

SAVINGS - INVESTMENTS Model **In EGYPT**

Cherine Mohamed Morsi

*School of Computing, Engineering and Technology
University of Sunderland
E-mail: shereen_morsi@hotmail.com*

Professor Alfredo Moscardini

*School of Computing, Engineering and Technology
University of Sunderland
E-mail:alfredo.moscardini@sunderland.ac.uk*

Abstract

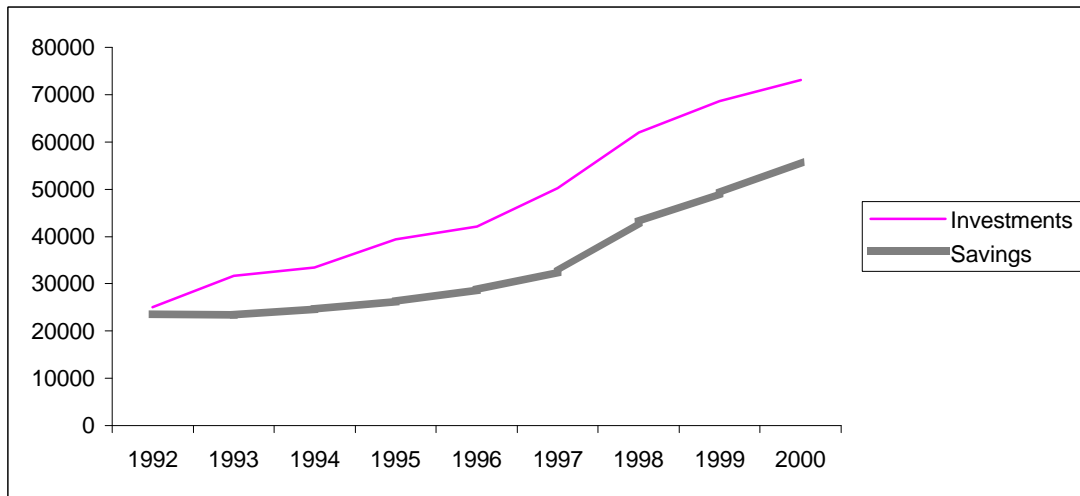
The purpose of the System Dynamics method is to study the relationship between structure and behavior in non-linear, dynamic systems. In such systems, the significance of various structural components to the behavior pattern exhibited, changes as the behavior unfolds. Changes in structural significance, in turn modifies that behavior pattern, which, in turn, feeds back to change the relative significance of structural components. We develop a macroeconomic model which we can study the characteristics of this feedback between structure and behavior. This model is based on multiplier-accelerator model, and inventory – adjustment model. This work is an extension of the work by Nathan Forrester on the use of basic macroeconomic theory to stabilize policy analysis. Our main contribution, in this paper, is embedding the gap between savings and investments that already exist in Egyptian economy and how eliminating this gap. Explaining the reasons beyond this problem need first exhibit Egyptian economic cycle representing in production Cycle: that produce gross domestic production (GDP), The GDP depends on potential production (which consists of Labor force and capital that available in our society) and total demand in short-term. Capital Formation cycle: That depends on Total Domestic Investment (which consists of public investment (government sector) and private investment (business, household sector). The Total Domestic investment depends on what 's available from local resources (Government's revenue and total local savings). The macroeconomic level contains many feedback loops that require from us to offer a structural interpretation of the behavior exist in Egyptian economy.

Introduction

Collecting savings and directing them to the various investment fields are the main requirements of development, therefore achieving increasing rates of economic development. This requires the presence of local savings sufficient to finance the investment necessary to achieve the required accumulation of capital to make the economic growth exceeds the population growth.

Thus we see a relationship between the savings and the economic growth, the more the savings, the more the investments and the higher the rate of growth of production through the accumulation of capital.

This paper is trying to explain the previous savings – investments problem by using system dynamic approach that will help us evaluate the current problems and the proposed solution.



Through the graph, it is obvious that investments is increasing more than the increase of local savings, this gap means there is a shortages in capital requirements to build internal production capacity to achieve economic growth and development. That creates a tendency to resort to internal and external sources of finance. One of the most important external sources is external debt. Managing internal and external debt represents a real challenge to the state. With the shortage of domestic Savings to feed the required growth, the dependency on internal and external capital flows, including debt, becomes a necessity. But the effects of the build up of debt have crucial negative effect on the recipient economy in the long run.

Guided by the economic models suggesting that growth rate can be stepped up by increasing Savings for Investment, the government has often resorted to local and foreign capital borrowing to supplement domestic savings in their efforts to fuel industrialization and production capacity. The borrowed capital is also often used to finance capital imports necessary to expand the export industries and for capital outlays for upgrading the infrastructure.

Conceptual Model

Dynamic Hypothesis

The inadequacy of domestic capital and savings leads to a shortage of satisfying domestic development and industrialization plans. In the beginning of the borrowing process, capital and investments increase significantly, levels of expected income and production increase and further development targets are set for the future, so local and foreign debt is required.

The process is reinforcing and growing significantly. A buildup of internal capacity mean achieve desired capital may lead to the easiest way which is borrowing, but at a certain point of time the debt increase and we should pay it in maturity period.

So to achieve high economic growth depend on the recourses that available to invest, but when trying to reach this highly growth by using debt it lead to decrease the income of our country to pay the loans by interest rate and the effect of it appear on low level of savings and this increase the gap between the savings and investment.

Structural Assumptions:

To capture the process, we must start with describing the internal mechanisms of capacity buildup via capital acquisition, the domestic savings and the total domestic investments flows that lead to the aggregation of domestic income or production (GDP). This cycle can be describes with the multiplier accelerator mechanism first developed by Samuelson 1939.

The first important concept in the multiplier-accelerator model is the mutual dependency of consumption and output. Consumption depends on the level of output, and output responds to the level of aggregate demand. Together represent the multiplier process; it is positive loop feedback reinforcing process. Through the multiplier, a disturbance in demand produces a change in output and a proportional change in consumption, which feeds backs to further disturbance in aggregate demand.

The second important concept in the multiplier –accelerator model is that investment depends on demand. The model represents investment as a function of the change in consumption, but the underlying concept is that increased demand requires increased capital stock to maintain factor balance in the production process. For the purposes of this study it is convenient to restate the relationship by expressing desired investment as a function of desired capital and desired capital as a function of the expected long-term demand. This dependence of investment on demand creates the accelerator process. Through the accelerator, a disturbance in demand produces a change in output and a proportional change in desired capital and desired investment, which disturbs demand.

Here a minor modification was made to the model; investment is determined by a simple stock adjustment formula for capital. Total capital investment is the sum of capital depreciation plus the difference between desired and actual capital the actual capital stock is the accumulated difference between investments depreciation. Another alteration of the basic model is the introduction of the production capacity concept. In basic model, output is a one period lag of demand, regardless of the capacity to produce. The assumption is changed so that output is affected by potential output as well as demand. And potential output is formed as Cobb-Douglas function of two factors, Labor force and Capital. Both Labor and capital are adjusted in response

to change in expected demand. Expected demand is a moving average of current demand. Employment responds to short-term change in demand, while capital responds to long-term change in demand. The difference between output and potential output is explained by change in capacity utilization. Primarily through the use of over and under time.

These two modifications to the model developed by Samuelson has been suggested also by Nathan Forrester in his distinguished study of the stabilization of the US economy.

