lambda_t q_t e^{-\rho t}) / \partial \alpha = -\partial H_t / \partial K_t = -e^{-\rho t} \lambda_t f'(k_t) + e^{-\rho t} \lambda_t m f'(k_t), \quad (35)$$

$$\partial(\lambda_t q_t e^{-\rho t}) / \partial \alpha = -\partial H_t / \partial K_t = -e^{-\rho t} \lambda_t (1-m) f'(k_t), \quad (36)'$$

From (v),

$$\partial(\lambda_t q_t e^{-\rho t}) / \partial \alpha = \lambda_t (-q_t \rho e^{-\rho t} + e^{-\rho t} \dot{q}_t) + q_t e^{-\rho t} \dot{\lambda}_t = -e^{-\rho t} \lambda_t f'(k_t) (1-m), \quad (37)$$

By dividing both sides by $e^{-\rho t} \lambda_t$, then,

$$q_t - \rho q_t + q_t (\lambda_t / \lambda_t) = f'(k_t) (1-m), \quad (38)$$

From (7), $q_t = 0$, with (38),

$$f'(k_t) = \rho - \rho m, \quad m < 0. \quad (39)$$

Note that, if the degree of financial embargo is zero, the result will just be the static equilibrium condition. For optimal capital stock, the marginal product of capital equals interest rate.

When the degree of the financial embargo increases the interest rate decreases and the capital flows out of the country. This result might prove Walt & Wet conclusion that there were huge capital outflows of the South Africa during the embargo. Note also that the wage of white people will be affected under the assumptions of the model since they own the capital stock. Thus, imposing the financial embargo will affect directly the whites in this country.

Now, let us apply the second assumption:

The Hamiltonian will be:

$$H_t = [u(c_t) - \lambda_t \{c_t + i_t + \rho d_t - f(k_t) + M\} + \lambda_t q_t i_t - \lambda_t g_t \text{ Apartheid}] e^{-\rho t}, \quad (2)$$

We will have the same optimal solutions as without imposing an installation cost for investment. In addition, we will have the following additional equations:

The household controlled by the interest groups, who I am assuming that the whites in the economy will benefit from maximizing the apartheid system, since it gives them more power in the economy.

$$(iv) \partial H_t / \partial (\text{Apartheid}) = -e^{-\rho t} \lambda_t a + e^{-\rho t} \lambda_t g_t = 0 \quad (40)$$

This leads to the following equation:

$$g_t = a, \quad (40)'$$

Where $a = dM / dA$, when apartheid increases, sanctions increase by a .

According to (40)', the shadow cost of the apartheid g_t equals the responsiveness of sanctions to the apartheid system a . If the responsiveness of the international sanctions to the apartheid system is zero, then the shadow cost of the apartheid system becomes zero.

$$(iiv) \partial (\lambda_t g_t e^{-\rho t}) / \partial a = -\partial H_t / \partial M_t = e^{-\rho t} \lambda_t \quad (41)$$

Equation (41) leads to:

$$\lambda_t (e^{-\rho t} \rho g_t + e^{-\rho t} \dot{g}_t) + e^{-\rho t} g_t \dot{\lambda}_t = e^{-\rho t} \lambda_t \quad (42)$$

Note that from the solution of a case without imposing an adjustment cost for investment, $\dot{\lambda}_t / \lambda_t = 0$. In addition, according to the assumption that a is constant and since $g_t = a$, thus, the growth in g_t equals zero as well. Thus (42) becomes:

$$\rho = 1/a \quad (43)$$

Equation (43) is a very important result. According to the assumptions of the model, ρ equals the interest rate, which equals the wage rate of whites. According to this result, when the responsiveness of international sanctions to apartheid increases, the wage rate of whites decreases. In other words, if an international response occurs as a result of the apartheid system in South Africa, whites will be directly affected. On the other hand, the reduction of the interest rate will lead to that environment becoming unattractive to foreign investment. Capital will flow out of the country. This result proves that the sanctions were very effective, since they hit

directly the power of the whites. This may explain the end of the apartheid in South Africa.

