APPENDICES

Appendix A: (Data Sources)

All the needed data in the current research are based on the secondary data from the different sources collected. The data used were obtained from the SCI, MPO, CBI, and the Ministry of Agriculture (Jihad-Keshavarzi) databases from 1966/67 to 2000/01. The reason for using the database depends on the availability of the data sources in Iran, i.e. the agricultural employment and capital were available only until 2000/01 and 2002/03, respectively (MPO, Macroeconomic Office). From these databases, I obtained the measured agricultural value added (CBI) and the aggregate agricultural capital stock (MPO, Macroeconomic Office), both of which were converted into constant thousands Rial (1997=100) local currency. The database also provided the labour in the agricultural sector based on thousands persons (MPO, Macroeconomic Office), the irrigated and non-irrigated land in thousand hectares (SCI, Various Issues).

The rural and urban populations, the total population, and other social data were collected from the SCI (Various Issues). Wage in the agricultural sector is based on the total payment of the agricultural worker in different years (1997=100) divided by the total agricultural employment (SCI, Various Issues). Price of the capital is calculated based on the user's cost of capital. The concept analysis of the user's cost of capital relies mainly upon the pioneered works of Jorgensen (1963). The user's cost of capital is the unit cost for the use of a capital asset for one period, i.e., the price for employing or obtaining one unit of the capital services. The user's cost of capital is also referred to as the 'rental price' of the capital goods, or the 'capital service price'. The mathematical formulation can be expressed as follows:

$$C_t^p = (Dep_t + IN_t - CINF_t) \qquad \text{(A - 1)}$$

Where C^p is price of one capital unit, Dep. is the depreciation rate of the capital per year, IN is interest rate in the medium term where it shows a proxy of opportunity cost for capital and $CINF_t$ is the inflation rate for the capital goods. Equation (1) states that while the depreciation rate or interest rate increases, it will lead to an increase in the capital price; and while the inflation rate for the capital goods increases, it will lead to a decrease in the capital price, and vice versa.

The real exchange rate (Rial to US Dollar) is obtained from the MPO (Macroeconomic Office). Whereas, the data on export and import are obtained from the SCI (Various Issues) and they are converted into US Dollar (OECD index, 1990=100). The OECD income per capita and OECD index, and other international statistics (1990=100) are obtained from the World Development Indicators (WDI, 2003).

Supplementary statistics, such as the rates in deaths and births, consumption of the agricultural products, as well as the employment and unemployment in the rural area, were obtained from the SCI (Various Issues); whereas, the agricultural price index, inflation rate, national income, and the price index in both the urban and rural areas were gained from the CBI (Various Issues).

The period of 1976 to 2021 was selected for the simulation. The reason for selecting this period is the year 1976 till 2001 the real data are provided through different sources for comparing to simulated data to find the validity of model. Meanwhile the year 1400

(Solar-Hejri) is called horizon of planning by Iranian government, which it will be accordance to year 2021 AC.

Appendix B: (Theoretical Clarification about Estimated Functions)

1-Production Function

Generally, the production function prescribes a mathematical relationship between the volume(s) of output and volume(s) of input. In its most general mathematical form, a production function is expressed as:

$$Q = f(X_1, X_2 \ldots X_n) \qquad \text{(B-1)}$$

where Q is equal to the quantity of output, X_1, X_2... X_n are equal to inputs (such as capital, labour, land, technology, or management).

Basically, there are two general classes of production: first, those that exhibit variable proportional return, and second, those that exhibit constant proportional return (homogeneous). The CD function is classified in a constant proportional return function, and the Translog classifies in the variable proportional return function.

The Translog production function (Christensen et al., 1971 and 1973) in the general form, for the n inputs can be expressed as:

$$LnQ = \alpha + \sum_{i=1}^{n} \beta_i LnX_i + (1/2)\sum_{i=1}^{n} \delta_{ii}(LnX_i)^2 + \sum_{i=1}^{n}\sum_{j=2}^{n} \delta_{ij}(LnX_i)(LnX_j) \qquad \text{(B-2)}$$

$$(i \neq j)$$

The Translog function is obtained by expanding the Taylor's series and omitting the term up from the third order to n^{th} order (i.e., expanding the Taylor series only up to the second order while there is a truncation error). The Translog function does not impose any pre-specified restriction on the elasticity of the substitution among production factors. For example, while the CES function assumes constant return to scale, the Translog function has Variable Return To Scale (VRTS). The general form of the Translog function is flexible and it is possible to derive a variety of functional forms such as Homothetic, CD and Homogenous, with respect to the production form.

Table (B-1) reports the mathematical formulations for the seven estimated functional forms. The calculation of the marginal products (MP) and elasticities (E) for inputs are shown in columns 3 and 4, respectively. Column 5 shows the number of the estimated parameters for each functional form.

Table B-1: Mathematical Formulations for the Seven Functional Forms, Marginal Products (MP_i) and Elasticities (E_i)

Function Name	Functional Form	Marginal Products (MP_i)	Elasticities (E_i)	No. of Estimated Parameter	Form	Stage of Production
CD	$Q = \alpha \prod_{i=1}^{n} X_i^{B_i}$	$\alpha\beta_i X_i^{-1} \prod_{i=1}^{n} X_i^{B_i}$	β_i	(n+1)	Nonlinear and no interaction among inputs are considered	** A: Exhibits Stage II only for each individual factor and with respect to scale given strict concavity B: Exhibits Stage I or II only for each individual factor and with respect to scale given strict quasi-concavity
Approximate of CES	$Q = \alpha \prod_{i=1}^{n} X_i^{B_i}$ Where $(1 - \beta_1 - \beta_2 - \ldots - \beta_{n-1}) = \beta_n$	$\alpha\beta_i X_i^{-1} \prod_{i=1}^{n} X_i^{B_i}$	β_i	n	Nonlinear and no interaction among inputs are considered	** A: Exhibits Stage II only for each individual factor and with respect to scale given strict concavity B: Exhibits Stage I or II only with respect to scale given strict quasi-concavity
Polynomial	$Q = \alpha + \sum_{i=1}^{n} \beta_i X_i + \sum_{i=1}^{n} \delta_i (X_i)^2$	$\beta_i + 2\delta_i X_i$	$\frac{(\beta_i + 2\delta_i X_i) X_i}{Q}$	2n+1	Nonlinear and no interaction among inputs are considered	** A: Exhibits Stages II and III for each individual factor and with respect to scale given strict concavity B: Exhibits Stage I only or II and III with respect to each individual factor and scale given strict quasi-concavity
Transcendental	$Q = \alpha \prod_{i=1}^{n} X_i^{\beta_i} e^{\lambda_i X_i}$	$((\beta_i / X_i) + \lambda_i) * Q$	$((\beta_i / X_i) + \lambda_i) * X_i$	2n+1	Nonlinear and no interaction among inputs are considered	** A: Exhibits Stages I, II and III with respect to each factor and scale given quasi-concavity B: Exhibits Stages II and III for each individual factor and with respect to scale given strict concavity
Translog	$Ln(Q) = \alpha + \sum_{i=1}^{n} \beta_i LnX_i + (1/2) \sum_{i=1}^{n} \delta_{ii} (LnX_i)^2$ $+ \sum_{i=1}^{n} \sum_{j=2}^{n} \delta_{ij} ((LnX_i)(LnX_j))$ $(i \neq j)$	$(\beta_i + \delta_{ij} (LnX_i)$ $+ \sum_{j=2}^{n} \delta_{ij} (LnX_j))(Q / X_i)$	$(\beta_i + \delta_{ii} (LnX_i)$ $+ \sum_{j=2}^{n} \delta_{ij} (LnX_j))$ $i \neq j$	(1/2) (n+1) (n+2)	Nonlinear and interaction among inputs are considered	Properly exhibits stage I, II, and III
Generalized Quadratic form	$Q = \alpha + \sum_{i=1}^{n} \beta_i X_i + (1/2) \sum_{i=1}^{n} \delta_{ii} (X_i)^2$ $+ \sum_{i=1}^{n} \sum_{j=2}^{n} \delta_{ij} ((X_i)(X_j))$ $(i \neq j)$	$(\beta_i + \delta_{ij} (X_i)$ $+ \sum_{j=2}^{n} \delta_{ij} (X_j))$	$(\beta_i + \delta_{ii} (X_i)$ $+ \sum_{j=2}^{n} \delta_{ij} (X_j))(X_i / Q)$ $i \neq j$	(1/2) (n+1) (n+2)	Nonlinear and interaction among inputs are considered	Properly exhibits stage I, II, and III
Generalized Leontief	$Q = \alpha + \sum_{i=1}^{n} \beta_i (X_i)^{1/2}$ $+ (1/2) \sum_{i=1}^{n} \sum_{j=1}^{n} \delta_{ij} ((X_i)^{1/2} (X_j)^{1/2})$	$(1/2) \beta_i (X_i)^{-1/2}$ $+ (1/2) \sum_{j=1}^{n} \delta_{ij} (X_i)^{-1/2} (X_j)^{1/2})$	$((1/2) \beta_i (X_i)^{-1/2}$ $+ (1/2) \sum_{j=1}^{n} \delta_{ij} (X_i)^{-1/2} (X_j)^{1/2})$ $*(X_i / Q)$	(1/2) (n+1) (n+2)	Nonlinear and interaction among inputs are considered	Properly exhibits stage I, II, and III

* n in the fifth column denotes the number of inputs, ** Source: Beattie and Taylor (1986)

2- Dynamic Demand for Labour

A dynamic demand model is used to estimate the demand for the agricultural labour. The dynamic demand model specifies that the actual employment has a gap from the optimal employment in the economy. Hence, the dynamic demand model can be established as follows:

$$LnN_t^* = Lnf(X_t) + U_t \qquad \text{(B - 3)}$$

where N_t^* is the optimal level of employment (planned employment), X_t is a vector of the independent variables, and U_t is a residual term. Where N^* is not observable and measurable, every variable in the process of econometric estimation should be numerical. Nerlove's (1958) process is used to convert the variables based on the partial adjustment. Two forms of cost have been obtained based on partial adjustment; first, DC and second, AC. The DC is the cost of the distance between the optimal employment and the actual employment, and AC is the cost of firing or hiring workers to achieve the optimal employment. For example, if the cost of DC is more than AC, the firm then decides to hire new workers or fire employed workers to reduce its total cost (reduce the gap) and consequently reach to the optimal level of employment. According to this role, all firms want to minimize the employment cost based on these AC and DC. The employment cost for one period can be defined as follows:

$$TC = c_1(LnN_t^* - LnN_t)^2 + c_2(LnN_t - LnN_{t-1})^2 \qquad \text{(B - 4)}$$

$$where \quad DC = f(LnN_t^* - LnN_t), \quad AC = g(LnN_t - LnN_{t-1})$$

where N_t is actual employment N_{t-1} is actual employment in last period, the Equation (B-4) is considered as a quadratic form because of the better model specification. Minimizing Equation (B-4) with respect to the level of employment and rearranging it, Equation (B-5) has been obtained (Amini, 2002) as follows:

$$LnN_t - LnN_{t-1} = \lambda(LnN_t^* - LnN_{t-1}) \qquad \text{(B - 5)}$$

$$where \quad \lambda = \frac{c_1}{c_1 + c_2} \quad ,$$

where λ shows the adjustment coefficient, 1/λ shows the speed of adjustment between the actual and optimal level of employment. Therefore, the speed of the worker adjustment is equal to 1/λ. This fraction states the number of years it takes time the gap between the optimal and actual employment is reduced to zero.

From Equation (B-5), the optimal level of employment can be extracted and after that substitute it into Equation (B-3). Then, Equation (B-6) is resulted as follows:

$$LnN_t = (1-\lambda)LnN_{t-1} + \lambda Lnf(X_t) + U_t \qquad \text{(B - 6)}$$

Consequently, the λ can be estimated econometrically. To determine the vector X, the total cost is minimized, assuming that the capital and labour are the two main inputs, such as:

$$Total\ \ Cost = c(r, w, y) \qquad \text{(B - 7)}$$

Where r is the price of capital, w is the wage rate and y is the total output, Equation (B-7) is homogenous of degree one. Using Shephards Lemma, and derive it with respect to labour, a derived demand for the labour can be obtained. Therefore, Equation (B-8) called "demand for labour", is depended on the production level and price of other inputs (Theil, 1980).

$$L^d = \frac{\partial C(r,w,y)}{\partial w} = L^d(r,w,y) \qquad \text{(B-8)}$$

The vector X includes the production and price of inputs. Substituting Equation (B-8) to (B-6) produces Equation (B-9). Equation (B-9) is a dynamic labour demand and it can be estimated by the econometric methods (Amini, 2002).

$$\begin{aligned} LnN_t &= \alpha_0 + \alpha_1 \ln(N_{t-1}) + \alpha_2 Ln(y_t) \\ &+ \alpha_3 Ln(w_t) + \alpha_4 Ln(r_t) \qquad \text{(B-9)} \end{aligned}$$

Appendix C: (Validation Test)

1-Introduction

To evaluate the coordination between the simulated and real values, the mean squares error (MSE) or the similar comparisons of model predicated values with the actual outcome are common simulation model validation techniques. 'Back casting' is running the model backwards to see how well it predicts the past conditions from the present conditions, a useful way to test realism of the model. These are called 'pseudo-histories' for comparisons to the 'reference samples'.