We will introduce some modification to the assumptions of Nathan Forrester as well. In his model, Forrester assumes that investment is determined by a simple stock adjustment formula for capital .We will distinguish between desired investment, which is the difference between desired and actual capital stock plus capital-depreciation. And actual investment, which depends on the adequacy of total domestic investment capabilities. The model developed by Nathan Forrester assumes the actual and desired investment are the same and the economy can automatically provide the amounts required of investment, which is not true in the real world and especially in the case of Egypt. For the purpose of this study we will cut the major loop of the multiplier-accelerator model. Actual investment will be total domestic investment capacity and its depends on private investment (come from local savings in banks and it depends in fraction of investment for private sector) and public investment (come from government sector and it depends on current revenue for government and fraction of investment) Plus we will add foreign investment as fraction of GDP. The discrepancy between actual and desired investment will represent the desired loan.

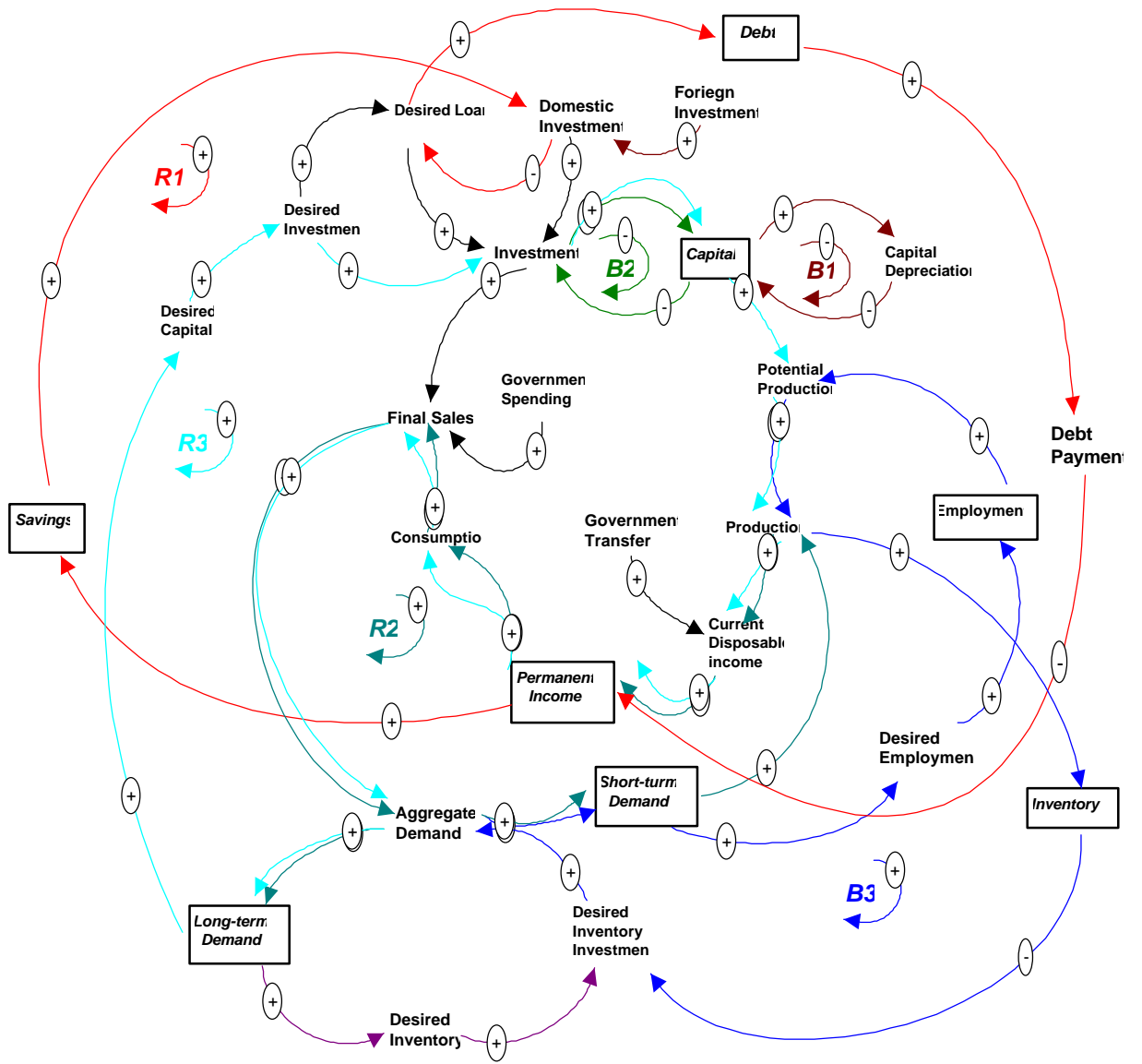
This paper will use the multiplier –accelerator model as a basic structure that show the accumulation of capital need desired investment and according to shortage resource lead government to finance by external debt and that will lead to accumulate loans and it will decrease through the loan payment which take from total income of the country.

None of the above modifications change the theory underlying the models of Samuelson or Nathan Forrester. They make more explicit the disequilibrium adjustment process that produce the mechanism of building up capital and output in response to change in demand and vise versa. These modifications serve the purpose of this study.

The Second important concept is the Inventory –adjustment model, inventory is treated as the stock of finished goods, which increase by output and decrease by final sales, and inventory feedback to output through desired inventory investment by expected demand, desired inventory investment is equal the difference between desired and actual inventory, and desired inventory is proportional to long-term expected demand.

The inventory loop adds to model to express about business cycle and determine the total aggregate demand in Egyptian economy.

Causal Loop Diagram



Danger Loop (R1):

This loop starts when the gap between total domestic investment desired investment created, the government tends to borrow as a way for increasing resources to achieve wanted investment and this will return achieving high economic growth, the debt will increase and will decrease by loan payment which lead to decrease permanent income, so the savings will decrease and it will lead to another loop of borrowing.

Multiplier Process (R2):

In this loop consumption depend on the level of production, and production respond to the level of short term expected demand, when production increase, the current disposable income, and permanent income will increase so that will increase the level of consumption which makes increase in demand and lead to produce more and so on.

Accelerator Process (R3):

