Using System Dynamics Methodology to analyse the Economic Impact of Tourism Multipliers

Mohamed Loutfi, Alfredo Moscardini
School of Computing, Engineering and Technology, University of Sunderland,
Sunderland, SR6 0DD
United Kingdom
+44 191 515 2763
mohamed.loutfi@sunderland.ac.uk
a.moscardini@sunderland.ac.uk
and

Kevin Lawler
Sunderland Business School, University of Sunderland,
Sunderland, SR6 0DD
United Kingdom
+44 191 515 2341
kevin.lawler@sunderland.ac.uk

Abstract

The importance of tourism for economic development is widely recognised . This is reflected in the great interest shown by governments by promoting foreign direct investment and freeing both public and private sector projects. Most tourism studies concentrate on analysing the economic and social effects of tourism. The impact of the multiplier has been studied widely using traditional econometric techniques.

This paper focuses on analysing the economic impact of tourism revenue on the Egyptian economy. The economic theory and the mathematical modelling involved in such scenarios is discussed but the main thrust of the paper is the encapsulation of this situation by Causal Loop Models .

A dynamic model, run in Powersim, is then described where important non-linear dynamical movements and the significance of systems thinking in this framework are considered . This model considers the dynamics of tourism in Egypt and its impact on GNP.

1. Introduction

The importance of tourism for an economy is independent of whether it is developed or developing. . Inskeep showed that in 1989 tourism revenues world-wide were nearly 209 billion dollars growing at 9% yearly. This revenue then represented nearly 7% of total international trade and 30% of total international income. Tourism played a major role in modernising the Spanish economy. In the USA, tourism generated 5 million jobs and was 6.7% of GNP in the USA in 1989 (Inskeep, 1991).

It is not only income effects that make tourism sectors important. These sectors include foreign investment, subsidies and taxation. Infrastructure and resources are considered the most important feature for any country in a competitive world fighting to attract market share. In developing and advanced countries, tourism is viewed as an important means to boost levels of income and employment. There has been much research on tourism and relationships with economic development. Thus Kraph argues that tourism has a crucial role in developing countries. It helps to lower deficits in the Balance of Payments, increase levels of economic growth and raise job opportunities (Pearce, 1992).

Kasse concentrated on the benefits and costs of tourism. He showed that through a certain investment in the tourism sector, income could be produced that may be used in developing different sectors of the economy. Van Doorn concludes that development theories should take into consideration the direct and the indirect effect of tourism (Pearce, 1992).

Egypt is considered to have a reasonable infrastructure and adequate resources for tourism.. It has the advantage of a unique history and climate that has preserved some of the most ancient artefacts in the world. It has a good geographical location situated between three continents with a long coasts on the Mediterranean and Red Sea.. Egypt also has a stable political and social system.

This paper focuses on analysing the economic impact of tourism sector revenues on the Egyptian economy. It begins by reviewing some of the most important previous studies that discuss models of tourism multipliers . It then examines a simple Keynesian model and relates this to Egyptian data. The paper presents the results of a regression analysis that considers relative effects on GNP, consumption, investment and import expenditures. Causal and System Dynamic models are then introduced and compared with econometric results. The policy implications are then discussed.

2 The Tourism Multiplier

Most studies on Tourism have concentrated on analysing the economic and social effects of tourism specially by what is termed the multiplier effect. This term is a derivative of the multiplier effect first introduced by Samuelson (Samuelson, 1960). It determines the benefit to the economy for every unit of currency that is spent. It is noted that most of the conversations about the effect of tourism on economic development concentrated on the multiplied effect of tourism on the National economy.

2.1 Traditional Approaches:

Archer reflects on interrelationships between three kinds of expenditure:

1) Direct expenditure.
2) Indirect expenditure.
3) Stimulated expenditure.

Indirect expenditure and stimulated expenditure are called the secondary effects of the multiplier and the sum of these are called the total effect of the multiplier (Archer, 1982).