Note also that we can find more implications from my model if we combine both assumptions together. We can figure out the effect of apartheid on each variable in the model, but then the model will have to be made more complicated. Further research may be undertaken to offer further contributions on this topic.

Appendix 6: The constructions of the dummy variables:

Table A-6: The construction of the dummy variables:

Time	INST	REACTION	TARGET	APARTHEID	EMBARGO1	EMBARGO2	EMBARGO3
1960:1	1	3	3	1	0	0	0
1960:2	1	3	3	1	0	0	0
1960:3	1	3	3	1	0	0	0
1960:4	1	3	3	1	0	0	0
1961:1	1	3	3	2	0	0	0
1961:2	1	3	3	2	0	0	0
1961:3	1	3	3	2	0	0	0
1961:4	1	3	3	2	0	0	0
1962:1	1	3	3	2	0	0	0
1962:2	1	3	3	2	0	0	0
1962:3	1	3	3	2	0	0	0
1962:4	1	3	3	2	0	0	0
1963:1	1	3	3	2	0	0	0
1963:2	1	3	3	2	0	0	0
1963:3	1	3	2	2	0	0	1
1963:4	1	3	2	2	0	0	1
1964:1	1	3	2	2	0	0	1
1964:2	1	3	2	2	0	0	1
1964:3	1	3	2	2	0	0	1
1964:4	1	3	2	2	0	0	1
1965:1	1	3	3	2	0	0	0
1965:2	1	3	3	2	0	0	0
1965:3	1	3	3	2	0	0	0
1965:4	1	3	3	2	0	0	0
1966:1	1	3	3	2	0	0	0
1966:2	1	3	3	2	0	0	0
1966:3	1	3	3	2	0	0	0
1966:4	1	3	3	2	0	0	0
1967:1	2	3	3	2	0	0	0
1967:2	2	3	3	2	0	0	0
1967:3	2	3	3	2	0	0	0
1967:4	2	3	3	2	0	0	0
1968:1	2	3	3	2	0	0	0
1968:2	2	3	3	2	0	0	0
1968:3	2	3	3	2	0	0	0
1968:4	2	3	3	2	0	0	0
1969:1	2	3	3	2	0	0	0
1969:2	2	3	3	2	0	0	0
1969:3	2	3	3	2	0	0	0
1969:4	2	3	3	2	0	0	0
1970:1	2	3	3	2	0	0	0
1970:2	2	3	3	2	0	0	0
1970:3	2	3	3	2	0	0	0
1970:4	2	3	3	2	0	0	0
1971:1	2	3	3	2	0	0	0
1971:2	2	3	3	2	0	0	0
1971:3	2	3	3	2	0	0	0
1971:4	2	3	3	2	0	0	0
1972:1	2	3	3	2	0	0	0
1972:2	2	3	3	2	0	0	0
1972:3	2	3	3	2	0	0	0
1972:4	2	3	3	2	0	0	0
1973:1	1	3	2	3	0	0	1
1973:2	1	3	3	3	0	0	0
1973:3	3	3	3	3	0	0	0
1973:4	3	3	2	3	0	0	1