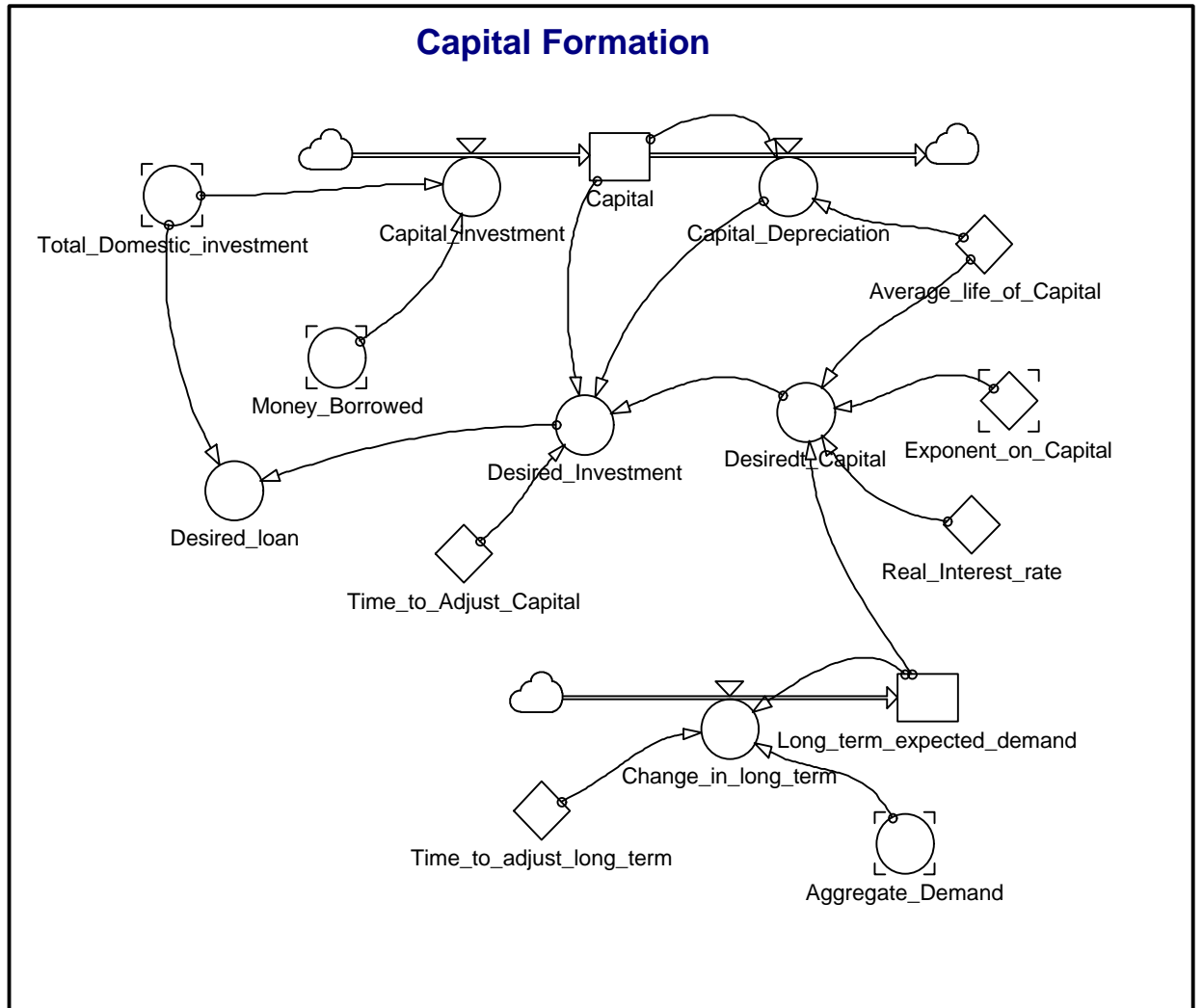
The investment depend on long term expected demand, when investment increase the capital, potential production, production, current disposable income and permanent income will increase which lead consumption to increase aggregate demand and that will raise long term expected demand and sequentially raise desired capital and desired investment.

Business Cycle (B3):

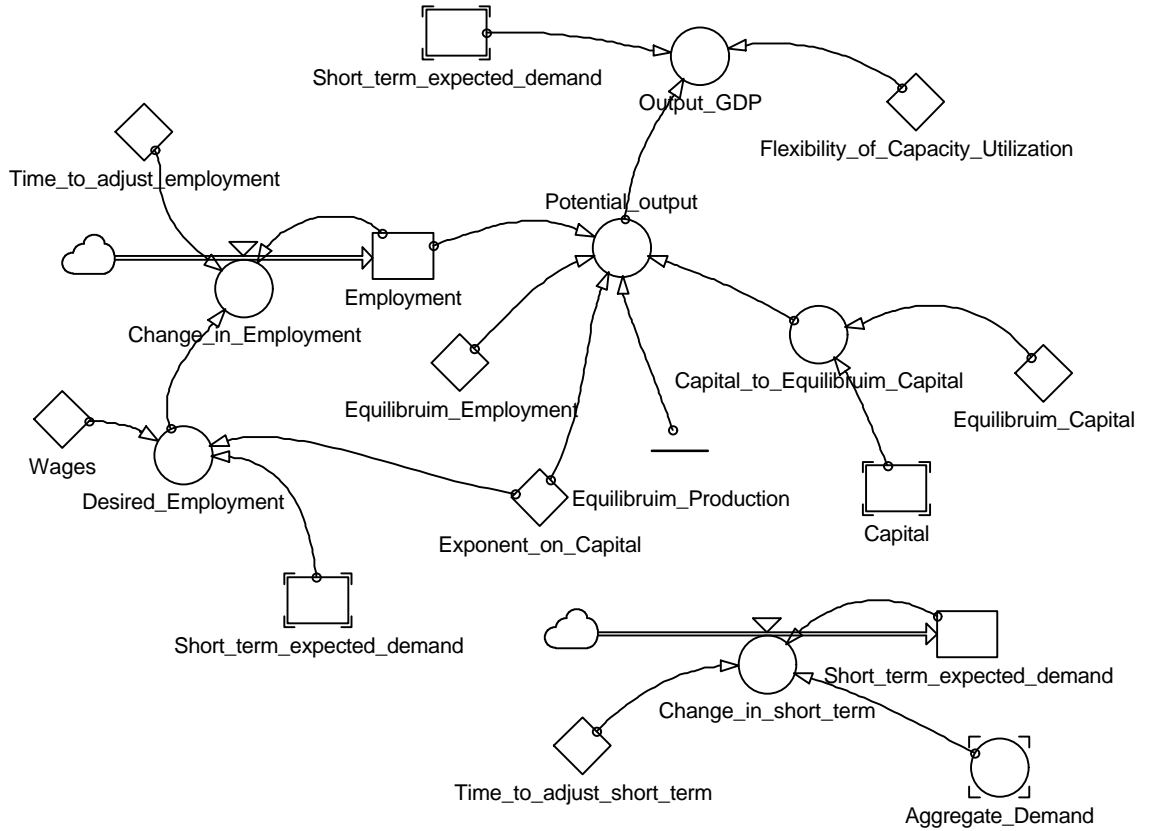
The effects of this loop can be traced starting at aggregate demand, An increase in aggregate demand raises short term expected demand, which pushes up desired employment .The increase in desired employment raises employment and that will lead to greater production and accumulation of inventory so high level of inventory will decrease level of desired inventory investment.