Lundberg used the following formula to calculate multiplier effects (Lundberg, 1995).

$$TIM = \frac{1 - TPI}{MPS + MPI} \qquad (1.1)$$

where:
TIM = The tourism multiplier

TPI = The marginal propensity to import for tourists
MPS = The marginal propensity to save
MPI = The marginal propensity to import for local residence

Using published data for the Bahamas Islands, Lundberg (Lundberg, ibid) estimated the value of tourism multiplier as:

$$TIM = \frac{1-0.231}{0.281+0.456} = \frac{0.659}{0.737} = 0.894$$

Ryan (Ryan, 1991) devised an alternative formula for tourism multipliers as follows:

$$TIM = A \times \frac{1}{1-BC} \qquad (1.2)$$

where
A = The percentage of tourist expenditure on home-produced goods and services.
B = The percentage of domestic expenditure on domestic goods and services.
C = The percentage of stimulated expenditure from residence on home-produced goods and services.

Taking the same example of the Bahamas will give TIM = 0.87

Lundberg showed that the value of the tourism multiplier differs from one country to another (Lundberg, ibid). Thus that the tourism multipliers for Canada are around 2.43, for Ireland 2.7, for Greece 1.4, for Hawaii 1.3 respectively. For Murphy, the difference in tourism multipliers between countries is due to interrelationships between different sectors. The value of the multiplier increases when interrelationships compound and decrease when outflows increase(Murphy, 1985). There is no doubt that multiplier values correlate with several variables. The most important of these is the number and quality of tourists, tourist facilities, domestic expenditure and future trends in these variables.

The data used for calculations is often crude as there are data problems in estimating values for tourism income. Tourism income is included both in the balance of payments and in the balance of non-observable transactions. It is positive only if the expenditure of foreign tourists is larger than the expenditure of domestic residence abroad.

For greater accuracy, tourism income must be related to tourism costs .Major costs are :

- Import expenditure for the tourism industry.
- Expenditures of the host country on investments needed for the tourism industry.
- Expenditure necessary for promotion of domestic tourism.
- Expenditure necessary for training labour for tourism needs.

External domestic expenditure(imports) include the following variables:

- Money transfers from foreign tourism companies to countries of origin.
- External loans debts servicing to foreign countries.
- Expenditure for hotels owned by foreigners.
- Expenditure on essential foreign labour to service domestic tourism.

Calculating net tourism revenue is a difficult issue and therefore most studies calculate tourism revenues as listed in the Balance of Payments. Some studies have tried to measure leakages from tourism, In Sri Lanka these are estimated at 25% of all the tourism income (Pearce 1992).

2.2 Tourism Multipliers Based On A Simple Keynesian Model

We use a simple Keynesian macro-economic model for the Egyptian economy. The details of this model are summarised by the following equations:

$$C = c_0 + c_1 Y_d + \varepsilon \quad (1.3)$$
$$I = i_0 + i_1 Y + \varepsilon \quad (1.4)$$
$$M = m_0 + m_1 Y + \varepsilon \quad (1.5)$$
$$T = t_0 + t_1 Y + \varepsilon \quad (1.6)$$
$$Y_d = Y - T \quad (1.7)$$
$$Y = C + I + E + X + Tr - M \quad (1.8)$$

This model consists of 6 equations. The endogenous variables appear on the left hand side. The model contains three exogenous variables:

E: Government expenditure,
Tr: Tourism revenues.
X: Exports expenditure.

Equation 1.3 shows that private consumption C, depends on disposable income, Y_d , where c_1 is the marginal propensity to consume. Equation 1.4 shows the Private Investment, I, is related positively to Y where i_1 is the marginal propensity to invest. Equation 1.5 shows that Imports, M, are positively related to Y and depends on the marginal propensity to Import, m_1. Equation 1.6 shows that Taxes, T, depend on Y where t_1 is the rate of tax. The autonomous components for Consumption, Investment, Import and Taxation are identified by c_0, i_0, m_0, t_0. The error term, ε represent the random components that are not explained by the regression coefficient.

.

An appropriate substitution from equation 1.3 to 1.8 yields:

$$Y = \frac{A_0 + E + X + Tr + \varepsilon}{1 - c_1(1 - t_1) - i_1 + m_1} \quad (1.9)$$

Various tourism multipliers can now be calculated.