The validation process using the statistical test involves comparing the performance of the model, either the recorded data for the system or against a subjective judgment of what output should be, given a broad understanding of the system or type of system which the model represents. After drawing the time series data from real-system and simulated-system, the validation process involves testing for goodness of fit for the simulation data. However, the minimum degree of conformity between the real and simulated data should exist. Here, some common statistical tests, RMSE[1], RMSPE[2] and UT[3] inequity are presented. These approaches are capable of comparing the actual rates of the change in the time series data and compute the average forecast error.

[1]- The RMSE is a measure of deviation of the simulated values y^s from the actual data y^a, where θ shows the number of observation. The RMSE can be expressed mathematically as follows:

$$RMSE = \sqrt{\frac{1}{\theta}\sum_{i=1}^{\theta}(y_{T+i}^s - y_{T+i}^a)^2} \qquad \text{(C-1)}$$

[2]- The RMSPE is a measure of the deviation of the simulated values from the actual values in term of percentage.

$$RMSPE = \sqrt{\frac{1}{\theta}\sum_{i=1}^{\theta}\left(\frac{y_{T+i}^s - y_{T+i}^a}{y_{T+i}^a}\right)^2} *100 \qquad \text{(C-2)}$$

1 Root Mean Squares Error

2 Root Mean Squares Percentage Error

3 U-Thail

[3]- The UT inequity coefficient is another test for measuring the deviation of the simulated values from the actual ones. This can be presented as follows:

$$UT = \sqrt{\frac{\frac{1}{\theta}\sum_{i=1}^{\theta}(y_{T+i}^{s} - y_{T+i}^{a})^2}{\frac{1}{\theta}\sum_{i=1}^{\theta}(y_{T+i}^{s})^2 + \frac{1}{\theta}\sum_{i=1}^{\theta}(y_{T+i}^{a})^2}} \qquad \text{(C - 3)}$$

The value of UT always falls between 0 and 1. If U=0, the predicted values are equal to the actual value, and there is a perfect fit. If U=1, the predictive performance of the model is bad. In other words, the value of one indicates that the predictions are no more accurate in forecasting the socio-economic variables than a naïve. Normally, when the value of UT is less than 1, the prediction of the model is better than a naive model.

The predication of the error source can also be identified by taking into account the numerator of the Theil's inequality coefficients, namely the U^m, U^s, and U^c.

$$U^m = (\overline{Y}^s - \overline{Y}^a)^2 / [\frac{1}{\theta}\sum_{i=1}^{\theta}(Y_{T+i}^{s} - Y_{T+i}^{a})^2] \qquad \text{(C - 4)}$$

$$U^s = (SDS - SDA)^2 / [\frac{1}{\theta}\sum_{i=1}^{\theta}(Y_{T+i}^{s} - Y_{T+i}^{a})^2] \qquad \text{(C - 5)}$$

$$U^c = [2*(1-r)*(SDS*SDA)] / [\frac{1}{\theta}\sum_{i=1}^{\theta}(Y_{T+i}^{s} - Y_{T+i}^{a})^2] \qquad \text{(C - 6)}$$

Where, $U^m + U^s + U^c = 1$

U^m equals to the basis proportion is an indication of the systematic error, where a value closes or equals to zero is desirable.

U^s is the variance proportion which measures the equality between the standard deviation of the simulated (SDS) and the actual (SDA) values. A value which is close or equal to zero is desirable.

U^c is the covariance proportion which measures the unsystematic error, where a value close to one is preferable.

SDS is the standard deviation of the simulated value, SDA is the standard deviation of the actual value, and r is the correlation coefficient between the simulated and the actual values. The perfect correlation of the simulated or predicated values, with the actual or observed values, would imply the ideal distribution of inequality over the three simulated of the error as U^m=U^s and U^c=1.

Barles (1996) acknowledges that the SD has been criticized for relaying too much on informal, subjective, and qualitative model validation procedures. He maintains, however, that the validation of any model (including statistical models) cannot be entirely a formal, objective process because:

[1]- Validity depends on purposes, which are inherently non-technical, qualitative issues.

[2]- Building confidence in a model is a gradual process dispersed throughout the methodology, starting with problem identification and continuing even after the implementation of policy recommendations.

[3]- Philosophers of science have (in any event) not been able to define the formal validation process guaranteeing the validity of any theory.

2-System Dynamics Model Validity

In developing the SD model of the Iranian agriculture, the specifications of the estimated equations are substituted in the SD model to specify the relationships among a number of important variables. In this section, the overall simulation results from the SD model for the socio-economic variables are discussed. Then, the 'base model' (baserun) results are presented as the current behaviour of the system without any policies. This section is divided into two main sub-sections. The first relates to the model validity; including several routine tests such as error checking, dimension test, and subsequently the model is simulated. After the simulation in the second phase, other tests such as behaviour reproduction test (ex-post simulation), sensitivity analysis and extreme condition test are performed.

The validation procedure involves comparing the performance of the model either by the recorded data for the system, or against a subjective judgement of what the output should be; given a broad understanding of the system or the type of system which the model represents. An important part of the validation process is the tracking of the historical data (actual data) by the simulated data.

The first recommended step in validation is drawing out the data in a time series with the real-system recorded performance, and the model-output on the same graph. The second procedure involves testing whether the simulation model fits to describe a particular situation (goodness of fit), i.e., the degree of conformity of the formulated times series data to the observed or actual data. Such procedure may engage an analysis of some statistical tests.

The model validity is divided into five sub-sections; first, error checking tests; second, dimensional consistency test; third, behaviour reproduction tests (simulation of the model and compares it with the real world and carries out statistical tests, RMSPE, UT, etc.); fourth, sensitivity analysis; and fifth, extreme condition tests.

2.A - Behaviour Reproduction Tests

Before starting any behaviour reproduction test, some additional regular tests were done after the model was simulated. These tests are addressed by Sterman (2000: 859-891) for the assessment of dynamic model such as boundary adequacy, structure and parameter assessments, as well as integration error tests. Checking the behaviour of the simulated model with the real data is very important test for any model's validity.

An RMSPE value of zero implies a perfect relationship between the simulated and actual values. As the RMSPE value increases, the error increases and the validity decreases. In the econometric methods, when the R-squared value increases, the RMSPE values generally decreases. The RMSPE for the rural population in the SD model is lesser than 1.5% (1.17%). Hence, it shows that the simulated values are very good predicators for the actual values. The rural population is a very important variable in an SD model because it forms the agricultural labour supply and has several interlinks with other variables in the model. The rural population involves in too many Feedback Loops (FBL) in the SD model

The other fitting criterion which I use to validate and judge the results of the SD model is the UT, defined before. This equation compares the errors obtained by the purposed forecasting method with the actual data. As such, a UT value that is lower than/ equal to/ higher than one, implies a forecasting capability better than/ equal to/ worse than the random walk model. The UT value for the rural population is near to zero (0.0086), hence we can state that the simulated values are acceptable. For the nine important variables in the SD model reported in Table (2).

Table C-1: Validation Test for Nine Important Variables in the System Dynamic Model

No.	Name of Variable simulated	RMSPE (%)	UT	Correlation	R^2
1	**Rural Population**	**1.17**	**0.0086**	**0.99**	**0.98**
2	**Total Population**	**4.10**	**0.031**	**0.99**	**0.99**
3	**Agricultural Production**	**7.7**	**0.05**	**0.98**	**0.96**
4	**Agricultural Employment**	**1.46**	**0.011**	**0.97**	**0.94**
5	**Agricultural Capital**	**16.1**	**0.10**	**0.91**	**0.83**
6	**Agricultural Export**	**34**	**0.15**	**0.80**	**0.64**
7	**Agricultural Import**	**28**	**0.19**	**0.52**	**0.27**
8	**National Income per capita**	**4.36**	**0.024**	**0.99**	**0.98**
9	**Agricultural Price index**	**8.38**	**0.08**	**0.99**	**0.98**

Figure (1) to (9) presents the simulated values which refer to the period from 1976-2021 and the actual from 1976-2002. For example, Figure (1) shows an 'overshoot and collapse' behaviour type. The simulated values demonstrate a very good coordination (accompany) with the actual values. Based on the simulation, the rural population increased until 1992 and it then would start to decrease until 2021. In other words, the simulated data overshot to 1992 and it would then collapse to 2021. It collapses because the rate of emigration from the rural to urban areas, plus the deaths rate which is more than the birth rate in the rural areas. Hence, we can state that the unemployment problem will move from the rural to urban areas in the near future.

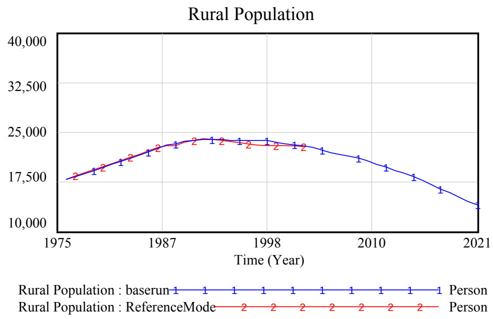


Figure 1: Simulated and Actual Values for the Rural Population (Thousand People)

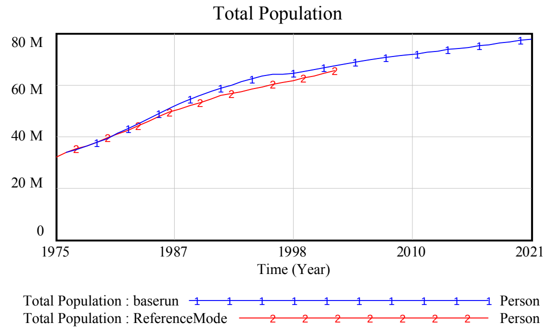


Figure 2: Simulated and Actual Values for the Total Population (Million People)

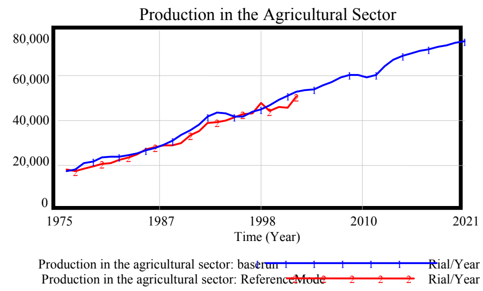


Figure 3: Simulated and Actual Values for the Agricultural Production (Billion Rial, 1997=100)

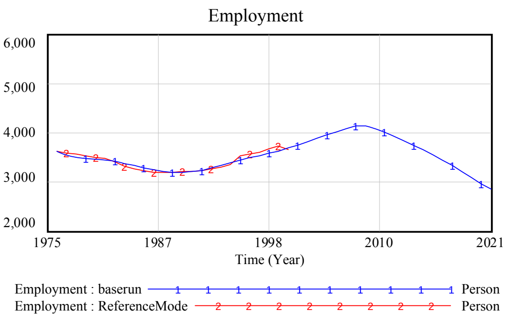


Figure 4: Simulated and Actual Values for the Agricultural Employment (Thousand People)

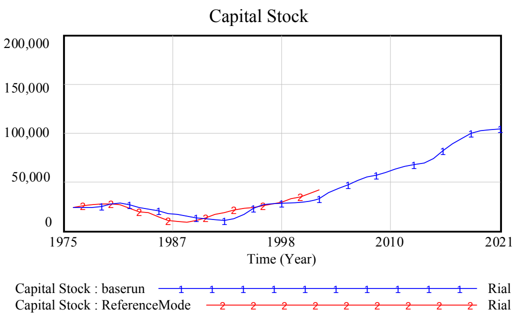


Figure 5: Simulated and Actual Values for the Agricultural Capital (Billion Rial, 1997=100)

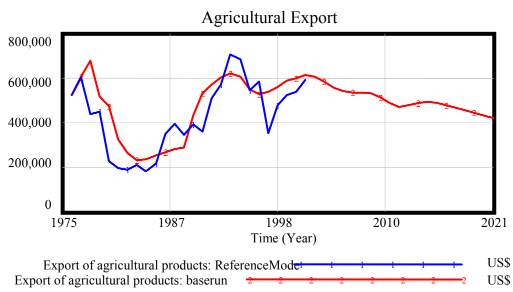


Figure 6: Simulated and Actual Values for the Agricultural Export (US Dollar, 1990=100)