FORMAL MODEL

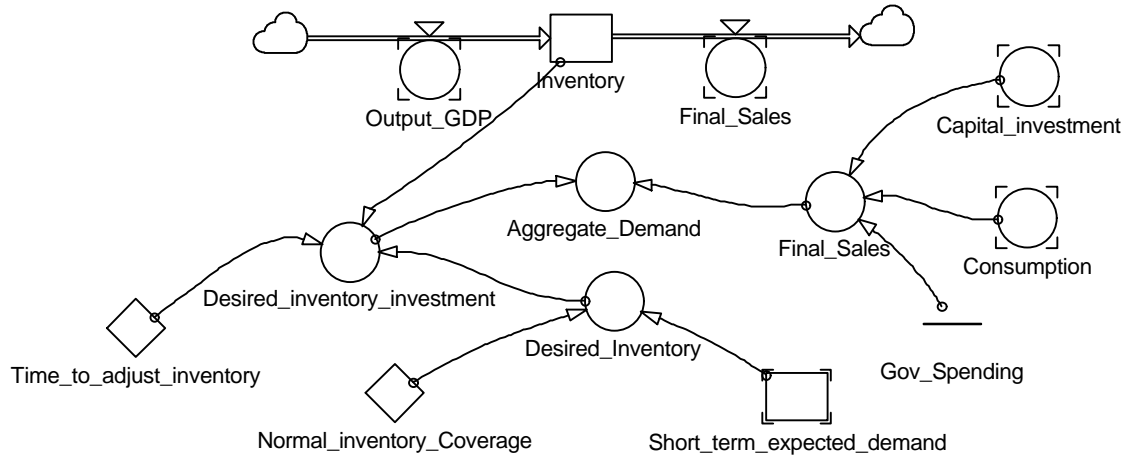
Stock and Flow diagram



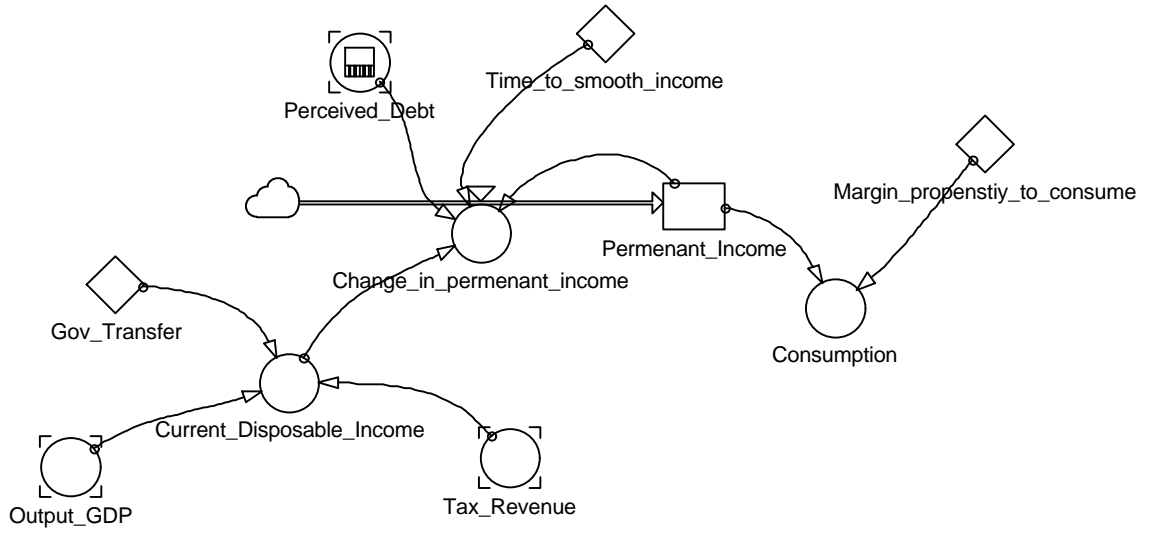
Demand For Production



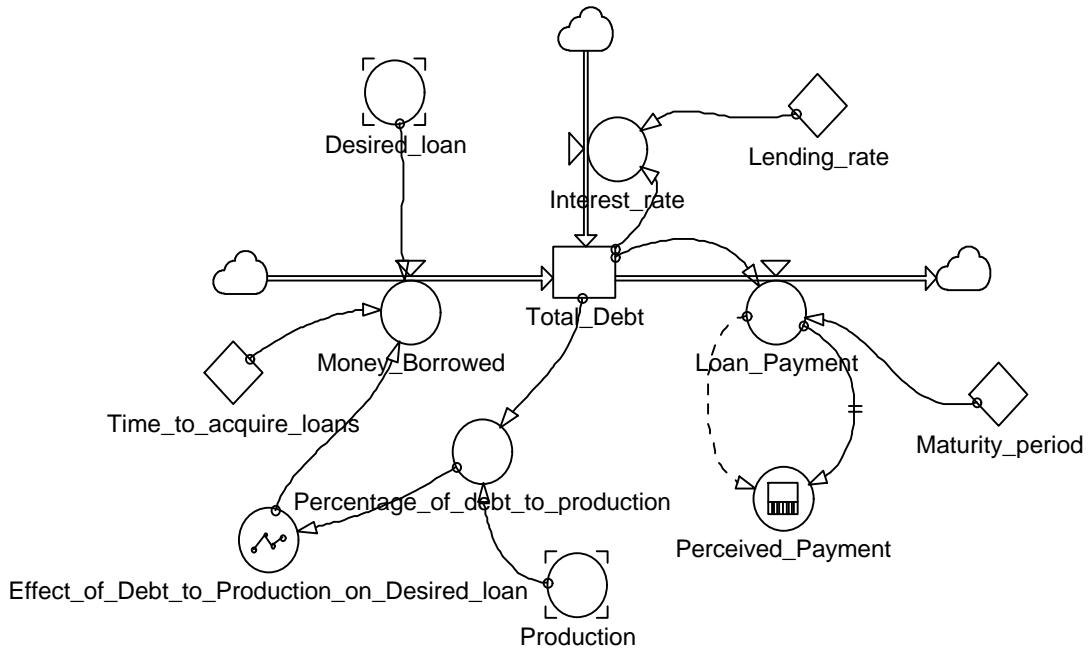
Inventory Adjustment

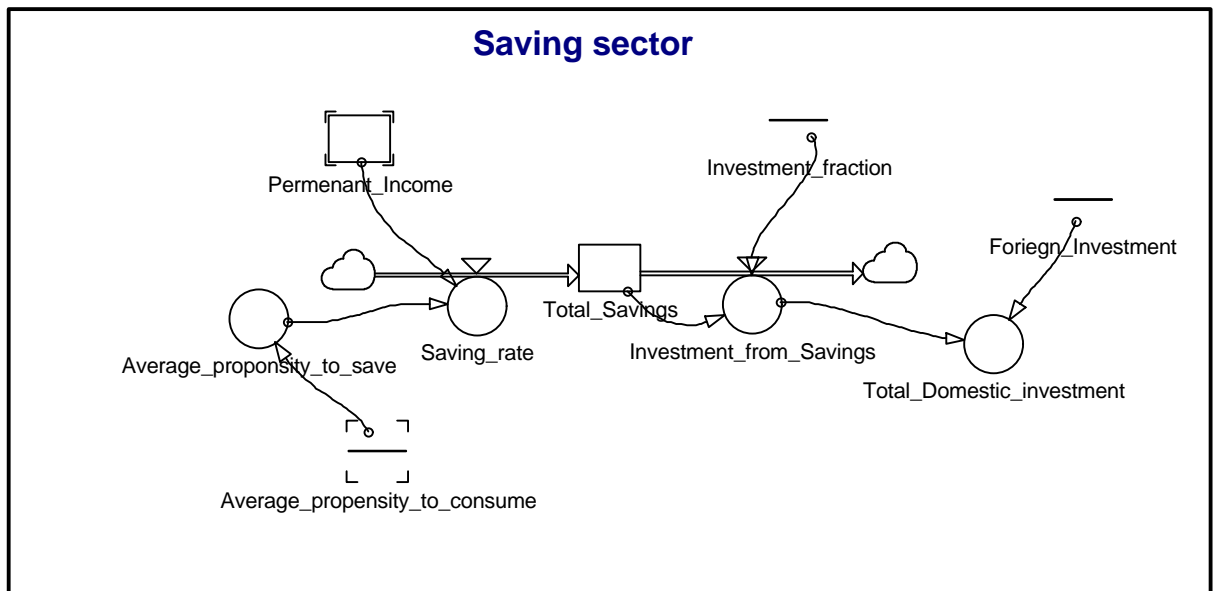


Income Creation



Debt formation





Documentation

The following are the model variables with full description. Appendix (1) contains powersim printout of all variables, equations and documentation sorted alphabetically

Production (GDP) :

Production is a weighted average of potential production and short-term expected demand.

$$\text{Production} = \text{Potential_Production} * (1 - \text{Flexibility_of_Capacity_Utilization}) + \text{Short_term_expected_demand} * \text{Flexibility_of_Capacity_Utilization}$$

LE means Local Pounds

- Production measured in (LE/Year)
- Potential production measured in (LE/Year)
- Short-term expected demand measured in (LE/Year)
- Flexibility of capacity utilization measured in (Dimensionless)

Potential production:

Potential production is determined by labor force (represent in no. of employees) and capital stock according to Cobb-Douglas production function.

$$\text{Potential production} = \text{Equilibrium_Production} * (\text{Employment_to_Equilibrium_Employment})^{(1 - \text{Exponent_on_Capital})} * (\text{Capital_to_Equilibrium_Capital})^{\text{Exponent_on_Capital}}$$

- Equilibrium production measured in (LE/Year)
- Employment to Equilibrium Employment measured in (persons)

- Capital to Equilibrium capital measured in (LE)
- Exponent on capital measured in (Dimensionless)

Employment:

Employment is the total man-hours dedicated to production.