1974:1	2	3	2	2	0	0	1
1974:2	2	3	2	2	0	0	1
1974:3	2	3	2	2	0	0	1
1974:4	2	3	2	2	0	0	1
1975:1	2	3	2	2	0	0	1
1975:2	2	3	2	2	0	0	1
1975:3	2	3	2	2	0	0	1
1975:4	2	3	2	2	0	0	1
1976:1	2	3	2	2	0	1	1
1976:2	1	3	2	1	0	1	1
1976:3	1	3	2	1	0	1	1
1976:4	1	3	2	1	0	1	1
1977:1	1	3	2	1	0	1	1
1977:2	1	3	2	1	0	1	1
1977:3	1	3	2	1	0	1	1
1977:4	1	3	2	1	0	1	1
1978:1	2	3	2	2	0	1	1
1978:2	2	3	2	2	0	1	1
1978:3	2	3	2	2	0	1	1
1978:4	2	3	2	2	0	1	1
1979:1	2	3	2	2	0	1	1
1979:2	2	3	2	2	0	1	1
1979:3	2	3	2	2	0	1	1
1979:4	2	3	2	2	0	1	1
1980:1	2	3	3	2	0	1	0
1980:2	2	3	2	2	0	1	1
1980:3	2	3	3	2	0	1	0
1980:4	2	3	3	2	0	1	0
1981:1	2	3	3	2	0	0	0
1981:2	2	3	3	2	0	0	0
1981:3	2	3	3	2	0	0	0
1981:4	2	3	3	2	0	0	0
1982:1	2	3	3	2	0	0	0
1982:2	2	3	3	2	0	0	0
1982:3	2	3	3	2	0	0	0
1982:4	2	3	3	2	0	0	0
1983:1	2	3	3	2	0	0	0
1983:2	2	3	3	2	0	0	0
1983:3	2	3	3	2	0	1	0
1983:4	2	3	3	2	0	1	0
1984:1	1	3	3	1	0	1	0
1984:2	2	3	3	2	0	1	0
1984:3	2	3	3	2	0	1	0
1984:4	2	3	3	2	0	1	0
1985:1	2	3	3	2	0	1	0
1985:2	2	3	1	2	0	1	1
1985:3	1	1	1	3	0	1	1
1985:4	2	1	1	2	0	1	1
1986:1	2	1	1	2	1	1	1
1986:2	1	1	1	3	1	1	1
1986:3	1	3	1	2	1	1	1
1986:4	2	2	1	2	1	1	1
1987:1	2	2	2	2	1	1	1
1987:2	2	2	2	2	1	1	1
1987:3	2	2	1	2	1	1	1
1987:4	2	2	2	2	1	1	1
1988:1	1	2	2	1	1	1	1
1988:2	2	2	2	2	1	1	1
1988:3	2	2	2	2	1	1	1
1988:4	2	2	2	2	1	1	1

1989:1	2	2	2	2	1	1	1
1989:2	2	2	2	2	1	1	1
1989:3	2	2	2	2	1	1	1
1989:4	2	2	2	2	1	1	1
1990:1	2	3	1	3	1	0	1
1990:2	2	3	2	2	1	0	1
1990:3	2	3	2	2	1	0	1
1990:4	2	3	2	2	1	0	1
1991:1	2	3	1	2	1	0	1
1991:2	2	3	2	2	1	0	1
1991:3	2	3	2	2	1	0	1
1991:4	2	3	2	2	1	0	1
1992:1	2	3	3	2	0	0	0
1992:2	2	3	3	2	0	0	0
1992:3	2	3	3	2	0	0	0
1992:4	2	3	3	2	0	0	0
1993:1	2	3	3	2	0	0	0
1993:2	2	3	3	2	0	0	0
1993:3	2	3	3	2	0	0	0
1993:4	2	3	3	2	0	0	0
1994:1	2	3	3	2	0	0	0
1994:2	3	3	3	4	0	0	0
1994:3	3	3	3	4	0	0	0
1994:4	3	3	3	4	0	0	0
1995:1	3	3	3	4	0	0	0
1995:2	3	3	3	4	0	0	0
1995:3	3	3	3	4	0	0	0
1995:4	3	3	3	4	0	0	0
1996:1	3	3	3	4	0	0	0
1996:2	3	3	3	4	0	0	0
1996:3	3	3	3	4	0	0	0
1996:4	3	3	3	4	0	0	0
1997:1	3	3	3	4	0	0	0
1997:2	3	3	3	4	0	0	0
1997:3	3	3	3	4	0	0	0
1997:4	3	3	3	4	0	0	0
1998:1	3	3	3	4	0	0	0
1998:2	3	3	3	4	0	0	0
1998:3	3	3	3	4	0	0	0
1998:4	3	3	3	4	0	0	0
1999:1	3	3	3	4	0	0	0
1999:2	3	3	3	4	0	0	0
1999:3	3	3	3	4	0	0	0
1999:4	3	3	3	4	0	0	0
2000:1	3	3	3	4	0	0	0
2000:2	3	3	3	4	0	0	0
2000:3	3	3	3	4	0	0	0
2000:4	3	3	3	4	0	0	0
2001:1	3	3	3	4	0	0	0
2001:2	3	3	3	4	0	0	0
2001:3	3	3	3	4	0	0	0
2001:4	3	3	3	4	0	0	0
2002:1	3	3	3	4	0	0	0
2002:2	3	3	3	4	0	0	0
2002:3	3	3	3	4	0	0	0
2002:4	3	3	3	4	0	0	0
2003:1	3	3	3	4	0	0	0
2003:2	3	3	3	4	0	0	0
2003:3	3	3	3	4	0	0	0
2003:4	3	3	3	4	0	0	0