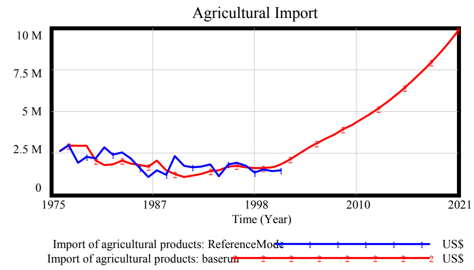


Figure 7: Simulated and Actual Values for the Agricultural Import (US Dollar, 1990=100)

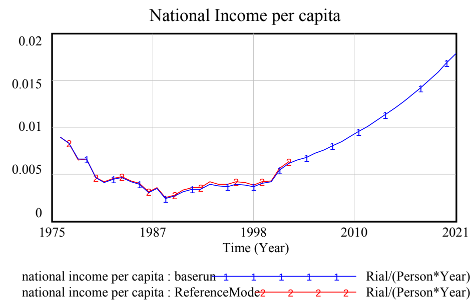


Figure 8: Simulated and Actual Values for the National Income per capita (Rial, 1997=100)

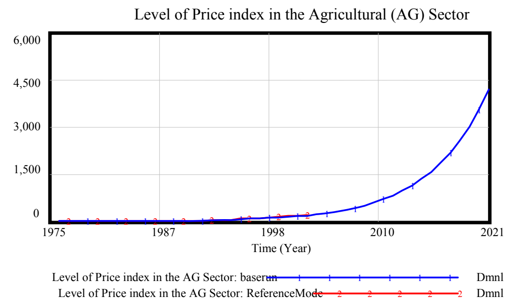


Figure 9: Simulated and Actual Values For the Agricultural Price Index (Percent)

2.B - Sensitivity Analysis Test

Sensitivity testing is the process of changing the assumption about the value of constant in the model and examining the resulting output. The sensitivity analysis checks on whether the conclusion changes in ways important to the stated purpose when the assumptions are varied over the plausible range of uncertainty. There are three types of sensitivity: numerical, behaviour mode, and policy sensitivity. The numerical sensitivity exists when a change in assumption changes the numerical values of the results. The behaviour mode sensitivity exists when a change in the assumptions changes the patterns of behaviour generated by the model. The policy sensitivity exists when a change in the assumptions reserves the impact or desirability of a proposed policy (Sterman, 2000: 883).

In the social sciences, the numerical sensitivity may matter little, if at all. For most purpose, the behaviour mode sensitivity (business models) and specifically the policy sensitivity are used in the human system examples.

The uncertainty in the parameter (constant) values is an important factor, and therefore, must be tested. In conducting the sensitivity analysis, the varying parameter (constant) in the plausible range of uncertainty must be identified. Similarly, the sensitivity test to these parameters, over a much wider range, must also be carried out. Relating the sensitivity analysis to the general objective, the test must therefore be focussed on the relationships and parameters related to employment and production, as well as the highly suspected uncertainty which may likely be influential. On the other hand, if a parameter has no uncertainty or may not be influential, or may be a little influential but high uncertainty, or highly influential but little uncertainty, no tests are required. Vensim DSS has the capability to do repeated simulations in which the model variables are changed for each simulation. The multivariate method (change all together) is used in this study. In this method, all constants are changed together simultaneously. This can be very helpful in understanding the behavioural boundaries of a model and testing the robustness of model-based Policies.

A policy maker can carry out various sensitivity analysis sets by using the current SD model. The objective of the current study places its focus on the policies that are related to employment and production. Therefore, the sensitivity analyses on these two important variables were conducted. These analyses were done based on the social and economic elements of the SD model. For this purpose, five different sensitivity analyses based on the five scenarios were established in this study. To achieve the final results, 1000 simulations were completed for each of these sensitivity analyses.

Scenario I- The sensitivity of the labour demand was examined in Scenario (I). Whereas, the method of production was changed to the capital using or the capital saving method, at the same time, the price of the capital was allowed to increase or decrease simultaneously. Therefore two risky and influential parameters (the employment production elasticity and cross price elasticity) were expected to fluctuate over the time.

Figures (10) to (11) illustrate the results of the Monte Carlo's simulation based on Scenario (I) on the employment, production, rural population, and unemployment rate, respectively. These Figures demonstrate the 25%, 50%, 75%, 95%, and 100% confidence bounds for these variables in a sample of 1000 simulations. The estimated coefficients for the dynamic demand for labour (employment production elasticity and cross price elasticity) are all assumed to be distributed normally and independently with positive and negative standard deviation (Mean+STDV and Mean-STDV) of their mean values so as to identify the maximum and minimum variations. For example, given these assumptions, there were 25%, 50%, 75%, and 95% chances that employment would be about 4100-3750, 4150-3000, 4150-2250, 4150-1700, respectively; and a 100% chance that employment would be between 4150-1600 thousand people in 2010. Obviously, Figure (10) indicates that there is no possibility to increase employment when the employment production elasticity and cross price elasticity change over the simulation time from the period of 2010 to 2021.

It is considerable how the confidence intervals widen during the growth phase, and then narrows again as the employment declines in the SD model. The uncertainty increased from 1975 to 1999, and then started to decrease from 2000 to 2021. Figure (11) indicates the changes in the two parameters which can increase production in the period of 2007 to 2021. Whereas, a small effect on the rural population is observed (Figure 12). Figure (13) shows that the effect on unemployment is tremendous. For example, the unemployment rate can increase with 100% confidence bounds up to 33% in 2010.

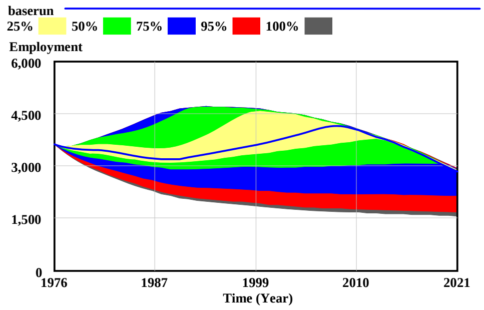


Figure 10: Results of Sensitivity Analysis for the Agricultural Employment (Thousand People) Based on Scenario (I)

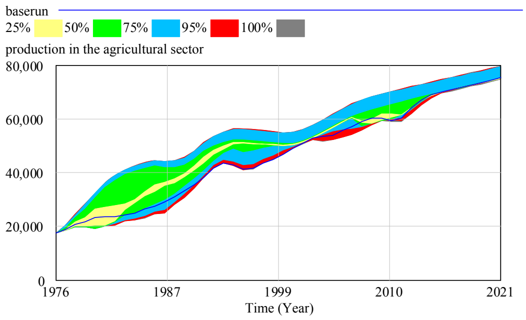


Figure 11: Results of Sensitivity Analysis for the Agricultural Production (Billion Rial, 1997=100) Based on Scenario (I)

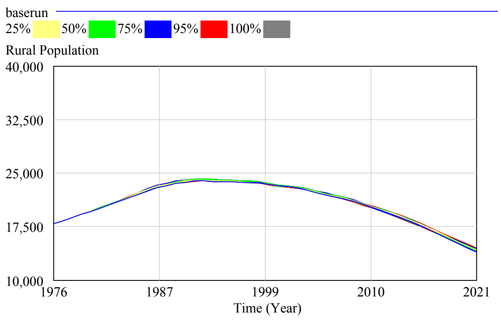


Figure 12: Results of Sensitivity Analysis for the Rural Population (Thousand People) Based on Scenario (I)

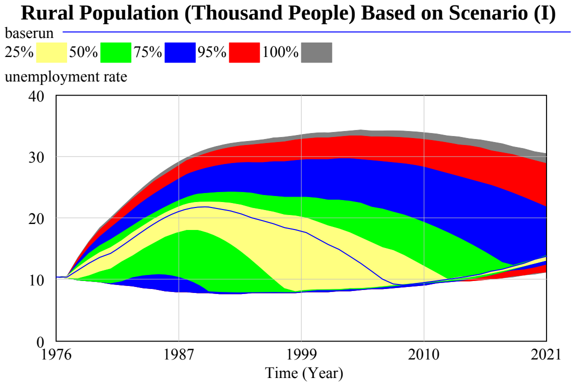


Figure 13: Results of Sensitivity Analysis for the Unemployment Rate (Percent) Based on Scenario (I)

Scenario II- During the simulation period, the income and price elasticity changed in the Scenario (II). The income elasticity indicated the effect of the income on the demand for agricultural products, while the price elasticity showed the response of the demand for the agricultural products, with respect to the variations in prices. Both are considered as distributed normally and independently with positive and negative standard deviations of their own mean values to identify the maximum and minimum variations.

Figure (14) demonstrates the sensitivity analysis for the employment. It showed that the confidence bounds expanded until 2005 and they contracted from 2006 to the end of the simulation time. Figure (15) has different behaviours in respect to Figure (14). The confidence bounds fluctuate, and in 2021 it reaches the maximum expansion. The production with 100% chance will be about 175000 to 25000 billion Rials in 2021.

Figure (16) and (17) illustrate the demands for the agricultural products (per capita) and labour. The demand for the agricultural products expands and fluctuates (upper bound) during the simulation study. The important point is that the confidence bounds nearly, distributed normally around the simulation line. Figure (17) indicates that when the income and price elasticity for agricultural products changes due to uncertainty, the labour demand can increase or decrease in the expanding range by passing time. Hence, the effect of income and price elasticity on the labour demand is great.

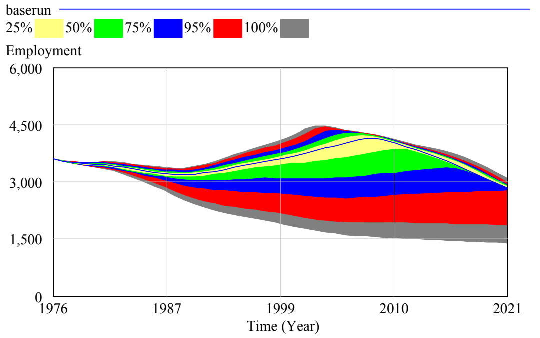


Figure 14: Results of Sensitivity Analysis for the Agricultural Employment (Thousand People) Based on Scenario (II)

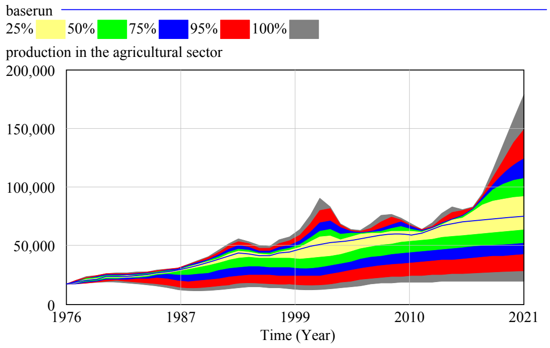


Figure 15: Results of Sensitivity Analysis for the Agricultural Production (Billion Rial, 1997=100) Based on Scenario (II)

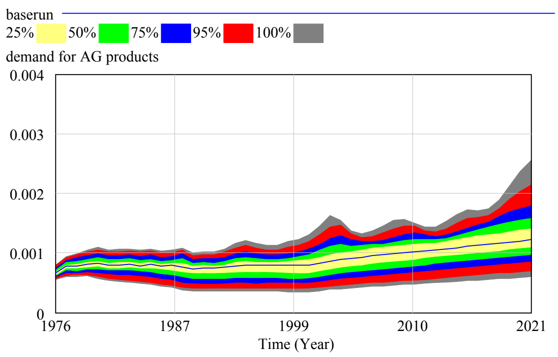


Figure 16: Results of Sensitivity Analysis for the Agricultural Demand per capita (Billion Rial, 1997=100) Based on Scenario (II)

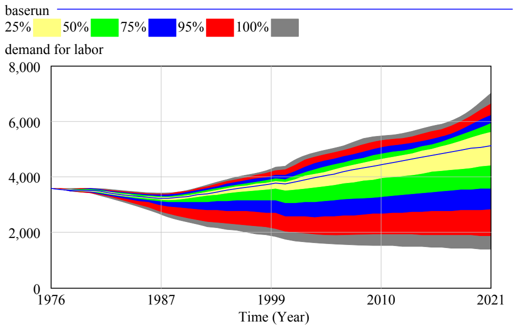


Figure 17: Results of Sensitivity Analysis for the Agricultural Labour Demand (Thousand People) Based on Scenario (II)

Scenario III-The under-cultivated land and investment seem to be influential and risky factors in the SD model. Hence, the changes due to these factors according to Random-Uniform distribution were considered in Scenario (III). The assumption is that the land can increase and decrease 25% during the entire simulation study. The investment can also increase and decrease in the simulation period.

Due to other activities in the agricultural sector (fishery, forestry, hunting, poultry, etc.), the land influences was minimal, as these activities imposed a minor dependency on the agricultural land in the process of production.

"There is a happy side to policy sensitivity, i.e., insensitivity. If a policy analysis hold up a parameters are varied over selected ranges, then those parameter values need not be estimated with any greater accuracy than those ranges" (Richardson, 1981: 279). Hence, the land variations and investment indicate the nearly insensitivity results in the selected variables.