- Employment measured in (persons)

Change In Employment:

The Change in Employment determined by the net difference between Desired and actual Employment and divide by time to adjust employment.

$$\text{Change in employment} = (\text{Desired_Employment} - \text{Employment}) / \text{Time_to_adjust_employment}$$

- Change in employment measured in (Persons/Year)
- Desired employment measured in (persons)
- Time to adjust employment measured in (years)

Desired Employment:

Desired employment is proportional to short-term expected demand. It's equal to exponent on labor in the production function multiplied by short-term expected demand divided by the wages.

$$\text{Desired employment} = (1 - \text{exponent on capital}) * \text{short-term expected demand} / \text{wages}$$

- Desired employment measured in (Persons)
- Short-term expected demand measured in (LE/Year)
- Wages measured in (LE/persons/year)

Short-term expected demand:

Sectors that produce have their expectation about sales in future ,so short-term expected demand determined as average of aggregate demand .

- Short-term expected demand (LE/Year)

Change In short-term expected demand :

The Change in short-term expected demand determined by the net difference between aggregate demand and short-term expected demand and divide by time to adjust short-term expected demand.

$$\text{Change short-term expected demand} = (\text{Aggregate demand} - \text{short-term expected demand}) / \text{time to adjust short-term expected demand}$$

- Change short-term expected demand measured in ((LE/Year/Year)
- Aggregate demand measured in (LE/Year)
- Time to adjust short-term expected demand measured in (Years)

Capital:

The Stock of Capital is accumulated by investment and decreased by depreciation. Therefore, the rate of change in capital is equal to the difference between Capital investment and Capital depreciation.

- Capital measured in (LE)

Capital investments:

The Capital investment is the total investments that lead to increase the capital, and it is summation of available of the total domestic investments and the money borrowed.

$$\text{Capital investments} = \text{MAX}(0, (\text{Total_Domestic_investment} + \text{Money_Borrowed}))$$

- Capital investments measured in (LE/Year)
- Money Borrowed measured in (LE/Year)
- Total Domestic investments measured in (LE/Year)

Capital Depreciation:

Physical capital is assumed to have a constant average service life. Capital depreciation is there for proportional to capital stock.

$$\text{Capital Depreciation} = \text{Capital} / \text{Average Life of Capital}$$

- Capital Depreciation measured in (LE/Year)

Desired Investment:

The desired investments is determined by the difference between desired capital which the county need to reach it to achieve highly economic growth and capital divide by the time need to achieve this capital plus capital depreciation.

$$\text{Desired investments} = ((\text{Desired Capital} - \text{Capital}) + \text{Capital Depreciation}) / \text{Time to adjust Capital}$$

- Desired investment measured in (LE/Year)
- Desired Capital measured in (LE)
- Time to adjust capital measured in (Years)

Desired Capital:

Capital unlike labor is a long-lived asset for production sector. Capital should respond more slowly than labor to changes in demand and inventory conditions. Desired capital is therefore a function of long term expected demand.

$$\text{Desired capital} = \text{Exponent on capital} * \text{Long term expected demand} / (1/\text{average life of capital}) + \text{interest rate}$$

- Desired capital measured in (LE/Year)
- Long term expected demand measured in (LE)
- Interest rate measured in (fraction/Year)
- Average life of capital measured in (years)

Long term expected demand

The long term expected demand is an exponential average of aggregate demand, and it considers the expectation of long term demand, and it initializes by equaling the total production (GDP).

- Long term expected demand measured in (LE).

Change in Long-term expected demand:

The Change in Long-term expected demand is determined by the net difference between aggregate demand and Long-term expected demand and divided by time to adjust Long-term expected demand.

$$\text{Change Long-term expected demand} = (\text{Aggregate demand} - \text{Long-term expected demand}) / \text{time to adjust long-term expected demand}$$

- Change long-term expected demand measured in ((LE/Year/Year)
- Aggregate demand measured in (LE/Year)
- Time to adjust long-term expected demand measured in (Years)

Inventory:

The rate of change in inventory is the difference between production and final sales.

- Inventory measured in (LE)

Final Sales:

The final sales represent the total demand in the economy, so it's the summation of consumption plus investment and government expenditure.

$$\text{Final Sales} = \text{consumption} + \text{capital investments} + \text{government expenditure}$$

- Final sales measured in (LE/Year)
- Consumption measured in (LE/Year)
- Capital investment measured in (LE/Year)
- Government expenditure measured in (LE/Year)

Desired inventory:

Desired inventory is assumed to be proportional to short-term expected demand.

$$\text{Desired inventory} = \text{Normal inventory coverage} * \text{short-term expected demand}$$

- Desired inventory measured in (LE)
- Normal inventory coverage measured in (Years)

Desired inventory investment:

The desired inventory investment is determined by the difference between desired and actual inventory.

$$\text{Desired inventory investment} = (\text{desired inventory} - \text{inventory}) / \text{time to adjust inventory}$$

- Desired inventory investment measured in (LE/Year)

- Desired inventory measured in (LE)
- Inventory measured in (LE)
- Time to adjust inventory measured in (Years)

Permanent income:

Permanent income is average of current disposable income , the rate of change in permanent income is the fraction of the discrepancy between current disposable income and permanent income .

- Permanent income measured in (LE/Year)

Change in permanent income :

The change in permanent income is the difference between current disposable income, permanent income and perceived debt service.

$\text{Change in permanent income} = \frac{\text{Current disposable income} - \text{permanent income} - \text{perceived debit service}}{\text{time to smooth income}}$
--

- Change in Permanent income measured in (LE/Year/Year)
- Current disposable income measured in (LE/Year)
- Perceived debit service measured in (LE/Year)
- Time to smooth income (Year)

Consumption:

The consumption is the amount of money spend on domestic products and services per year.

$\text{Consumption} = \text{Permanent income} * \text{Average Propensity to consume}$

- Consumption measured in (LE/Year)

Total Savings:

Total Savings are the total deposits that exist in Banks from Government sector plus Non-Government sector and it is increased by saving rate and decreased by private investments.

- Total Savings measured in (LE)

Saving rate:

The saving rate is the rest of income that not consume and it depends on average propensity to save and permanent income

$\text{Saving rate} = \text{Permanent income} * \text{Average propensity to save}$
--

- Saving rate measured in (LE/Year)
- Average propensity to save measured (fraction/year)

Investment from Savings:

The investment from savings means the resources that available from internal country and directed to invest in all projects .

$$\text{Investment from savings} = \text{Dleaymtr}(\text{otal_Local_Saving}, 1, 1, \text{Total_Local_Saving}) * \text{Invest_frac}$$

- Investment from savings measured in (LE/Year)

Total Domestic investments

The total domestic investments determined by total investment from government sector and non-government sector plus foreign investment .

$$\text{Total Domestic investments} = \text{Investment_from_Savings} + \text{Foriegn_Investment}$$

- Total Domestic investments measured in (LE/Year)

Investment fraction:

The investment fraction is determined as percentage of local resources available. And it put as constant depend on the actual situation in country.

Tax Revenue:

The tax revenue is the total amount of money gained by the government from taxes per each year; it is defined by total GDP multiplied by the tax fraction.

$$\text{Tax Revenue} = \text{Production} * \text{TaxFraction}$$

- Tax Revenue measured in (LE/Year)

Total Debt:

The total debt is considered the outstanding of loans and it accumulated by both money borrowed and accrual of interest rate and depleted by debt service rate.