The multiplier on income is :

$$\frac{\partial Y}{\partial Tr} = \frac{1}{1 - c_1(1 - t_1) - i_1 + m_1} \quad (1.10)$$

The multiplier for consumption can be calculated as

$$\frac{\partial C}{\partial Tr} = \left(\frac{\partial C}{\partial Y}\right)\left(\frac{\partial Y}{\partial Tr}\right) = \left(\frac{\partial C}{\partial Y_d} \times \frac{\partial Y_d}{\partial Y}\right)\left(\frac{\partial Y}{\partial Tr}\right) \qquad (1.11)$$

The multiplier for investment:

$$\frac{\partial I}{\partial Tr} = \left(\frac{\partial I}{\partial Y}\right)\left(\frac{\partial Y}{\partial Tr}\right) \qquad (1.12)$$

The multiplier for imports

$$\frac{\partial M}{\partial Tr} = \left(\frac{\partial M}{\partial Y}\right)\left(\frac{\partial Y}{\partial Tr}\right) \qquad (1.13)$$

It is noticed that the value of the tourism multiplier is affected positively with the size of the Marginal propensities to spend. Any increase in the MPC or the MPI will lead to the increase of the value of the multiplier, on the other hand any increase in the MPM or the taxation rate will decrease the value of the tourism multiplier.

2.2.1 Analysis of the Keynesian Model

The previous model will be analysed using yearly time series data connected to the Egyptian Economy covering the period from 1972 till 1990. all the variables of the model will be measured in million Egyptian pounds. The data is taken from International Fiancial Statistics, the IMF and the National Bank of Egypt. Equations 1.1 to 1.6 are analysed using an ordinary least Squares, non-linear regression with 3 stages (3SLS). This correlation will account for the random variables so we can be sure that the parameters that have been chosen efficiently and consistently. (Pindyck *et al*, 1981) The outcome is shown in table 1. It is noticed that all the output from the model is within the range predicted by economic theory.

Changes in consumption due to changes in disposable income are positive and equal to (0.77) with a statistical significance (1%). The spontaneous component in the consumption function has no statistical significance, i.e. the intercept of the consumption function is insignificant.
This implies that the ratio of consumption to the disposable income, which is called the average propensity to consume, is equal to the marginal propensity to consume in Egypt. Over and Above, the average propensity to consume will stay constant when the disposable income increases. i.e., consumption and income increase at the same rate in Egypt.

The parameters that measures the marginal propensity to invest to the size of income is positive ,(0.13), and it has statistical significance at (1%). The marginal propensity to import parameter that is estimated from the model at statistical significance (1%) is (0.37). Last, the taxation equation we find that the estimated parameters for the tax rate is (0.1) at statistical significance of (1%).

Table 2 shows the estimated regression parameters for the model The results are statistically significant 1% for the GNP equations and 5% for the consumption equations. The Durbin – Watson statistics shows the lack of multiple correlation for the private estimation for the residual. In this estimation, the model parameters with reduced forms confirms the positive effect of tourism revenues on GNP and its components. The results show that the effect of any increase in the tourism revenues changes due to the change in the components of the GNP, because we found that there is a positive effect for the tourism revenues on consumption and there is a weak effect on private investment. Also the results show that it was consistent with our expectations concerning the effect of tourism revenues on consumption, investment and import in Egypt.

The regression analysis gives values for the marginal propensities for consumption, income, imports and taxation as 0.77, 0.13, 0.37 and 0.01. Using these values we can estimate the tourism multipliers. The values for income, consumption, investment and imports are:

$$\frac{\partial Y}{\partial Tr} = 1.8 \quad \frac{\partial C}{\partial Tr} = 1.25 \quad \frac{\partial I}{\partial Tr} = 0.23 \quad \left(\frac{\partial M}{\partial Tr}\right) = 0.67$$

3. A System Dynamics Approach

We can model the previous theoretical argument by using Systems Dynamics. This approach constitutes a new methodology which promises to be more flexible and less data dependant than traditional regression analysis.

First a causal loop diagram was developed. Valuable insights can be gained by building such representations. It can be seen that there are three positive feedback loops balanced by three negative loops. Depending on the relative strength of these loops classical equilibrium or positive growth or decay may be expected.

Building a System Dynamics model from this loop is often dismissed as routine however this may be difficult even for experienced modellers. A typical model is shown in figure 2. Such models produce a valuable insights into lagged effects. These models then cease arcane dry mathematical concepts and take on real world meanings and relevance. Changes in consumption are usually measured by comparing quarterly data which presents a small problem for the modeller. System dynamics models tease out interdependence between variables allowing the small variable changes to be considered in a dynamic context, we have also abandoned the laundry list and now think dynamically.