2004:1	3	3	3	4	0	0	0
2004:2	3	3	3	4	0	0	0
2004:3	3	3	3	4	0	0	0
2004:4	3	3	3	4	0	0	0

Sources: Levy (1999), p.p. , Trade Policy Review, South Africa, GATT, Vol.1, September 1993, P.P. 21-23, on net sources; i.e. <http://africanhistory.about.com>, <http://www.sahistory.org.za>, and others.

- The degrees I give to each event depend on my own judgment according to my reading to various political and economic sources about South Africa.
- For annual data, I take the most dominated value for each year. For instance, if the 4 quarters of any year include the value one in any quarter, I consider the whole year takes the value one.

Notes on table A-6:

APARTHEID & PINST:

1960, 1: Sharpeville Massacre.

I consider the whole period of 1960s a period of political instability.

I give it (1) for *PINST* until 1966. Then, I give it (2) for *PINST* until 1969. While I consider the year of 1960 is (1) for the *APARTHEID* and (2) during the whole period from 1961 to 1969 because I consider periods of *APARTHEID* are periods of observed human rights violations cause worldwide outcry.

1973, 1 & 2: The Durban strikes, the first major labour unrest of the apartheid period. ((1) is considered to be in *PINST*). However, 1973, 2 & 3 & 4: In 1973, in response to the resulting labour shortages, blacks were allowed to work at skilled jobs in white areas. ((3) for *APARTHEID*), 1973,3 & 4. ((3) for *PINST*).

1976, 2 (June 16th), 1976, 3, 1976, 4, 1977, 1, 1977, 2, 1977, 3, 1977, 4: The Soweto uprising began June 16. More fundamentally, the uprising went on for approximately a year and a half. (1) Another opinion – “and so it continued for the rest of 1976.” So I consider here *PINST* = *APARTHEID* both are (1) during the period 1976, 2 (June 16th), 1976, 3, 1976, 4, 1977, 1, 1977, 2, 1977, 3, 1977, 4 which includes also the instable period of Biko’s death.

1977, 3: “September 1977, the brutal circumstances of Biko’s death caused a worldwide outcry and became a martyr and symbol of black resistance to the oppressive apartheid regime. The United Nations Security Council responded by finally imposing an arm embargo against South Africa.” *PINST*: (1) & *APARTHEID*: (1).

1984,1: In 1984 the South African government adopted a new constitution that gave Indians and coloureds some right to participate but continued to exclude blacks.

APARTHEID (1), *PINST* (1)

1985, 3: The first state of emergency. *APARTHEID* (3), *PINST* (1)

1986, 2: The second state of emergency. *APARTHEID* (3), *PINST* (1)

1986, 3: The tenth anniversary of the Soweto uprising. (1) (To be considered in *PINST* not in *APARTHEID*)

1988, 1: The government banned all major non white opposition groups and prohibited political activity by trade unions. *PINST* = *APARTHEID* = 1.

1990, 1: February, 1990, Nelson Mandela was released from prison. *APARTHEID* (3), *PINST* (2)

1994, 2: In April 1994, Mandela won the first all-race election to become president. ((3) for *PINST*) & ((4)for *APARTHEID*)

APARTHEID = *PINST* = (2), otherwise.

See for example: <http://africanhistory.about.com/library/weekly/aa-sharpevilleMassacre-a.htm>,

<http://www.sahistory.org.za/pages/specialprojects/labour-history/73-strikes.htm>,

<http://africanhistory.about.com/library/weekly/aa060801b.htm>,

<http://africanhistory.about.com/library/weekly/aa030402a.htm>, etc.