- Total debt measured in (Units)

Money Borrowed

The money borrowed is consider the gap between desired investment and domestic investment , and the size of this gap determine the loan that will take from abroad. and time taking to get this loan .

$$\text{Money borrowed} = \text{MAX} (0, \text{Desired_loan} / \text{Time_to_acquire_loans}) * \text{Effect_of_Debt_Output_on_Desired_Loan}$$

- Rate of money borrowed measured in (Units/Year)
- Gap (LE/Year)
- Time to acquire loans (Years)

Desired Loan:

The desired loan initialize when there is a difference between desired investment and total domestic investment and this difference lead to borrow local or foreign loan.

$$\text{Desired Loan} = \text{MAX}(\text{Desired_Investment} - \text{Total_Domestic_investment}, 0)$$

Loan Payment:

The loan payment is the acquired loan according to maturity date.

$$\text{Loan payment} = \text{Total_Debt} / \text{Maturity_period}$$

- Loan payment measured in (Units/Year)

Perceived Payments:

The payments are depend on the rate of money borrowed, lending rate of this loan, and how many years loan will stay until become acquired to pay.

$$\text{Perceived Payment} = (\text{DELAYPPLINF}(\text{Loan_Payment}, 4, 5))$$

- Payments measured in (Units/Year)

Lending rate:

The lending rate is interest rate that should pay over the loan in the end of maturity date of loan. And the rate of lend is average by 7% annually.

Interest Rate:

This interest rate is determined by debt and lending rate; after it calculated it add to stock of total debt.

$$\text{Interest Rate} = \text{Total Debt} * \text{Lending rate}$$

- Interest rate measured in (Units/Year)

Foreign investment:

The foreign investment is the total amount that foreign companies invest it in Egypt. And it will be one of alternative policies.

Effect of total debt to production to acquire another loan:

The effect of total debt to production to acquire loans means ,it represents state of the country by the ratio of total debt to production ,if this percentage high ,the country has to stop financing capital stock by borrowing money ,because the main problem in debt payment .

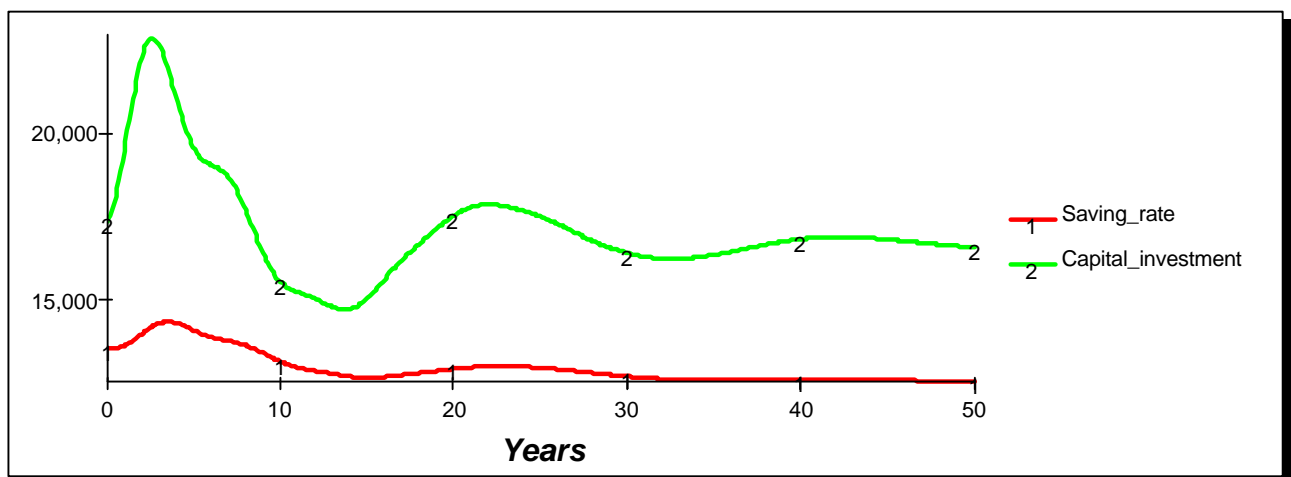
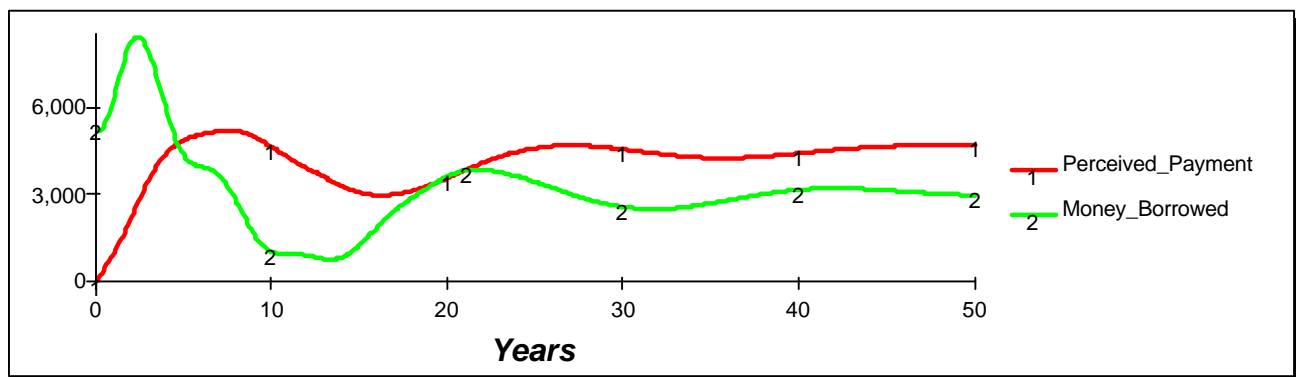
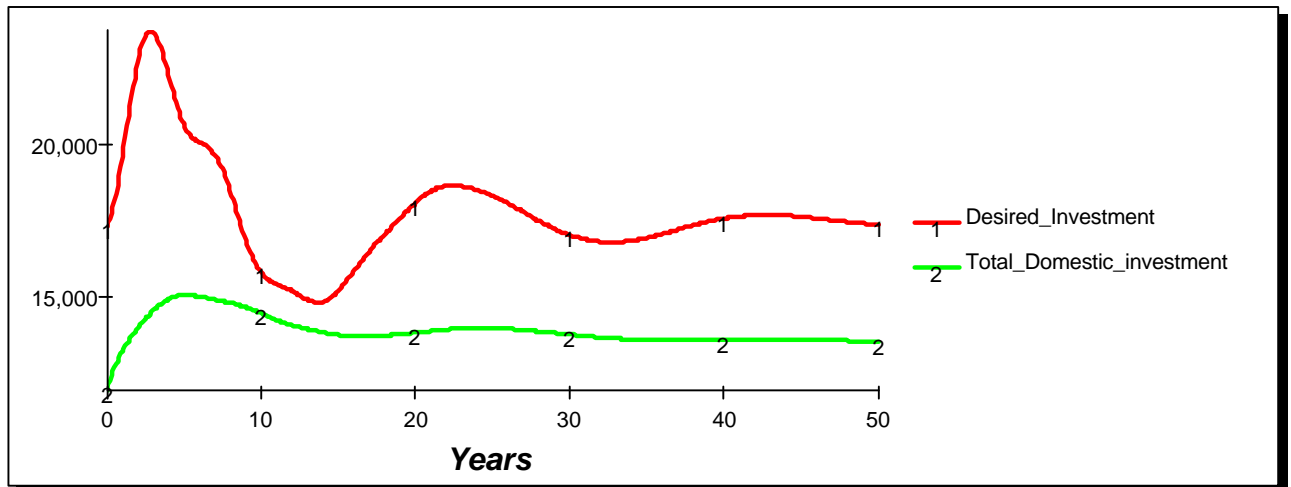
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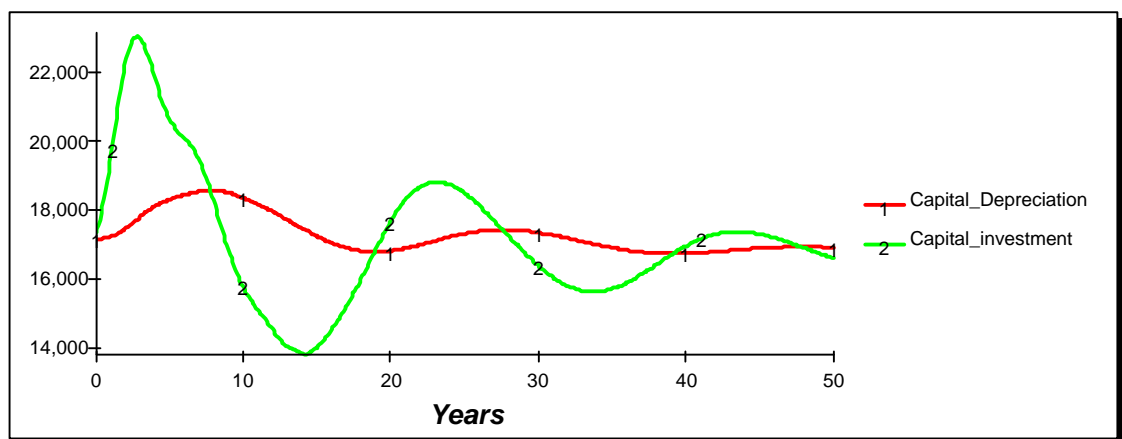
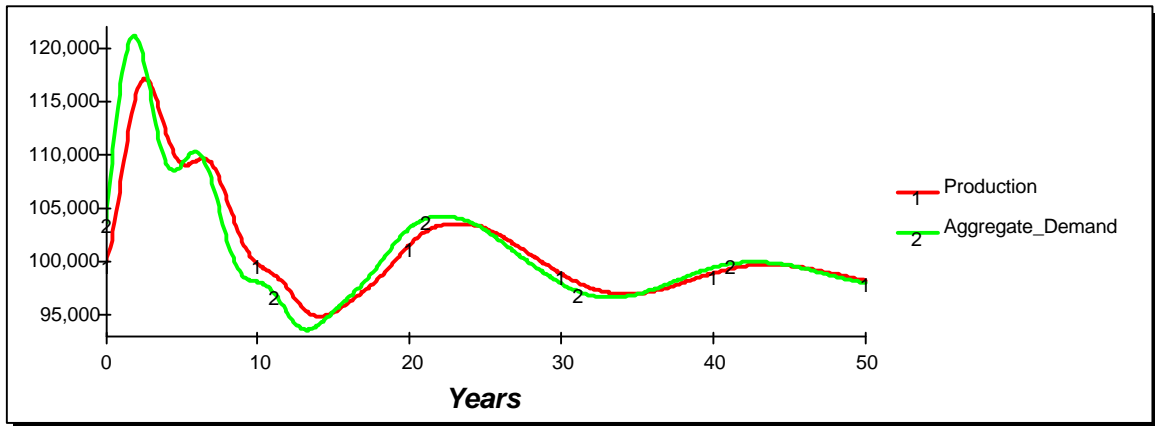
Model Behavior