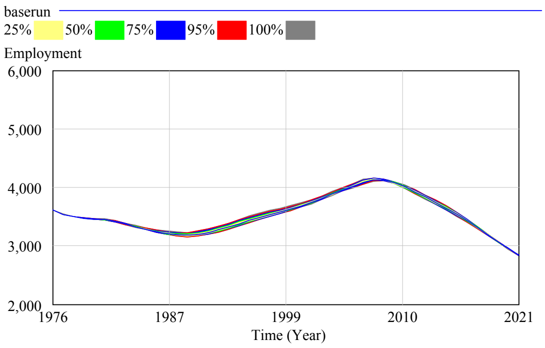


Figure 18: Results of Sensitivity Analysis for the Agricultural Employment (Thousand People) Based on Scenario (III)

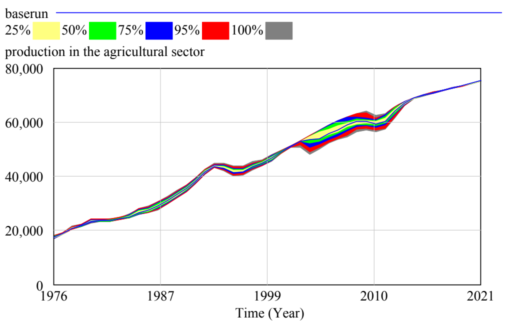


Figure 19: Results of Sensitivity Analysis for the Agricultural Production (Billion Rial, 1997=100) Based on Scenario (III)

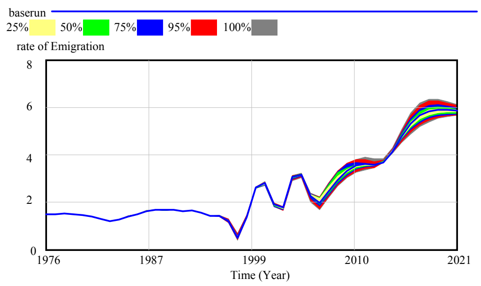


Figure 20: Results of Sensitivity Analysis for the Emigration Rate (Percent) Based on Scenario (III)

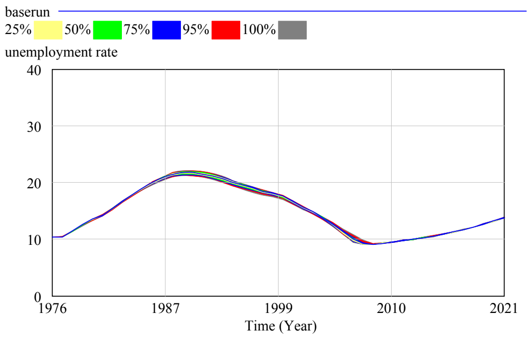


Figure 21: Results of Sensitivity Analysis for the Unemployment Rate (Percent) Based on Scenario (III)

Scenario IV- In Scenario (IV), some factors in the social model changed over the simulation time. The factors in the social section of the model are as follows:

[1]- Increase the rate of job opportunity in the industrial sector (change 25%, with Random-Uniform distribution).

[2]- Increase the rate of job opportunity in the construction and service sectors (change 25%, with Random-Uniform distribution).

[3]- Delay in the job opportunities and wage differences (change one third, with Random-Uniform distribution).

[4]- Probability of finding jobs in the urban areas (change 50%, with Random-Uniform distribution).

[5]- Exogenous social effects on the emigration (change 25%, with Random-Uniform distribution).

All the variables mentioned above are considered as Random-Uniform distribution for the sensitivity analysis.

Figures (22) to (26) demonstrate the results of 1000 simulations for the sensitivity analysis.

Figure (22) indicates that there was no confidence bound for the agricultural employment from 1976 to 1997. However, from 1998 to 2008, there is one side confidence bound, and from 2009 till 2021 two-side confidence bounds are presented for the agricultural employment. Clearly, these results show that if all the above variables in the social model change over time and with 100% chances, employment can not go beyond the range of 4600 and lesser than 1400 (thousands people) for all simulation years.

The confidence bound for the agricultural production started to expand and fluctuate from 2004, and in 2021 it would be contracted.

The confidence bound for the unemployment rate expands over time but not less/ more than 8% and 28%, respectively. The confidence bound for the net flow of emigration from the rural areas to urban areas fluctuated uniformly over the time simulation. The confidence bound for the rural population as shown in Figure (26) enlarged over the simulation period. Obviously, this is the cause of the increase uncertainty, and it also indicates that when some important parameters (variables) in the social model change, the rural population will lay centrality in large domain. For example, the rural population in 2021 can fluctuate with 100% chances between 21 to 7 million persons.

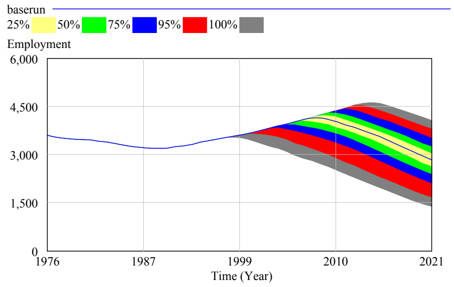


Figure 22: Results of Sensitivity Analysis for the Agricultural Employment (Thousand People) Based on Scenario (IV)

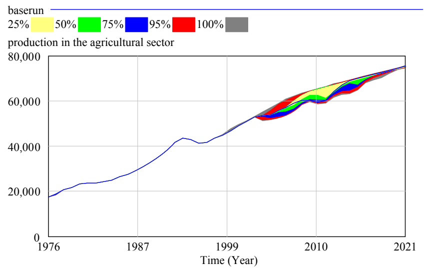


Figure 23: Results of Sensitivity Analysis for the Agricultural Production (Billion Rial, 1997=100) Based on Scenario (IV)

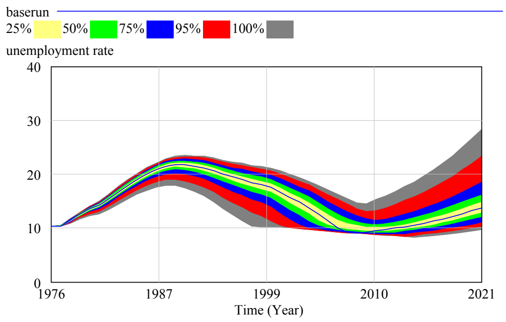


Figure 24: Results of Sensitivity Analysis for the Unemployment Rate (Percent) Based on Scenario (IV)

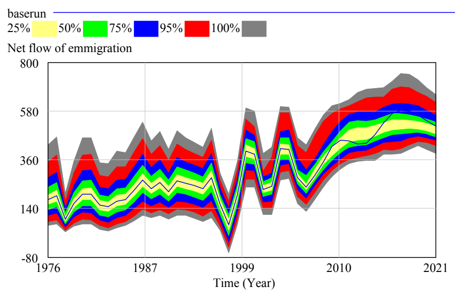


Figure 25: Results of Sensitivity Analysis for the Net Flow of Emigration (Thousand People) Based on Scenario (IV)

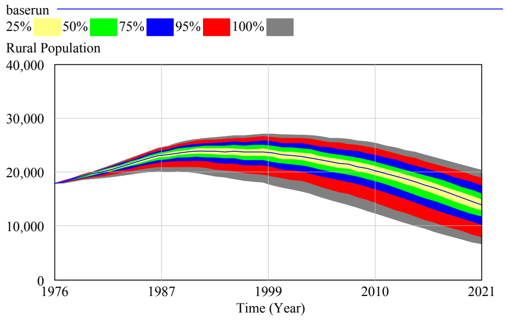


Figure 26: Results of Sensitivity Analysis for the Rural Population (Thousand People) Based on Scenario (IV)

Scenario V- In Scenario (V), a number of economic parameters are changed, and these are supposedly to be influential and risky over the simulation period. These economic parameters are as follows:

[1]- Retirement rate in the agricultural sector (25% decrease and 12.5% increase, with Random-Uniform distribution)

[2]- Investment rate (5.5% increase and 16% decrease, with Random-Uniform distribution)

[3]- Coefficient for the wage rate in the agricultural sector (one-forth of the standard deviation change, Random-Normal distribution)

[4]- Coefficient for the pure technical change (one-sixth of the standard deviation change, Random-Normal distribution)

[5]- Non-neutral technical change (one-sixth of the standard deviation change, Random-Normal distribution)

[6]- Supply of labour (25% change, Random-Uniform distribution)

Figures (27) to (30) illustrate the results of 1000 simulations for the economic parameter sensitivity analysis. Figure (27) for the agricultural employment indicates that the confidence bound expanded from 1976 to 1997, and then from 1998 to 2017, it would contract. For example in 2010, the agricultural employment confidence bound (for 100% chances) will fluctuate from 1,450 thousand people to 5,200. The confidence bounds for the agricultural production, from 1975 to the end of simulation period, fluctuated. However, there is a 50% chance to increase during the 2000 to 2021, while the chances for decreasing are also high. The results of the sensitivity analysis for the emigration rate confirmed that the confidence bound would expand from 1991 to 2021, but with the same trend (Figure 29). The interpreted results of the production and export are the same (Figure 30).

The results on sensitivity can help the policy makers and researchers to decide how on much a particular variable such as either production, employment, unemployment, demand and supply, emigration, or population and so on can increase or decrease with respect to the changes in some parameters (due to the risk in the parameters).

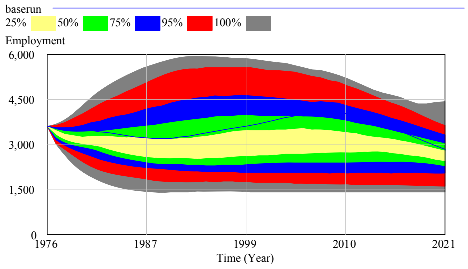


Figure 27: Results of Sensitivity Analysis for the Agricultural Employment (Thousand People) Based on Scenario (V)

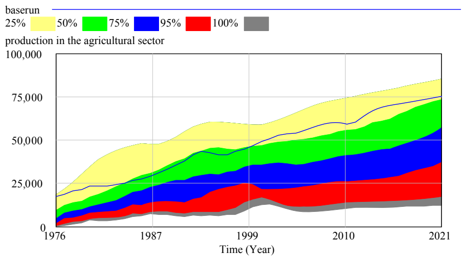


Figure 28: Results of Sensitivity Analysis for the Agricultural Production (Billion Rial, 1997=100) Based on Scenario (V)

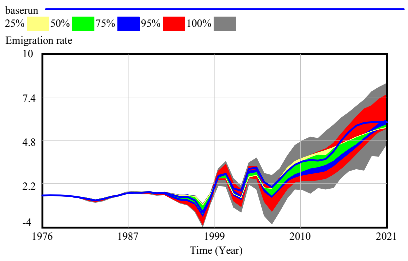


Figure 29: Results of Sensitivity Analysis for the Emigration Rate (Percent) Based on Scenario (V)

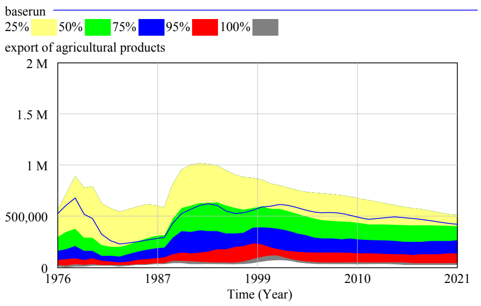


Figure 30: Results of Sensitivity Analysis for the Agricultural Export (US Dollar, 1990=100) Based on Scenario (V)

The interaction of the FBL and accumulations in SD model means that the dynamic confidence bounds generated by multivariate sensitivity analysis can be very different from the distribution of a given variance around the base case trajectory.

2.C - Extreme Condition Test

"Model should be robust in extreme condition. Robustness under extreme conditions means the model should behave in a realistic fashion no matter how extreme the inputs or policies imposed on it may be" (Sterman, 2000:869). For example, the production can never drop to zero or too high, although the factor of production increases or decreases tremendously. Similarly, employment cannot increase/ decrease too high when the supply or demand increases/ decreases extremely. Extreme condition tests can be used to identify whether a model behaves appropriately when the inputs take on extreme values such as zero or infinity. Sterman (2000) stated that "extreme condition tests can be carried out in two main ways: by direct inspection of the model equation and by simulation. Each decision rule (rate equation) should be examined in the model and able to find out whether the output of the rule is feasible and reasonable even when each input to the equation takes on its minimum and maximum".

When an extreme condition simulation generates implausible behaviour, the equations should examine the affected formulations to identify the precise source of the flaw. Hence, in this sub-section, three different scenarios are simulated. In each scenario, different shocks on the parameters were imposed, and the analyses of these effects are important on the variables such as production, employment, export, capital, emigration rate, unemployment rate and etc. The effects of these variables are also observed and compared to the primary model (baserun).