Such a methodological stance should produce gains in the training of economic graduates, because to some extent, it re-locates modern students with insights delivered in Keynes General Theory. This famous text has been criticised over the years for developing a dynamic macro economic theory linked together with sub system of static models. Hence, Keynes famous "Notes on the Trade Cycle" in the "General Theory" are dynamic insights which are largely overlooked nowadays by textbook writers and theorists.

Like many LDCs, Egypt suffers periodically from economic upswings and downswings and sudden changes in employment trends linked to these. In the last 20 years Egypt's working population has increased by around 14% whilst the pound has continued a slight downward since 1973. Inflation trends are reasonably stable compared with other LDC's in Africa and Asia. Egypt's 20 year inflation trend averages around 17-19% p.a.(UN Statistical Year Book 1997). Compared to many large LDC's, foreign debt is not more than 20% of GNP (IMF-1995) which is sound for a large LDC. This may change if the imminent collapse of the Tourism Industry cannot be averted (Aghion, 1998).

3.1 Causal Loop Model

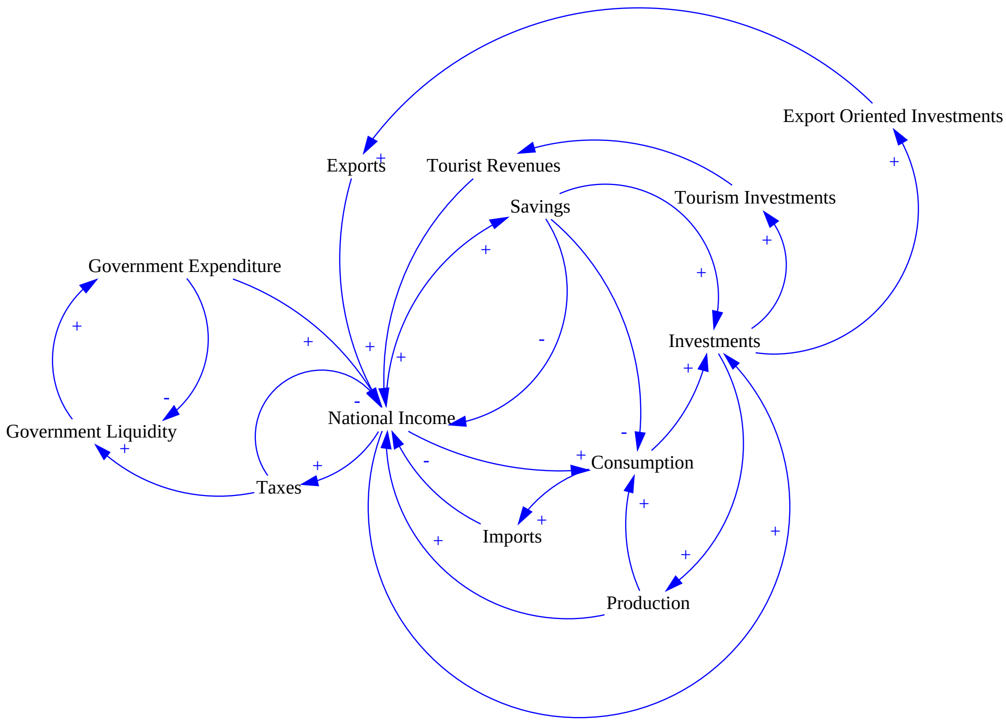

Figure 1 the Causal Model

3.2 System Dynamic Model

This is shown in Figure two.

3.3 Model Behaviour

The model was run over a simulation time of ten years using monthly intervals and Runge-Kutta fourth order solution techniques. We use the same data for the marginal values that was obtained from the regression analysis.