REACTION:

1985, 3: The government of South Africa suspended interest payment on foreign debt and introduced a dual-exchange-rate regime to discourage disinvestment. (1)

1985, 4: Freezing debt repayments. (1)

1986, 1: Freezing debt repayment. (1)

1986, 2: “February 1986, the government of South Africa has reached an interim agreement with creditors.” (1)

1986, 4 until 1989, 4: “South Africa developed extensive measures to circumvent the sanctions. South Africa also was able to tranship through countries that were not participating in the embargoes.” (2)

See Levy (1999), P.417-418

TARGET1

1963, 3 1963, 4: August, 1963: "United Nations # 181: Non-compulsory embargoes on weapons sales to South Africa." (2)

1964, 1 to 1964, 4: 1964: Comprehensive trade embargo from India and Investment embargo from Japan. (2)

1973, 1: Oil embargo by OPEC nations. (2)

1973, 4 – 1979: November 1973: "Oil Embargo to South Africa up till the fall of Shah in 1979, however, Iran continued to supply South Africa with oil." (2)

1976, 2: Arms embargo by the United Nations as a result of Soweto uprising. (2)

1977, 1 – 1977, 4: 1977: United Nations: Weapon embargoes and continuing oil embargo. (2)

1979, 1-1979, 4: 1979: Oil exports embargo from UK and Investment embargo from Sweden.

(2)

1980, 2: Mid-1980, s sanctions. (2)

1985, 2 – 1985, 4: 1985: June, "Fruit and vegetables import embargo and pure oil embargo from Norway, cancellation of Air traffic agreement from Denmark, Norway, and Sweden. July: Investment embargo, Krugerrands embargo, cultural and support boycott, financial embargo, termination of Nuclear energy contracts. October: oil embargo, nuclear energy embargo, trade embargo on weapons equipments from the commonwealth. November: Trade embargo on coal imports from South Africa by France. December: Navy control by Norway. 1985, 3: Financial embargo from Canada and financial embargo from UK." (1)

1985, 3: Financial embargo from Canada and financial embargo from UK. (2)

1986, 1 – 1986, 4: "1986 January: Trade embargo on Agricultural products by Sweden. March: Trade embargo on Fruits and vegetables by Ireland. May: Trade boycott from Denmark, June: An announcement of trade embargo on coal by Denmark. July: Oil embargo from Norway. August: Trade embargo on Agricultural products, coal, iron, and Uranium by New Zealand. September: Trade embargo on coal except Ferro-alloys, trade embargo on Kugerrands, and investment embargo by EU. Trade embargo on iron includes Ferro-alloys by Japan and Australia. October: trade embargo on the imports of Kruggerrands, weapons, Uranium, Iron, texture, agricultural products and food, trade embargo on computers exports and pure oil and its products by USA. November: Closing all Canadian tourism offices in South Africa by Canada." (1)

1987, 1 & 1987, 2: Undetermined but considered to be a period of sanctions. (2)

1987, 3: August: Investment embargo, financial embargo, Trade embargo on some products and extending sanctions for one more year by USA. (1)

1987, 4 to 1989, 4: 1987, 3 & 4: August, financial embargo by USA. The rest of the period is undetermined but considered to be a period of sanctions. (2)

1990, 1: March, the lift of the investment embargo from UK. (1)

1990, 2 – 1990, 4: Undetermined but considered to be a sanction period. (2)

1991, 1: February, re-imposing an investment embargo by EU. (1)

1991, 2: Undetermined but considered to be a sanction period. (2)

1991, 3 & 4: July, The lift of the embargo by USA except from some states. October, The lift of the sanction program against South Africa by Japan and USA only. (2)

1992, 1 & 2: 1992: January, returning the diplomatic relationship and the lift of the trade embargo on Iron and Kruggerands by Japan and EU. April, The lift of the trade embargo on oil, the lift of the cultural and scientific embargo by EU. (3)

1992, 3: Undetermined. (3)

1992, 4: October, the lift of the oil embargo by Italy. (3)

1993, 1: The end of sanctions by Norway. (3)

See: Trade Policy Review, South Africa, GATT, Vol.1, September 1993, P.P. 21-23

EMBARGO

EMBARGO1 takes the value one during the multilateral financial embargo from 1986 to 1991 and zero otherwise.