Scenario I-Selecting the type of shocks is optional and it has many varieties. However, only certain limited, influential and important scenarios for testing were chosen. In Scenario (I), a rapid increase (for two times) in the investment was imposed from 1980 to 1982 and 1991 to 1993. Figure (31) shows the impacts of these shocks on the growth rate of investment. The line marked with No. 1 demonstrates the effect of these shocks on the base model (Capital-Growth-Rate-shocks) and line marked with No. 2 demonstrates base model without any shocks (baserun). As it can be observed in Figure (31), the capital rises and falls for two times and before it returns to its baserun values. Hence, Figures (31) to (35) indicate that the system has successfully captured the shocks.

Figure (33) illustrates that the effect of this shock on the employment is small. The outcomes of the shock policy on the production in Figure (32) are the same as the capital, but with a slight fluctuation. Nevertheless, it is important that it returns to the baserun line in 2009.

The interpretation carried out on the agricultural export (Figure 35) is slightly different. It diverges from the baserun occasionally, but at the end of 2007, the shock line coincides to the baserun. Figure (36) illustrates that the effect of this shock on the rate of emigration is small.

To interpret these fluctuations is not a simple task. As mentioned earlier, on the complicated relationships and a lot of FBL cause the different and complex interpretations for each Figure. However, the important point is when an extreme condition simulation generates implausible behaviour; the equations of the affected formulation to identify the precise source of flaw should be examined. Obviously, when a system is complicated and with a lot of equations (like the current study), it causes many problems for researchers in finding the sources of flaw.

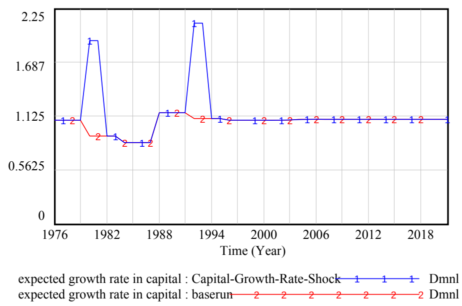


Figure 31: Growth Rate in the Agricultural Capital
(Shock Policy for the Investment, 1980, 1981, 1982, 1991, 1992, and 1994)

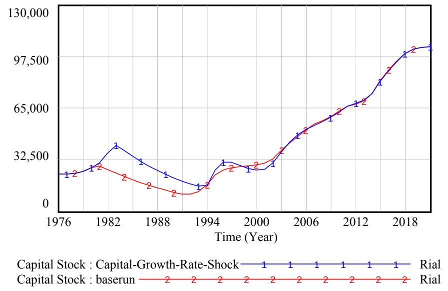


Figure 32: Capital in the Agricultural Sector
(Shock Policy for Investment, 1980, 1981, 1982, 1991, 1992, and 1994)

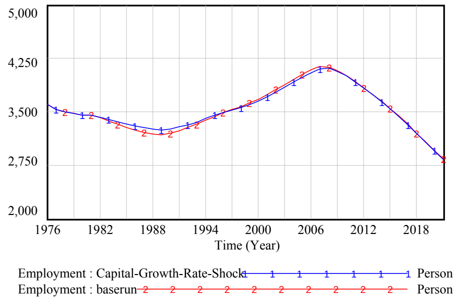


Figure 33: Employment in the Agricultural Sector
(Shock Policy for Investment, 1980, 1981, 1982, 1991, 1992, and 1994)

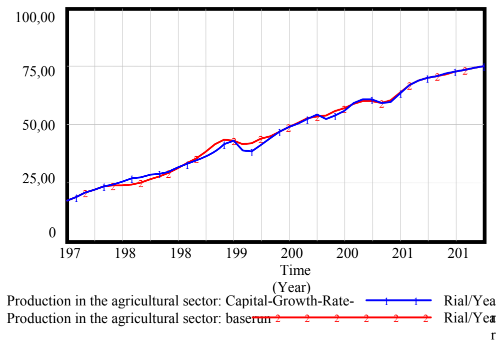


Figure 34: Production in the Agricultural Sector
(Shock Policy for Investment, 1980, 1981, 1982, 1991, 1992, and 1994)

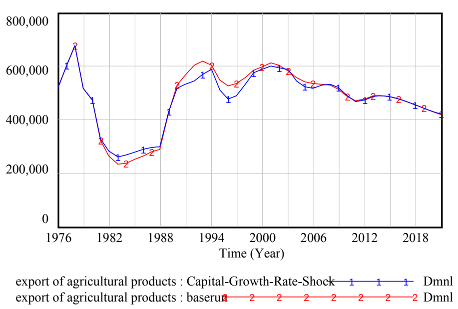


Figure 35: Export in the Agricultural Sector
(Shock Policy for Investment, 1980, 1981, 1982, 1991, 1992, and 1994)

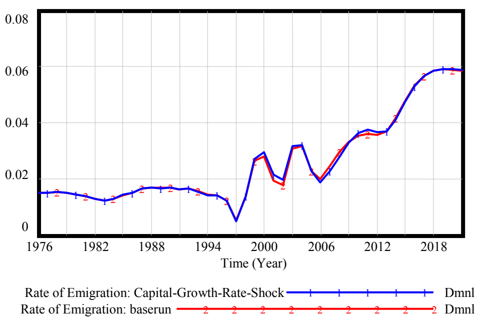


Figure 36: Emigration Rate
(Shock Policy for Investment, 1980, 1981, 1982, 1991, 1992, and 1994)

Scenario II-In Scenario (II), supposed the growth rate of job opportunity in all sectors (industrial, construction and service sectors) increased extremely. Figures (37) and (38) indicate that the growth rate increased for the industrial in 1980, 1981, and for the construction and service sectors in the 2000, 2001, and 2002 periods. It is remarkable to note that the year and period of shock is optional.

Based on the social model, the above shocks cause the job opportunities in the urban area to increase, and regarding to differences in wages in the rural and urban areas, emigration will increase over the simulation period. These shocks lead to the employment in the agricultural sector to decline (*see* Figure 39) and the production from 2002 to 2014 increases, as shown in Figure (40). Why does the agricultural production increase? This might be due to the declaration made before the agricultural sector of Iran was involved with labour surplus problem, and the decline in employment led to the marginal product of labour to increase. Hence Scenario (II) has indicated two important specificities in the SD model: first, the robustness of the model and second, the confirmation of the labour surplus problem in the agricultural sector in 2002-2014.

Figure (41) indicates that when the other sector employment absorbed the labour from the agricultural sector, it caused the unemployment level to decline from 1980 to 2008, and it would then reach the minimum values. Due to the decrease in the labour surplus problem, the production was predicted to increase, and hence caused the increment in the agricultural export, as shown in Figure (42).

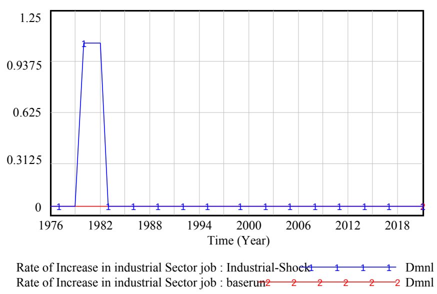


Figure 37: Growth Rate of Industrial Sector
(Shock Policy for Industrial 1980, 1981; Construction and Service Sectors for 2000, 2001, and 2002)

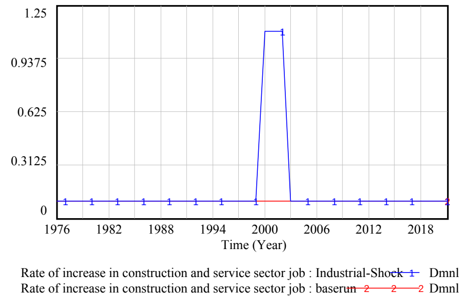


Figure 38: Growth Rate in Construction and Service Sectors
(Shock Policy for Industrial 1980, 1981; Construction and Service Sectors for 2000, 2001, and 2002)

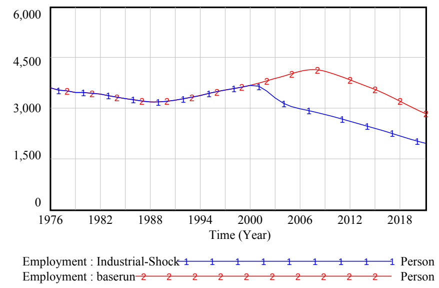


Figure 39: Employment in the Agricultural Sector
(Shock Policy for Industrial 1980, 1981; Construction and Service Sectors for 2000, 2001, and 2002)

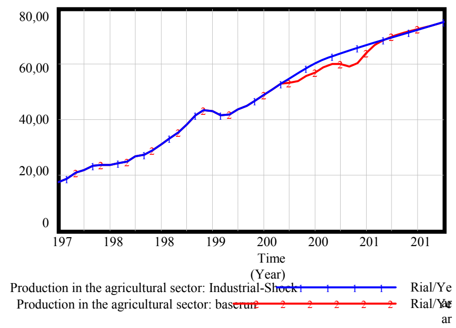


Figure 40: Production in the Agricultural Sector
(Shock Policy for Industrial 1980, 1981; Construction and Service Sectors for 2000, 2001, and 2002)

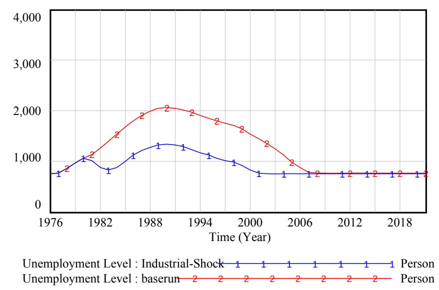


Figure 41: Unemployment Level in the Rural Areas
(Shock Policy for Industrial 1980, 1981; Construction and Service Sectors for 2000, 2001, and 2002)

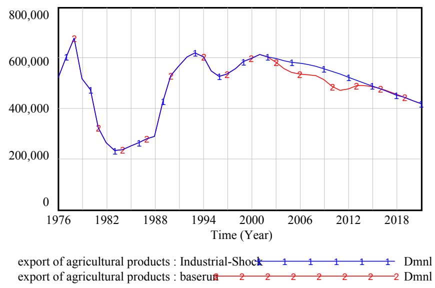


Figure 42: Export in the Agricultural Sector
(Shock Policy for Industrial 1980, 1981; Construction and Service Sectors for 2000, 2001, and 2002)

Scenario III- In Scenario (III), it was assumed that the government would increase the agricultural imports. This shock was imposed into the SD model by a ramp function (*see* Figure 43). The agricultural import had increased from 1980 to 1985, after it became stable. When the import increased, the first resultant was a decrease in the domestic production (Figure 45) and consequently, the employment also declined (Figure 44).
Figure (47) demonstrates the agricultural income per capita. Obviously, the trend indicates a significant decline. The agricultural consumption (Figure 48) increased slightly in the 1981-1997 period because of the increase in the agricultural import.
The other important point in the shock policy is the existence of the logical results for the variables after the shock is imposed. In the three scenarios, the results indicated that after the shock policy on the system, the system converged to its baserun and no implausible behaviours were detected.