In this part we will try to describe the major phases of behavior of the model in the base run, and then describe the simulation results for two alternative policies and compare the results.

1-Analysis of the Base Run:

The model in the base run is simulated a period of 50 years, and there are two main phases of behavior that we will discuss in detail.





The simulation shows significant oscillation in most variables .All variables share the same length of cycle period.

In general we can say that in the high part of the cycle the dominant loops are the multiplier, accelerator loops, while in downward part of each cycle the dominant loops are representing in financing gap and debt payment. These oscillations indicate the effect of the existence of negative feedback loops and delays.

The general behavior of the system can be described from economic point as follows:

There is a planned desired investment according to a high total demand, but Total domestic investments are not covering it, due to the saving rate is less than the investment rate. The gap between total domestic investments and desired investments will be overcome by borrowing money to build production capacity, when desired loan is acquired, investment in new capital stock increases and it requires an increase in labor force and that leads to an increase in production capacity and current disposable income which affects the saving rate by increasing it, but the saving rate rise depends on the average propensity to save and this average needs to increase first.

The production rise will lead to an increase in consumption, so the total demand will increase which will lead to another cycle, and the gap between saving and investment already exists, so the country will borrow again, but the outstanding total debt grows significantly and debt payment is higher than the loan acquisition rate. This means the percentage of total debt to production is high. This high percentage will lead to decreasing money borrowed. The effect of it leads to capital investment starting to fall below capital depreciation and according to it, capital stock starts to fall.

If we simulate for more than 50 years, the results will be oscillations every 10 years but at lower levels, because the economy is trapped in loans that on the long run will highly decrease the levels of demand, production, and income.

Appendices

init Capital = 258000
flow Capital = $-dt * \text{Capital_Depreciation} + dt * \text{Capital_investment}$
doc Capital = The Stock of Capital is accumulated by capital investment and decreased by capital depreciation, Therefore the rate of change in capital is equal to the difference between its.
init Employment = 10
flow Employment = $+dt * \text{Change_in_Employment}$
doc Employment = The Employment is defined as total employees are share in production.
init Inventory = 30000
flow Inventory = $+dt * \text{Production} - dt * \text{Final_Sales}$
init Long_term_expected_demand = 100000
flow Long_term_expected_demand = $+dt * \text{Change_in_long_term}$
init Permanent_Income = 80000
flow Permanent_Income = $+dt * \text{Change_in_permanent_income}$
doc Permanent_Income = Permanent income is an exponential average of current disposable income.
init Short_term_expected_demand = 100000
flow Short_term_expected_demand = $+dt * \text{Change_in_short_term}$
doc Short_term_expected_demand = The Short term expected demand is an exponential average of aggregate demand
init Total_Debt = 0
flow Total_Debt = $+dt * \text{Interest_rate} - dt * \text{Loan_Payment} + dt * \text{Money_Borrowed}$
init Total_Savings = 17000
flow Total_Savings = $-dt * \text{Investment_from_Savings} + dt * \text{Saving_rate}$
doc Total_Savings = it is the total saving from government sector that exist in central bank
aux Capital_Depreciation = $\text{Capital} / \text{Average_life_of_Capital}$
doc Capital_Depreciation = Physical capital is assumed to have a constant average service life. Capital Depreciation is there for proportional to capital stock.
aux Capital_investment = $\text{MAX}(0, (\text{Total_Domestic_investment} + \text{Money_Borrowed}))$
doc Capital_investment = It is the total investment that lead to increase the capital, and it is summition of available real total domestic investment.
aux Change_in_Employment = $(\text{Desired_Employment} - \text{employment}) / \text{Time_to_adjust_employment}$
doc Change_in_Employment = The change in Employment is equal the discrepancy between desired employment and actual employment divided by time to adjust employment.
aux Change_in_long_term = $(\text{Aggregate_Demand} - \text{Long_term_expected_demand}) / \text{Time_to_adjust_long_term}$
aux Change_in_permanent_income = $(\text{Current_Disposable_Income} - \text{Permanent_Income} - \text{Perceived_Payment}) / \text{Time_to_smooth_income}$
aux Change_in_short_term = $(\text{Aggregate_Demand} - \text{Short_term_expected_demand}) / \text{Time_to_adjust_short_term}$
doc Change_in_short_term = The change in short term is the difference between current aggregate demand and expected demand divided by time to adjust short term demand.
aux Final_Sales = $\text{Capital_investment} + \text{Consumption} + \text{Government_Expenditure}$
doc Final_Sales = it is the sum of consumption, investment and government expenditure.
aux Interest_rate = $\text{Total_Debt} * \text{Lending_rate}$