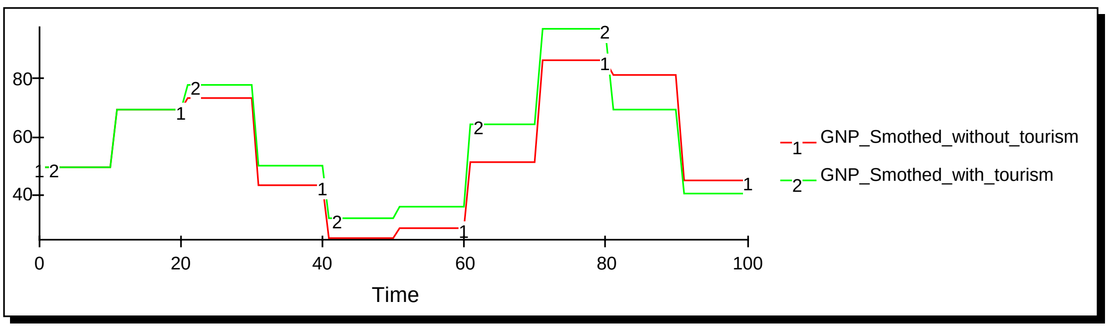

Figure 3 Effect on GNP

The model generates interesting swings in the GNP. These cycles become likely when it is realised that aggregate supply/demand have endogenous limits. Aggregate supply provides a ceiling in reality. Although it is possible to meet high aggregate demand by overtime working and running down stocks of finished goods aggregate supply cannot expand indefinitely. Aggregate supply slows down as the Egyptian economy approaches the boom. Having overreached itself the economy is likely to bounce back off a ceiling and begin a down turn. Moreover, the model implies a floor or a limit to the extent to which aggregate demand is likely to fall in recession.

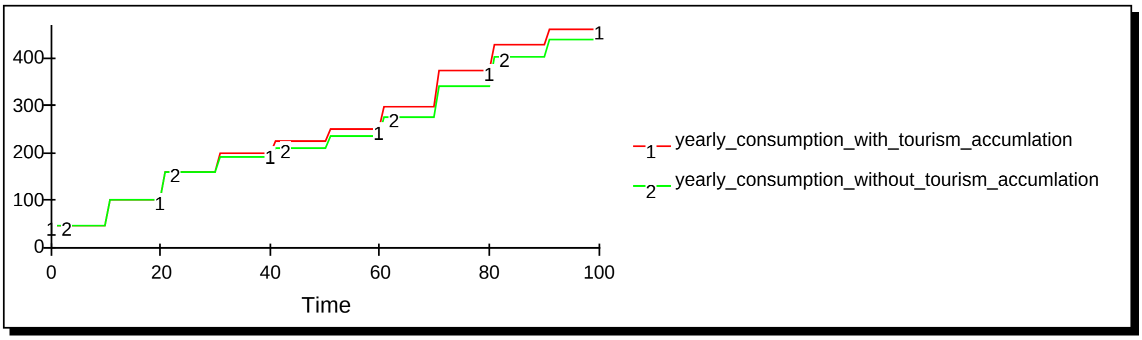

Figure 4 Consumption

Despite a typical Keynesian aggregate consumption profile for the Egyptian economy with and without the impetus created by the tourism multiplier. The shape of the aggregate function depicts a gradually falling marginal propensity to consume in link with Keynes "fundamental psychological law" (Keynes, ibid).

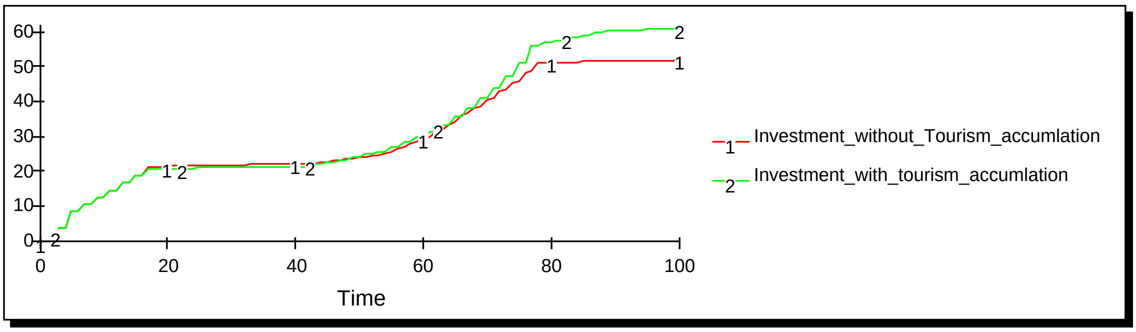

Figure 5 Investment

Figure 5 shows the flow of investment expenditure again indicating a falling marginal propensity to invest. The impact of the tourism multiplier on investment is as follows: initially induced investment increases at diminishing rate to time step 20 , there after to time step 40 point of inflexion are distinguished. From time step 40 induced investment accelerates at an increasing rate. Then the rate of increase declines progressively till the maximum at time step100. The boost provided by the tourism multiplier is evident in figure 5