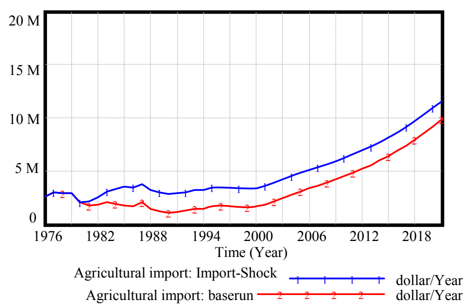


Figure 43: Effect on the Agricultural Import
(Import Ramp Function from 1980 to 1985)

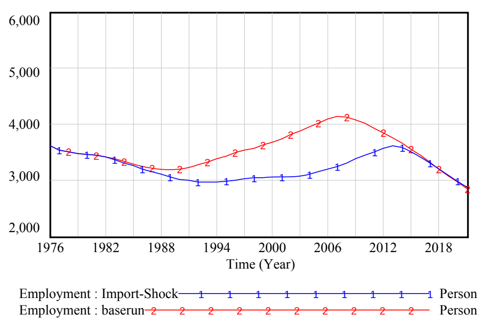


Figure 44: Employment in the Agricultural Sector
(Import Ramp Function from 1980 to 1985)

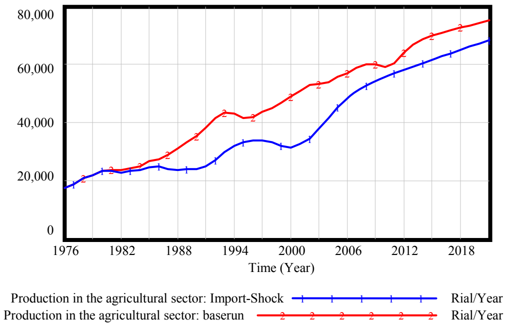


Figure 45: Production in the Agricultural Sector (Import Ramp Function from 1980 to 1985)

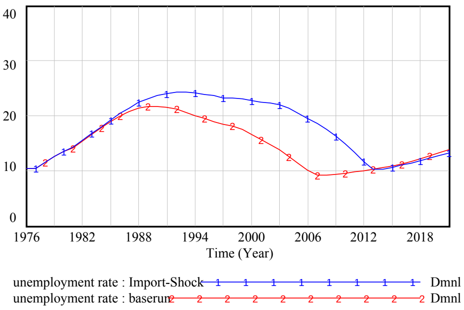


Figure 46: Unemployment Rate in the Agricultural Sector (Import Ramp Function from 1980 to 1985)

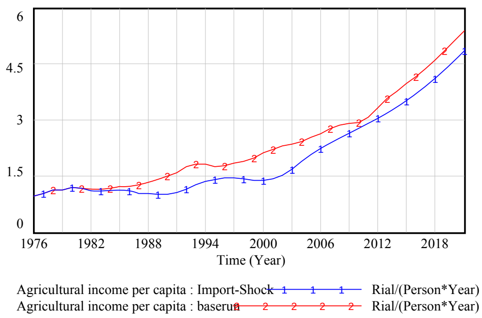


Figure 47: Agricultural Income per capita in the Rural Areas (Import Ramp Function from 1980 to 1985)

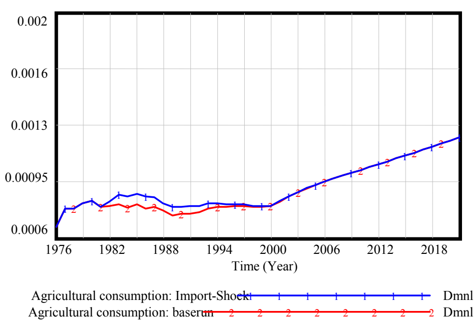


Figure 48: Agricultural Consumption per capita (Import Ramp Function from 1980 to 1985)

Appendix D: Payoff Optimization Method Tables

Table D-1: Simulated and Optimal Values of the Production and Employment Based on Scenario (I) without Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	60,758	3.042534	4,136	4,136	0
2008	60,145	65,766	9.345748	4,128	4,111	-0.41182
2009	60,151	69,770	15.99142	4,081	4,043	-0.93114
2010	59,235	72,453	22.31451	4,010	3,950	-1.49626
2011	60,297	74,253	23.14543	3,926	3,842	-2.13958
2012	63,941	75,649	18.31063	3,838	3,727	-2.89213
2013	66,918	76,934	14.96757	3,747	3,604	-3.81639
2014	68,783	78,228	13.73159	3,652	3,477	-4.79189
2015	69,990	79,560	13.67338	3,551	3,347	-5.74486
2016	70,911	80,925	14.12193	3,441	3,217	-6.50974
2017	71,751	82,311	14.71756	3,324	3,089	-7.0698
2018	72,591	83,707	15.31319	3,203	2,962	-7.5242
2019	73,451	85,111	15.87453	3,079	2,838	-7.82722
2020	74,325	86,519	16.40632	2,958	2,716	-8.1812
2021	75,202	87,930	16.92508	2,839	2,598	-8.4889
Total	**1,006,655**	**1,159,874**	**15.22061**	**53,913**	**51,657**	**-4.1845**

Note: Increase Production without Involvement of Market Factors

Table D-2: Simulated and Optimal Values of the Production and Employment Based on Scenario (I) with Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	60,758	3.042534	4,136	4,136	0
2008	60,145	66,016	9.76141	4,128	4,115	-0.31492
2009	60,151	70,176	16.66639	4,081	4,059	-0.53908
2010	59,235	72,901	23.07082	4,010	3,979	-0.77307
2011	60,297	74,695	23.87847	3,926	3,886	-1.01885
2012	63,941	76,090	19.00033	3,838	3,785	-1.38093
2013	66,918	77,395	15.65648	3,747	3,675	-1.92154
2014	68,783	78,729	14.45997	3,652	3,559	-2.54655
2015	69,990	80,113	14.46349	3,551	3,440	-3.12588
2016	70,911	81,537	14.98498	3,441	3,320	-3.51642
2017	71,751	82,982	15.65274	3,324	3,200	-3.73045
2018	72,591	84,441	16.32434	3,203	3,081	-3.80893
2019	73,451	85,906	16.95688	3,079	2,964	-3.73498
2020	74,325	87,377	17.56071	2,958	2,849	-3.68492
2021	75,202	88,852	18.15111	2,839	2,736	-3.62804
Total	**1,006,655**	**1,167,968**	**16.02466**	**53,913**	**52,784**	**-2.09411**

Note: Increase Production with Involvement of Market Factors

Table D-3: Simulated and Optimal Values of the Production and Employment based on Scenario (II) without Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	48,748	-17.3258	4,136	4,136	0
2008	60,145	56,698	-5.73115	4,128	4,207	1.91376
2009	60,151	62,589	4.053133	4,081	4,275	4.753737
2010	59,235	60,661	2.407361	4,010	4,327	7.905237
2011	60,297	54,135	-10.2194	3,926	4,320	10.03566
2012	63,941	53,375	-16.5246	3,838	4,277	11.43825
2013	66,918	54,191	-19.0188	3,747	4,219	12.59674
2014	68,783	54,876	-20.2187	3,652	4,156	13.80066
2015	69,990	55,387	-20.8644	3,551	4,090	15.17882
2016	70,911	56,097	-20.891	3,441	4,017	16.73932
2017	71,751	56,770	-20.8792	3,324	3,933	18.3213
2018	72,591	56,558	-22.0868	3,203	3,838	19.82516
2019	73,451	57,342	-21.9316	3,079	3,734	21.27314
2020	74,325	61,562	-17.1719	2,958	3,624	22.51521
2021	75,202	68,894	-8.38807	2,839	3,510	23.63508
Total	**1,006,655**	**857,883**	**-14.7788**	**53,913**	**60,663**	**12.52017**

Note: Increase Employment without involvement of Market Factors

Table D-4: Simulated and Optimal Values of the Production and Employment based on Scenario (II) with Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	59,995	1.748525	4,136	4,136	0
2008	60,145	64,722	7.609943	4,128	4,240	2.713178
2009	60,151	68,541	13.94823	4,081	4,349	6.567018
2010	59,235	68,058	14.89491	4,010	4,456	11.12219
2011	60,297	64,551	7.055077	3,926	4,551	15.91951
2012	63,941	69,784	9.138112	3,838	4,642	20.94841
2013	66,918	73,551	9.912131	3,747	4,727	26.15426
2014	68,783	75,848	10.27143	3,652	4,797	31.35268
2015	69,990	77,271	10.40291	3,551	4,810	35.4548
2016	70,911	71,920	1.42291	3,441	4,739	37.72159
2017	71,751	65,520	-8.6842	3,324	4,588	38.02647
2018	72,591	65,387	-9.9241	3,203	4,398	37.30877
2019	73,451	69,431	-5.47304	3,079	4,209	36.70023
2020	74,325	77,011	3.613858	2,958	4,047	36.81542
2021	75,202	82,038	9.090184	2,839	3,901	37.40754
Total	**1,006,655**	**1,053,628**	**4.666246**	**53,913**	**66,590**	**23.51381**

Note: Increase Employment with involvement of Market Factors

Table D-5: Simulated and Optimal Values of the Production and Employment based on Scenario (III) without Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	60,758	3.042534	4,136	4,136	0
2008	60,145	65,766	9.345748	4,128	4,227	2.398256
2009	60,151	69,770	15.99142	4,081	4,318	5.8074
2010	59,235	72,453	22.31451	4,010	4,344	8.329177
2011	60,297	74,253	23.14543	3,926	4,304	9.62812
2012	63,941	75,649	18.31063	3,838	4,231	10.23971
2013	66,918	76,934	14.96757	3,747	4,135	10.35495
2014	68,783	78,228	13.73159	3,652	4,025	10.21358
2015	69,990	79,560	13.67338	3,551	3,908	10.05351
2016	70,911	80,925	14.12193	3,441	3,788	10.08428
2017	71,751	82,311	14.71756	3,324	3,666	10.28881
2018	72,591	83,707	15.31319	3,203	3,545	10.67749
2019	73,451	85,111	15.87453	3,079	3,424	11.20494
2020	74,325	86,519	16.40632	2,958	3,305	11.7309
2021	75,202	87,930	16.92508	2,839	3,187	12.25784
Total	**1,006,655**	**1,159,874**	**15.22061**	**53,913**	**58,543**	**8.58791**

Note: Increase Production and Employment without involvement of Market Factors

Table D-6: Simulated and Optimal Values of the Production and Employment based on Scenario (III) with Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	60,758	3.042534	4,136	4,136	0
2008	60,145	66,016	9.76141	4,128	4,241	2.737403
2009	60,151	70,176	16.66639	4,081	4,352	6.640529
2010	59,235	72,901	23.07082	4,010	4,456	11.12219
2011	60,297	74,695	23.87847	3,926	4,547	15.81763
2012	63,941	76,090	19.00033	3,838	4,630	20.63575
2013	66,918	77,395	15.65648	3,747	4,683	24.97998
2014	68,783	78,729	14.45997	3,652	4,686	28.31325
2015	69,990	80,113	14.46349	3,551	4,638	30.6111
2016	70,911	81,537	14.98498	3,441	4,544	32.05464
2017	71,751	82,982	15.65274	3,324	4,414	32.79182
2018	72,591	84,441	16.32434	3,203	4,258	32.93787
2019	73,451	85,906	16.95688	3,079	4,086	32.70542
2020	74,325	87,377	17.56071	2,958	3,905	32.01487
2021	75,202	88,852	18.15111	2,839	3,722	31.1025
Total	**1,006,655**	**1,167,968**	**16.02466**	**53,913**	**65,298**	**21.11736**

Note: Increase Production and Employment with involvement of Market Factors

Table D-7: Simulated and Optimal Values of the Production and Employment based on Scenario (IV) without Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	60,758	3.042534	4,136	4,136	0
2008	60,145	65,766	9.345748	4,128	4,210	1.986434
2009	60,151	69,770	15.99142	4,081	4,206	3.062975
2010	59,235	72,453	22.31451	4,010	4,155	3.61596
2011	60,297	74,253	23.14543	3,926	4,081	3.948039
2012	63,941	75,649	18.31063	3,838	3,992	4.012507
2013	66,918	76,934	14.96757	3,747	3,893	3.89645
2014	68,783	78,228	13.73159	3,652	3,787	3.696605
2015	69,990	79,560	13.67338	3,551	3,676	3.520135
2016	70,911	80,925	14.12193	3,441	3,562	3.51642
2017	71,751	82,311	14.71756	3,324	3,447	3.700361
2018	72,591	83,707	15.31319	3,203	3,333	4.058695
2019	73,451	85,111	15.87453	3,079	3,219	4.546931
2020	74,325	86,519	16.40632	2,958	3,107	5.037187
2021	75,202	87,930	16.92508	2,839	2,996	5.530116
Total	**1,006,655**	**1,159,874**	**15.22061**	**53,913**	**55,800**	**3.500083**

Note: Increase Production, Employment, Export, Income per capita and Decrease Unemployment Rate, and Emigration Simultaneously without involvement of the Market Factors

Table D-8: Simulated and Optimal Values of the Production and Employment based on Scenario (IV) with Market Factors

Year	Simulated Production	Optimal Production	Production Change%	Simulated Employment	Optimal Employment	Employment Change%
2007	58,964	60,758	3.042534	4,136	4,136	0
2008	60,145	65,532	8.956688	4,128	4,228	2.422481
2009	60,151	69,395	15.36799	4,081	4,248	4.092134
2010	59,235	72,043	21.62235	4,010	4,264	6.334165
2011	60,297	73,852	22.48039	3,926	4,311	9.806419
2012	63,941	75,252	17.68975	3,838	4,373	13.93955
2013	66,918	76,518	14.34592	3,747	4,418	17.90766
2014	68,783	77,774	13.07154	3,652	4,427	21.22125
2015	69,990	79,057	12.95471	3,551	4,393	23.71163
2016	70,911	80,366	13.33362	3,441	4,320	25.5449
2017	71,751	81,693	13.85625	3,324	4,213	26.74489
2018	72,591	83,030	14.38057	3,203	4,081	27.4118
2019	73,451	84,374	14.87114	3,079	3,933	27.73628
2020	74,325	85,721	15.33266	2,958	3,774	27.58621
2021	75,202	87,072	15.78415	2,839	3,611	27.19267
Total	**1,006,655**	**1,152,437**	**14.48182**	**53,913**	**62,730**	**16.35413**

Note: Increase Production, Employment, Export, Income per capita and Decrease Unemployment Rate, and Emigration Simultaneously with involvement of the Market Factors

Table D-9: Simulated and Optimal Values of the Export and Income per capita based on Scenario (IV) without Market Factors