EMBARGO2 takes the value one during two main periods. The first period is from 1976 to 1980 which is considered the capital outflows period as a response to Soweto uprising and observed human rights violations. The second period is from 1983, 3 to 1990, 1. During this second period, Canada, UK, and USA imposed financial embargo on South Africa. **EMBARGO2** takes the value zero otherwise.

EMBARGO3 takes the value one for any type of economic sanctions stated in **TARGET1** and takes the value zero otherwise.

See: Levy (1999) and Trade Policy Review (September 1993).

Glossary of Symbols

K : Capital stock.

Y : Output.

N : The number of workers.

C : Consumption.

k : Per capita capital stock.

y : Per capita output.

c : Per capita consumption.

s : The saving rate.

n : Growth rate of labour.

$\dot{K}$: Change in capital stock over time.

$\dot{N}$: Change in labour over time.

$\dot{k}$: Change in per capita capital stock through time.

$\dot{k}/k$: Growth rate of per capita capital stock.

$\dot{y}/y$: Growth rate of per capita output.

r : Domestic interest rate.

$f'(k)$: Marginal product of capital.

I : Investment.

i : Per capita investment.

r_w : Foreign interest rate.

$f'(k)_{open}$: Marginal product of capital of the open economy.

X : Net exports.

x : Per capita net exports.

D : Debt.

rD : Interest outflow.

D : Per capita debt.

rd : Per capita interest outflow.

B : Current account deficit.

b : Per capita current account deficit.

$\dot{D}$: The growth of debt.

$\dot{d}$: The growth of per capita debt.

$Y - r_w D$: Income. (GNP).

$y - r_w d$: Per capita income. (per capita GNP).

ρ : The rate of time preference.

$T(i/k)$ or $T(\cdot)$: The installation cost.

q_t : The shadow value of per capita capital stock.

g_t : The shadow value of the apartheid.

M_t : The financial embargo.

m : The degree of the financial embargo.

PINST is a dummy variable takes on the following values:

- The value one if there are observed political problems that draw the attention of the international community,
- The value two if there is a stable state of political status, and
- The value three if there's any political reform.

REACTION is a dummy variable takes on the following values:

- The value one if there is any trial for financial circumventions as a reaction of the financial embargo,
- The value two if there is any trial for other economic circumventions as a reaction to the international economic sanctions, and
- The value three if there is no internal reaction.

TARGET1 is a dummy variable takes on the following values:

- The value one if there are comprehensive international sanctions rather than a financial embargo,
- The value two if there are no comprehensive economic sanctions, and
- The value three if there are no any types of sanctions imposed on South Africa.

EMBARGO1 is a dummy variable takes on the value 1 during the period of imposing the multilateral financial embargo from 1986 to 1991 and takes on the value 0 otherwise.

EMBARGO2 is a dummy variable takes on the value 1 during the periods of imposing any type of financial sanctions on South Africa and takes on the value 0 otherwise.

EMBARGO3 is a dummy variable takes on the value 1 during the periods of imposing any type of comprehensive sanctions on South Africa and takes 0 otherwise.

APARTHEID reflects the degree of the observed human rights' violations in South Africa. **APARTHEID** takes on the following values:

- (1) For the highest degree of the observed violation to human rights.
- (2) If there is a stable state of apartheid (Human rights violation does not draw the attention of the international community).
- (3) If there is an internal political reform to reduce the human rights violation. (I consider any trial for political reforms regarding the apartheid).
- (4) For the lift of the apartheid.

TRADESHARE is a quantitative variable that measures the ratio of trade to the GDP of South Africa as a measure of the degree of the openness of South Africa.

FOREIGNRATE is the lending rate – as a proxy for the world interest rate.

GROWTH_{USA} is the economic growth rate of USA, or, the growth rate of the per capita real GDP of USA.

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