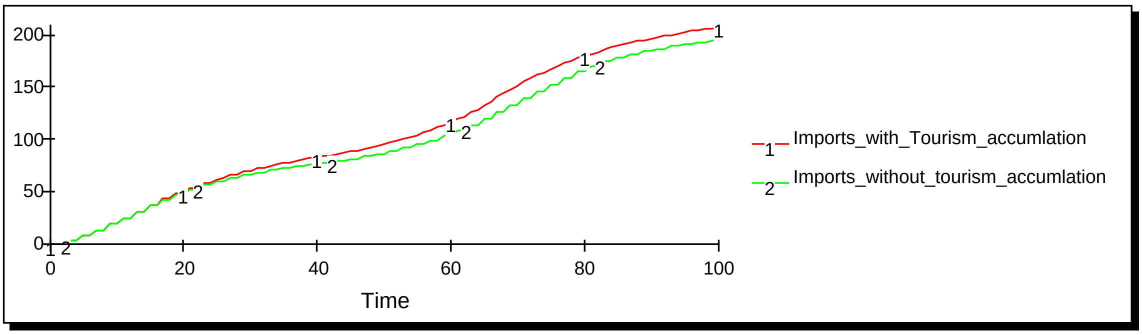

Figure 6 Imports

Figure 6 reveals the typical flow of imports expenditure whence the marginal propensity to import in a developing country is stable and increasing in line with rising GNP. Again the impact of the tourism multiplier is revealed as a shift factor enhancing import expenditure progressively after time step 40.

4. Conclusion

The paper has used an integrated approach to modelling the effect of tourism multipliers on the Egyptian economy.

A traditional econometric approach of multiplier estimation was utilised and the actual multiplier for Egypt where derived from previous study using SURE three stage regression.. The values of the multiplier were then utilized in a System Dynamics model of Egyptian tourism.

The power of System Dynamics is that different scenarios can be obtained using different input value for tourist expenditure and MPC, MPM, MPI. This cannot usually be achieved in a regression study. Hence the model developed has the potential to assist (a) teaching and learning strategies in economics (b) professional decision making in Egypt within the tourism sector. In this traditional econometric methods and powerful systems methodologies are complementary rather than competitive tools of analysis (Moscardini *et al*, 1998).

5. References

Aghion, P. (1998) *Endogenous Growth Theory* MIT Press1998
Archer, B.(1982) The value of multipliers and their policy implications, *Tourism Management, 3, No. 4*
Inskeep, E (1991), *Tourism planning*, New York, Van Nostrand.
Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*, Macmillan,
Lundberg, D. , (1995) *The Tourist Business, (sixth edition)*, New York Van Nostrand
Moscardini, A. Loutfi, M (1998) Systemic Insights into Economic Principles *The Sixteenth International Conference of the System Dynamics Society, Quebec*
Murphy, P. (1985) ,*Tourism : A community Approach*, London Routledge
Pearce, D. ,(1992) *Tourism Development, (second edition)*, New York: Longman,
Pindyck, R., and Rubinfield, D. (1981) *Econometric Models and Economic Forecasts*, Macmillan
Ryan, C. ,(1991) *Recreational Tourism*, London, Routledge.

Samuelson, P. A., (1960) Interactions between the Multiplier Analysis and the Principle of Acceleration. *Review of Economic Statistics.*

Table 1

The results of estimating the simple Keynesian model for the Egyptian economy using 3SLS method

C = -3574,6 + 0.77 Y_d + (-0.908) $(6.3)^*$
$$R^2 = 0.84, D.W = 0.77$$

I = 2186.4 + 0.13 Y + (2.517) $(5.359)^*$
$$R^2 = 0.89, D.W = 0.21$$

M = -2457,5 + 0.37 Y + (-0.958) $(5.238)^*$
$$R^2 = 0.75, D.W = 0.78$$

T = -615,6 +0.1 Y + (-1.133) $(6.940)^*$
$$R^2 = 0.87, D.W = 0.67$$

T -Ratios are in parentheses * Indicates significance at one percent level.