Year	Simulated Export	Optimal Export	Export Change%	Simulated Income-per-capita	Optimal Income-per-capita	Income-per-capita Change%
2007	534,230	549,241	2.809838	2.758	2.842	3.045685
2008	529,047	580,738	9.770587	2.858	3.119	9.13226
2009	512,900	609,692	18.87151	2.914	3.371	15.68291
2010	486,224	625,864	28.71927	2.936	3.574	21.73025
2011	471,201	629,231	33.5377	3.061	3.748	22.44365
2012	478,264	624,176	30.50867	3.325	3.918	17.83459
2013	488,134	614,964	25.98262	3.57	4.099	14.81793
2014	491,018	604,221	23.05476	3.773	4.296	13.86165
2015	486,615	593,155	21.89411	3.961	4.511	13.88538
2016	477,594	582,165	21.89538	4.157	4.743	14.0967
2017	466,441	571,311	22.48302	4.369	4.99	14.21378
2018	454,638	560,558	23.29766	4.601	5.255	14.2143
2019	442,845	549,867	24.16692	4.85	5.537	14.16495
2020	431,270	539,218	25.03026	5.114	5.837	14.13766
2021	419,929	528,604	25.87937	5.392	6.156	14.16914
Total	**7,170,350**	**8,763,005**	**22.21168**	**57.639**	**65.996**	**14.49886**

Note: Increase Production, Employment, Export, Income per capita and Decrease Unemployment Rate, and Emigration Simultaneously without involvement of the Market Factors

Table D-10: Simulated and Optimal Values of the Export and Income per capita based on Scenario (IV) with Market Factors

Year	Simulated Export	Optimal Export	Export Change%	Simulated Income-per-capita	Optimal Income-per-capita	Income-per-capita Change%
2007	534,230	557,705	4.394175	2.758	2.842	3.045685
2008	529,047	591,202	11.74848	2.858	3.106	8.677397
2009	512,900	620,235	20.92708	2.914	3.312	13.6582
2010	486,224	636,352	30.8763	2.936	3.404	15.94005
2011	471,201	639,797	35.78006	3.061	3.426	11.92421
2012	478,264	634,751	32.71979	3.325	3.444	3.578947
2013	488,134	625,331	28.10642	3.57	3.491	-2.21289
2014	491,018	614,162	25.07932	3.773	3.578	-5.1683
2015	486,615	602,525	23.81965	3.961	3.704	-6.48826
2016	477,594	590,893	23.72287	4.157	3.866	-7.00024
2017	466,441	579,380	24.21292	4.369	4.063	-7.00389
2018	454,638	567,981	24.93038	4.601	4.291	-6.73767
2019	442,845	556,667	25.70245	4.85	4.549	-6.20619
2020	431,270	545,422	26.4688	5.114	4.836	-5.43606
2021	419,929	534,238	27.22103	5.392	5.149	-4.50668
Total	**7,170,350**	**8,896,641**	**24.07541**	**57.639**	**57.061**	**-1.00279**

Note: Increase Production, Employment, Export, Income per capita and Decrease Unemployment Rate, and Emigration Simultaneously with involvement of the Market Factors

Table D-11: Simulated and Optimal Values of the Unemployment Rate and Emigration based on Scenario (IV) without Market Factors

Year	Simulated Unemployment Rate	Optimal Unemployment Rate	Unemployment Rate Change%	Simulated Emigration	Optimal Emigration	Emigration Change%
2007	9.183	9.183	0	290.68	255.19	-12.2093
2008	9.132	9.354	2.431012	350.25	313.45	-10.5068
2009	9.3	9.267	-0.35484	420.38	375.2	-10.7474
2010	9.514	9.459	-0.5781	447.5	384.09	-14.1698
2011	9.743	9.678	-0.66715	445.64	435.45	-2.2866
2012	9.981	9.93	-0.51097	430	476.77	10.87674
2013	10.23	10.21	-0.1955	432.49	504.26	16.5946
2014	10.52	10.53	0.095057	472.81	516.34	9.206658
2015	10.86	10.87	0.092081	527.54	517.92	-1.82356
2016	11.25	11.23	-0.17778	567.44	514.24	-9.37544
2017	11.68	11.62	-0.5137	582.65	508.47	-12.7315
2018	12.16	12.03	-1.06908	577.3	501.64	-13.1058
2019	12.67	12.47	-1.57853	559.67	493.66	-11.7945
2020	13.2	12.93	-2.04545	536.65	484.05	-9.80155
2021	13.76	13.42	-2.47093	512.34	472.56	-7.76438
Total	**163.183**	**162.181**	**-0.61403**	**7,153.340**	**6,753.290**	**-5.59249**

Note: Increase Production, Employment, Export, Income per capita and Decrease Unemployment Rate, and Emigration Simultaneously without involvement of the Market Factors

Table D-12: Simulated and Optimal Values of the Unemployment Rate and Emigration based on Scenario (IV) with Market Factors

Year	Simulated Unemployment Rate	Optimal Unemployment Rate	Unemployment Rate Change%	Simulated Emigration	Optimal Emigration	Emigration Change%
2007	9.183	9.183	0	290.68	255.19	-12.2093
2008	9.132	9.402	2.956636	350.25	241.99	-30.9094
2009	9.3	9.151	-1.60215	420.38	-60.94	-114.496
2010	9.514	9.059	-4.78243	447.5	-352.8	-178.838
2011	9.743	8.896	-8.69342	445.64	-391.02	-187.743
2012	9.981	8.776	-12.0729	430	-216.03	-150.24
2013	10.23	8.749	-14.477	432.49	28.53	-93.4033
2014	10.52	8.82	-16.1597	472.81	258.57	-45.3121
2015	10.86	8.982	-17.2928	527.54	441.07	-16.3912
2016	11.25	9.225	-18	567.44	572.19	0.837093
2017	11.68	9.536	-18.3562	582.65	659.1	13.12108
2018	12.16	9.91	-18.5033	577.3	710.68	23.10411
2019	12.67	10.33	-18.4688	559.67	734.71	31.27557
2020	13.2	10.81	-18.1061	536.65	737.62	37.44899
2021	13.76	11.33	-17.6599	512.34	724.89	41.48612
Total	**163.183**	**142.159**	**-12.8837**	**7,153.340**	**4,343.750**	**-39.2766**

Note: Increase Production, Employment, Export, Income per capita and Decrease Unemployment Rate, and Emigration Simultaneously with involvement of the Market Factors

APPENDIX E

Flow Diagram for the Socio-Economic System Dynamics Model (Model Structure)