aux $Investment_from_Savings = Total_Savings * Investment_fraction$
 aux $Loan_Payment = Total_Debt / Maturity_period$
 aux
 $Money_Borrowed = MAX(0, Desired_loan / Time_to_acquire_loans) * Effect_of_Debt_to_P$
 $roduction_on_Desired_loan$
 aux $Production = Potential_Production * (1 - Flexibility_of_Capacity_Utilization) +$
 $Short_term_expected_demand * Flexibility_of_Capacity_Utilization$
 doc $Production = Production$ is a weighted average of potential output and short term
 expected demand , And the weighting parameter is the flexibility of capacity utilization .
 aux $Saving_rate = MAX(0, Permenant_Income * Average_propensity_to_save)$
 doc $Saving_rate = The$ govenmnet saving rate is the annual saving from govrnment sector
 aux $Aggregate_Demand = Final_Sales + Desired_inventory_investment$
 aux $Average_propensity_to_save = (1 - Average_propensity_to_consume)$
 aux $Capital_to_Equilibruim_Capital = Capital / Equilibruim_Capital$
 aux $Consumption = Permenant_Income * Average_propensity_to_consume$
 doc $Consumption = The$ consumption function is based on the permanent income hypothesis
 of Fredman . Consumption is equal to a constant fraction of permanent income, the constant of
 disposable income spent on consumption goods equals the average propensity to consume.
 aux $Current_Disposable_Income = Production - (Tax_Revenue - Gov_Insurance)$
 doc $Current_Disposable_Income = Current$ disposable income is defined as total output less
 net taxes
 aux $Desired_Employment = ((1 - Exponent_on_Capital) * Short_term_expected_demand) / Wages$
 aux $Desired_Inventory = Normal_inventory_Coverage * Short_term_expected_demand$
 aux $Desired_inventory_investment = (Desired_Inventory -$
 $Inventory) / Time_to_adjust_inventory$
 aux $Desired_Investment = Capital_Depreciation + (Desiredt_Capital -$
 $Capital) / Time_to_Adjust_Capital$
 doc $Desired_Investment = Fixed$ Capital investment is given by a simple stock adjustment
 formula . the base rate of investment is equal to physical capital depreciation .The base rate is
 modified by the need to expand or contract the capital stock . desired investment is therefore
 equal to capital depreciation plus a fraction of the discrepancy between desired capital and actual
 capital stock and divided by time to adjust capital .
 aux $Desired_loan = MAX(Desired_Investment - Total_Domestic_investment, 0)$
 aux $Desiredt_Capital = Exponent_on_Capital * Long_term_expected_demand$
 $/(1 / Average_life_of_Capital + Real_Interest_rate)$
 doc $Desiredt_Capital = Capital$ is a long lived asset for the production sector . And desired
 capital is therefore a function of long term expected demand .
 aux
 $Effect_of_Debt_to_Production_on_Desired_loan = GRAPH(Percentage_of_debt_to_production, 0$
 $, 0.1, [1, 0.93, 0.85, 0.74, 0.66, 0.57, 0.53, 0.46, 0.4, 0.33, 0.26, 0.2, 0.17, 0.13 "Min:0;Max:1"])$
 doc $Effect_of_Debt_to_Production_on_Desired_loan = it$ represent state of the country by the
 ratio of total debt to production .
 aux $Employment_to_Equilemployment = Employment / Equilibruim_Employment$
 aux $Gov_investment = Tax_Revenue * Gov_investment_frac$
 aux $Gov_Saving = Tax_Revenue - (Current_gov_expenditure)$
 aux $Non_gov = Saving_rate - Gov_Saving$
 aux $Perceived_Payment = DELAYPPLINF(Loan_Payment, 1, 5)$

aux $\text{Percentage_of_debt_to_production} = \text{Total_Debt}/\text{Production}$

aux $\text{Potential_Production} = \text{Equilibrium_Production} * (\text{Employment_to_Equilibrium_Employment})^{(1 - \text{Exponent_on_Capital})} * (\text{Capital_to_Equilibrium_Capital})^{\text{Exponent_on_Capital}}$

doc Potential_Production = Potential output is determined by the stock of capital and employment as cobb - Douglas production function.

aux $\text{Tax_Revenue} = (\text{Production} * \text{Tax_rate})$

aux $\text{Total_Domestic_investment} = \text{Investment_from_Savings} + \text{Foreign_Investment}$

doc Total_Domestic_investment = The total domestic investment determined by government investment and private investment plus foreign investment

const $\text{Average_life_of_Capital} = 15$

doc Average_life_of_Capital = A simple time constant for the exponential decay formula . The average life of capital will be set to the value of 15 years. A lot of empirical studies suggest the same value .

const $\text{Average_propensity_to_consume} = .83$

doc Average_propensity_to_consume = The portion of income that is directed to consumption rather than savings and investment is relatively high

const $\text{Current_gov_expenditure} = 26211.4$

doc Current_gov_expenditure = Government Expenditure consider the total amount that the government spend on paying (salaries or wages, pensions, commodity and service requirement, defense outlays, subsidies, social funds and others) . Government expenditure put as constant and increased annually by 10% as analysis of historical data.

const $\text{Equilibrium_Capital} = 258000$

const $\text{Equilibrium_Employment} = 10$

const $\text{Equilibrium_Production} = 100000$

const $\text{Exponent_on_Capital} = .25$

const $\text{Flexibility_of_Capacity_Utilization} = .5$

doc Flexibility_of_Capacity_Utilization = it controls the under utilization of plant and overtime and overtime for labor . it is supposed to vary between 0 and 1 the parameter is set here to .5 representing the case of Egypt with little flexibility of capacity utilization due to the inadequacy of resources.

const $\text{Foreign_Investment} = 1000$

const $\text{Gov_Insurance} = 10000$

const $\text{Gov_investment_frac} = .15$

const $\text{Government_Expenditure} = 20000$

const $\text{Investment_fraction} = .65$

const $\text{Lending_rate} = .07$

const $\text{Maturity_period} = 5$

const $\text{Normal_inventory_Coverage} = .30$

const $\text{Real_Interest_rate} = .03$

const $\text{Tax_rate} = .30$

const $\text{Time_to_acquire_loans} = 1$

const $\text{Time_to_Adjust_Capital} = 3$

doc Time_to_Adjust_Capital = It represents the entire delay between the recognition of a change in capital needs and actual capital stock. the adjustment time reflects planning and delivery delays plus purposeful smoothing of investment activity.

const $\text{Time_to_adjust_employment} = .5$

```
const Time_to_adjust_inventory = .5
const Time_to_adjust_long_term = 3
doc Time_to_adjust_long_term = it insulates capital investment from short run swings in
demand Becasue capital has a long life , it should be adjusted only to relatively long run changes
in demand . the smoothing time should be long enough to filter out most business cycle
flctuations.
const Time_to_adjust_short_term = .5
doc Time_to_adjust_short_term = it must be long enough to smooth out minor shifts in
demand but short to permit recognition of business cycle variations in demand . The smoothing
time must be approximately one year or less to track business cycle fluctuations.
const Time_to_smooth_income = 2.5
doc Time_to_smooth_income = Milton Friedman, in his theory about consumption function,
estimates the time to smooth permanent income to be 2.5 years.
const Wages = 7500
```