Table 2

The results of estimating the reduced form equations using SURE method

C = -424.49 + 1.93 E + 0.74 X + 4.98 Tr
$$(-0.45)^* (2.39)^* (1.23)^* (4.27)^*$$
D.W = 1.35

I = 464.75 + 0.39 E + 0.88 X + 0.72 Tr
$$(1.82)(0.18)^{***} (5.39)^{***} (2.29)^{**}$$
D.W = 1.96

M = -118.04 + 0.46 E + 0.72 X + 3.39 Tr
$$(-0.16)(0.71)^{***} (1.47)^{***} (3.61)^{***}$$
D.W = 1.27

Y = -1908.13 + 2.59 E + 2.6 X + 6.41 Tr
$$(-1.33)^* (2.11)^* (2.82)^{**} (3.62)^*$$
D.W = 1.52

* Significant at the 1 percent level ** Significant at the 5 percent level
*** Significant at the 10 percent level

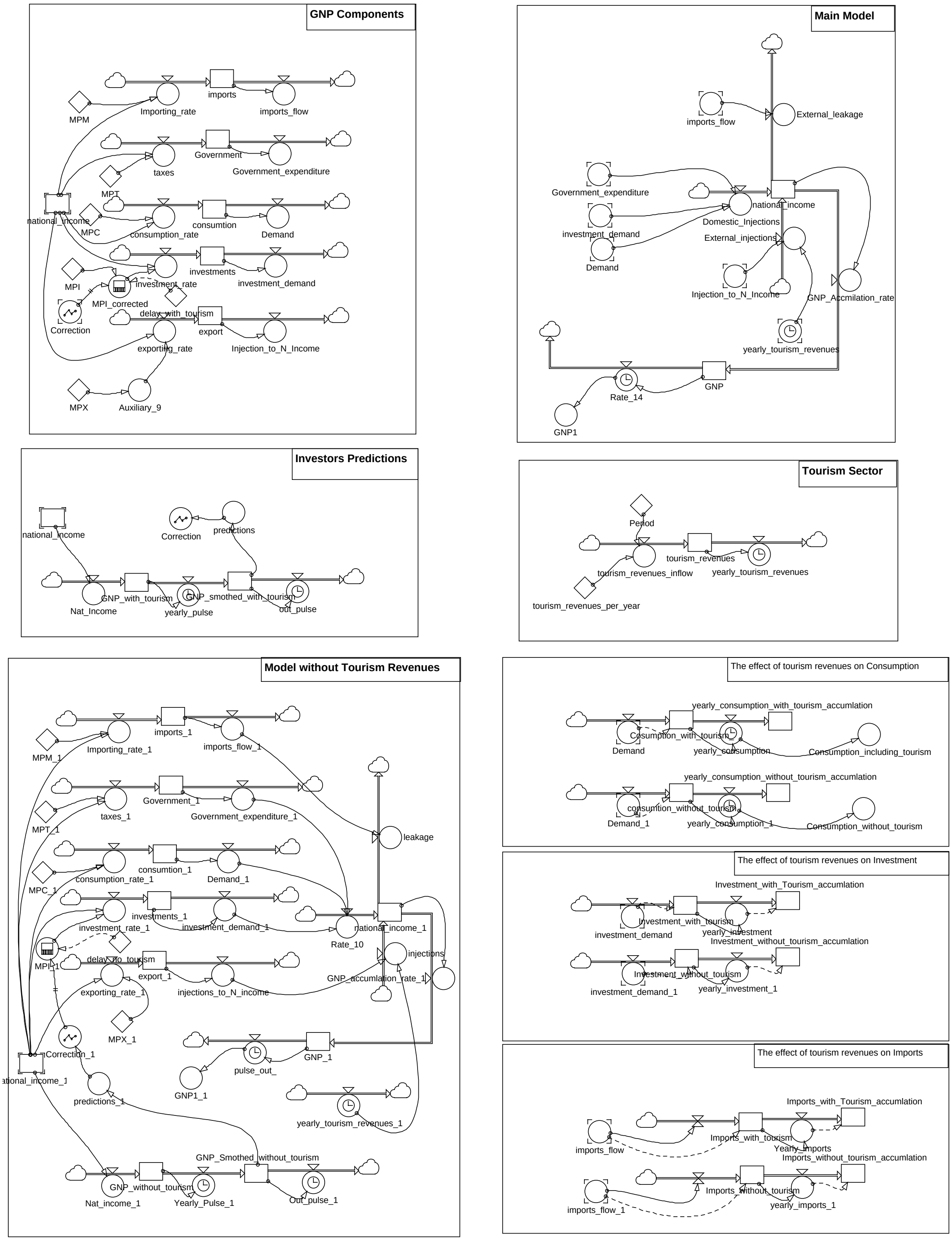

Figure 2. The System Dynamics model