Figure E-1: Social Model

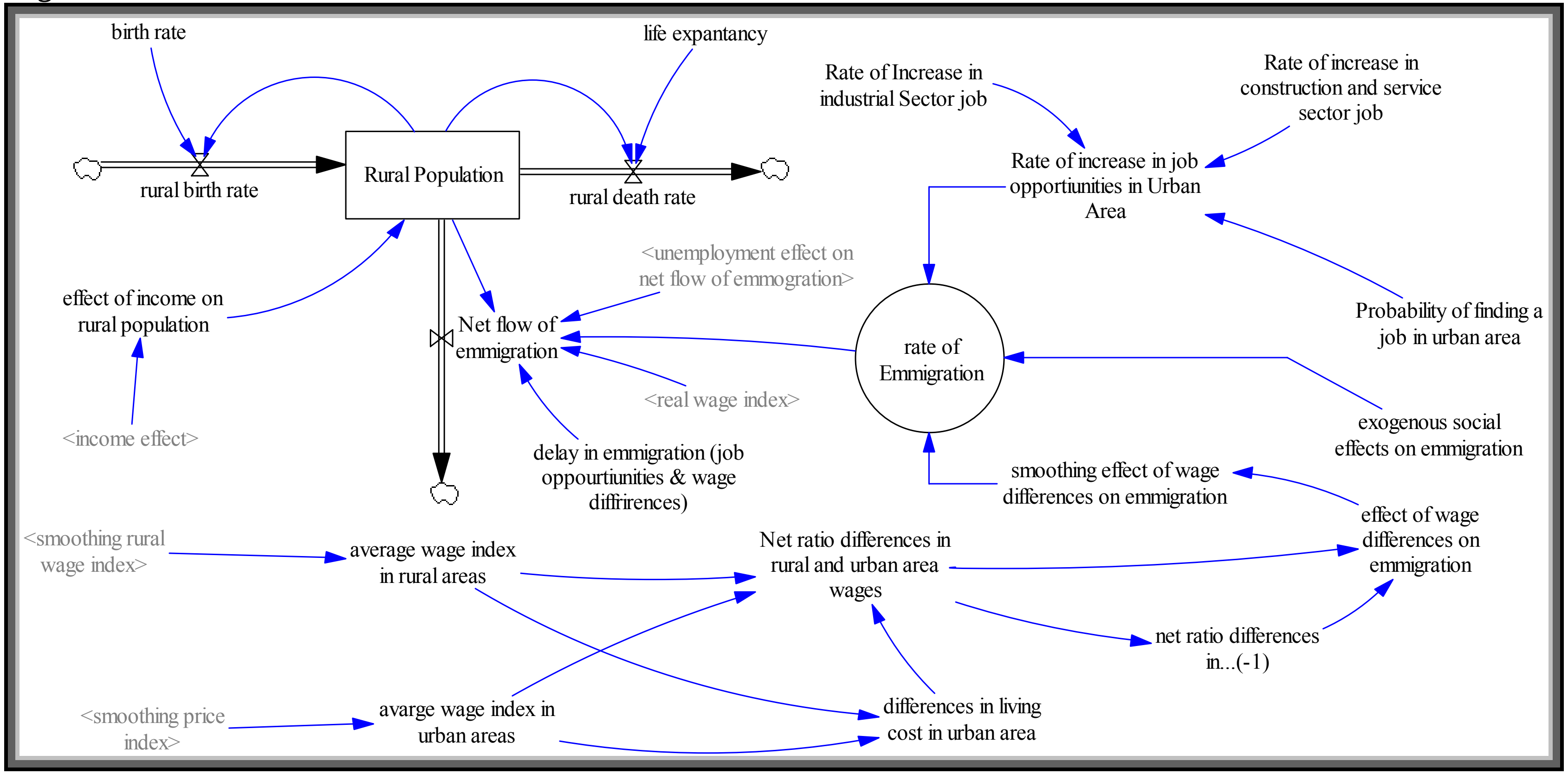


Figure E-2: Translog Coefficients Used in the System Dynamics Model

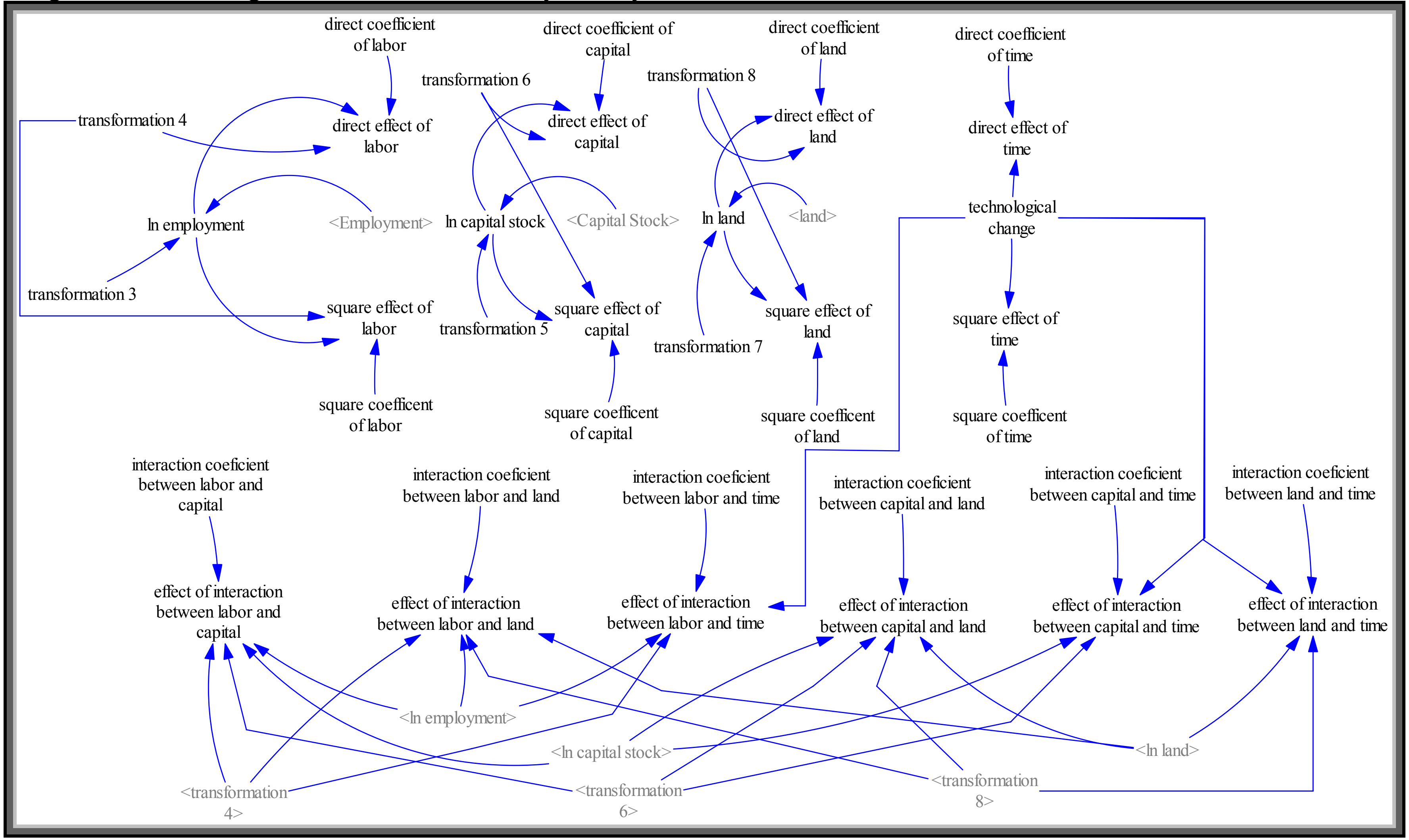


Figure E-3: Production Model

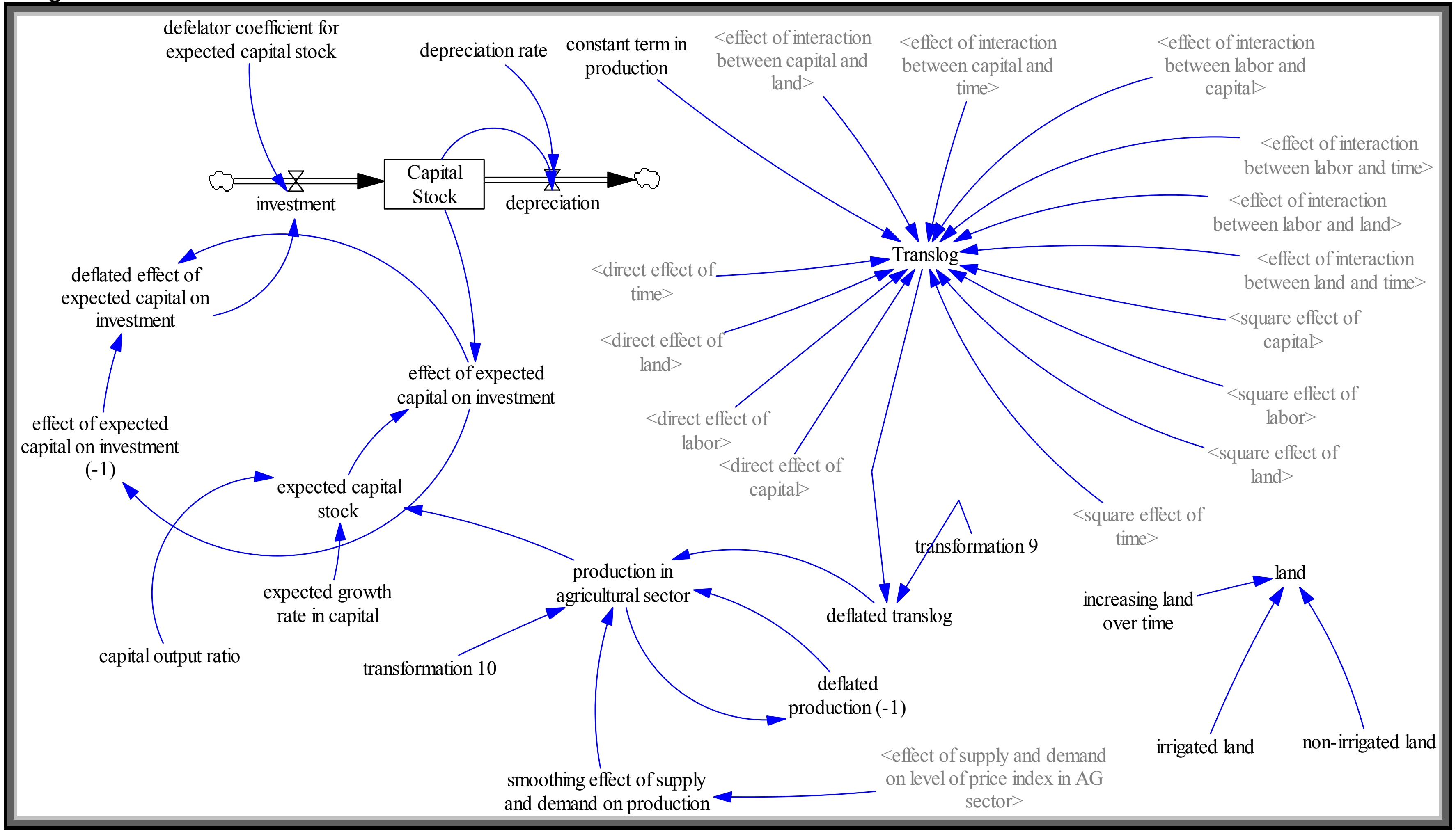


Figure E-4: Export-Import Model

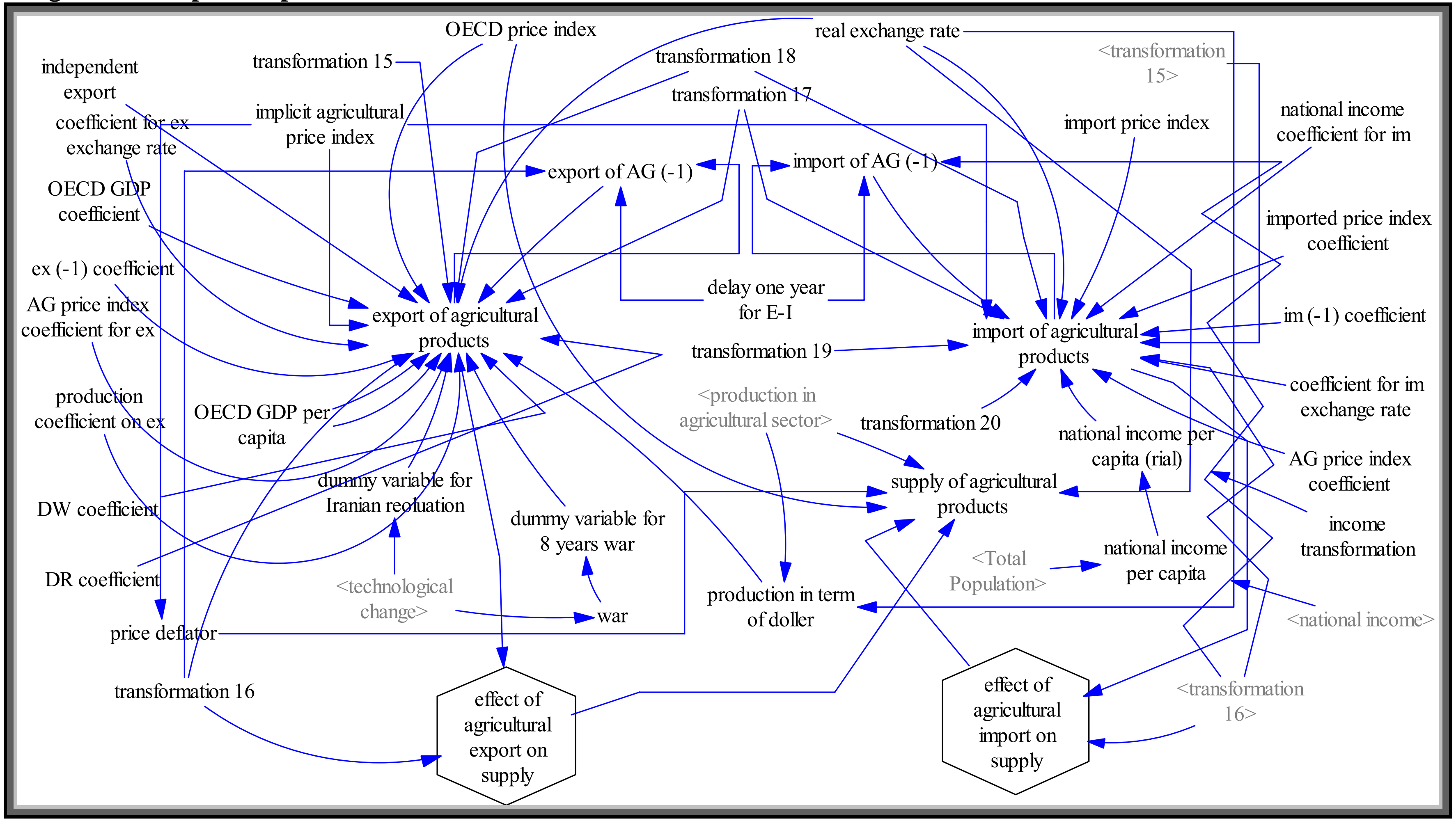


Figure E-5: Demand and Supply for Agricultural Products

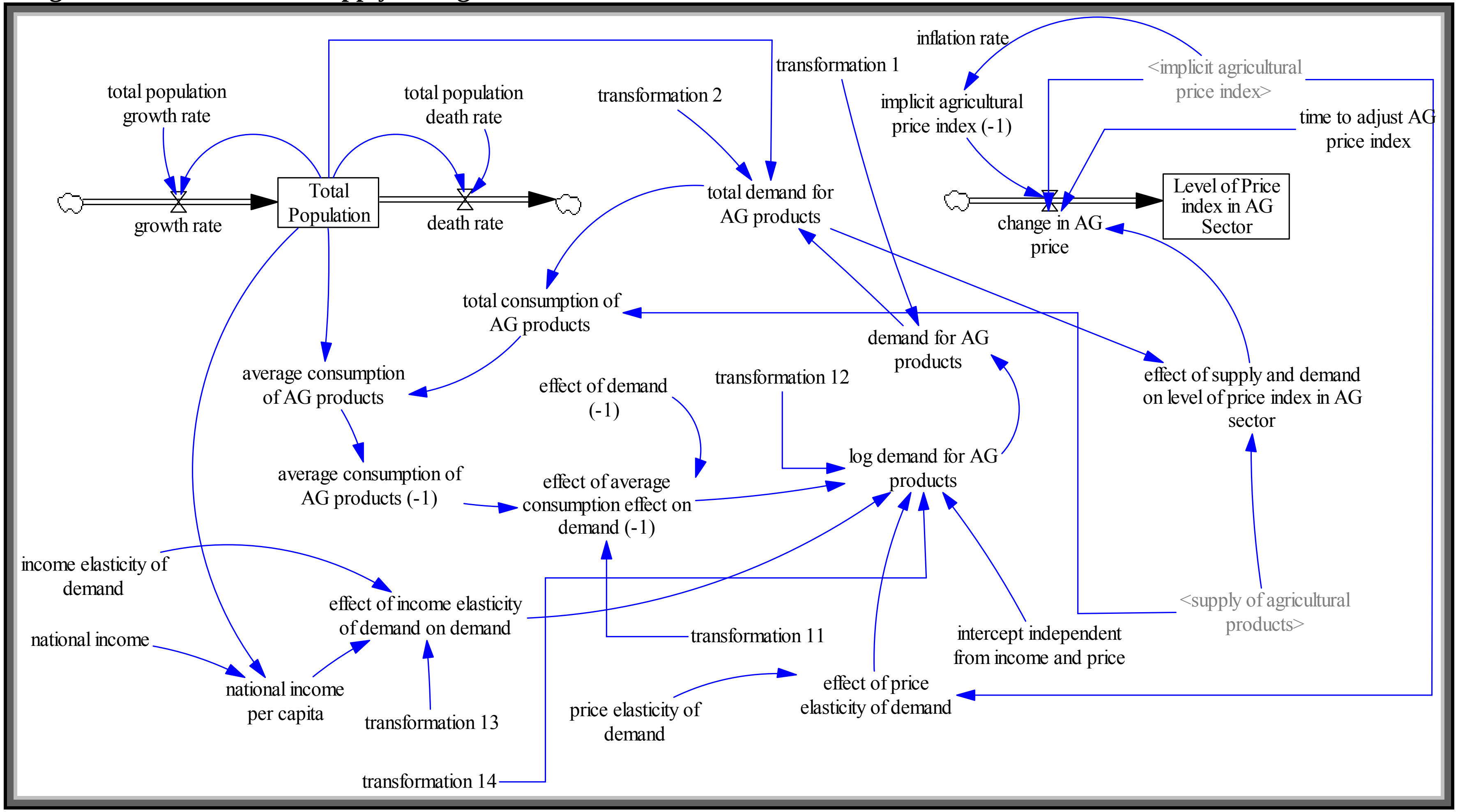


Figure E-6: Dynamic Demand for Labour

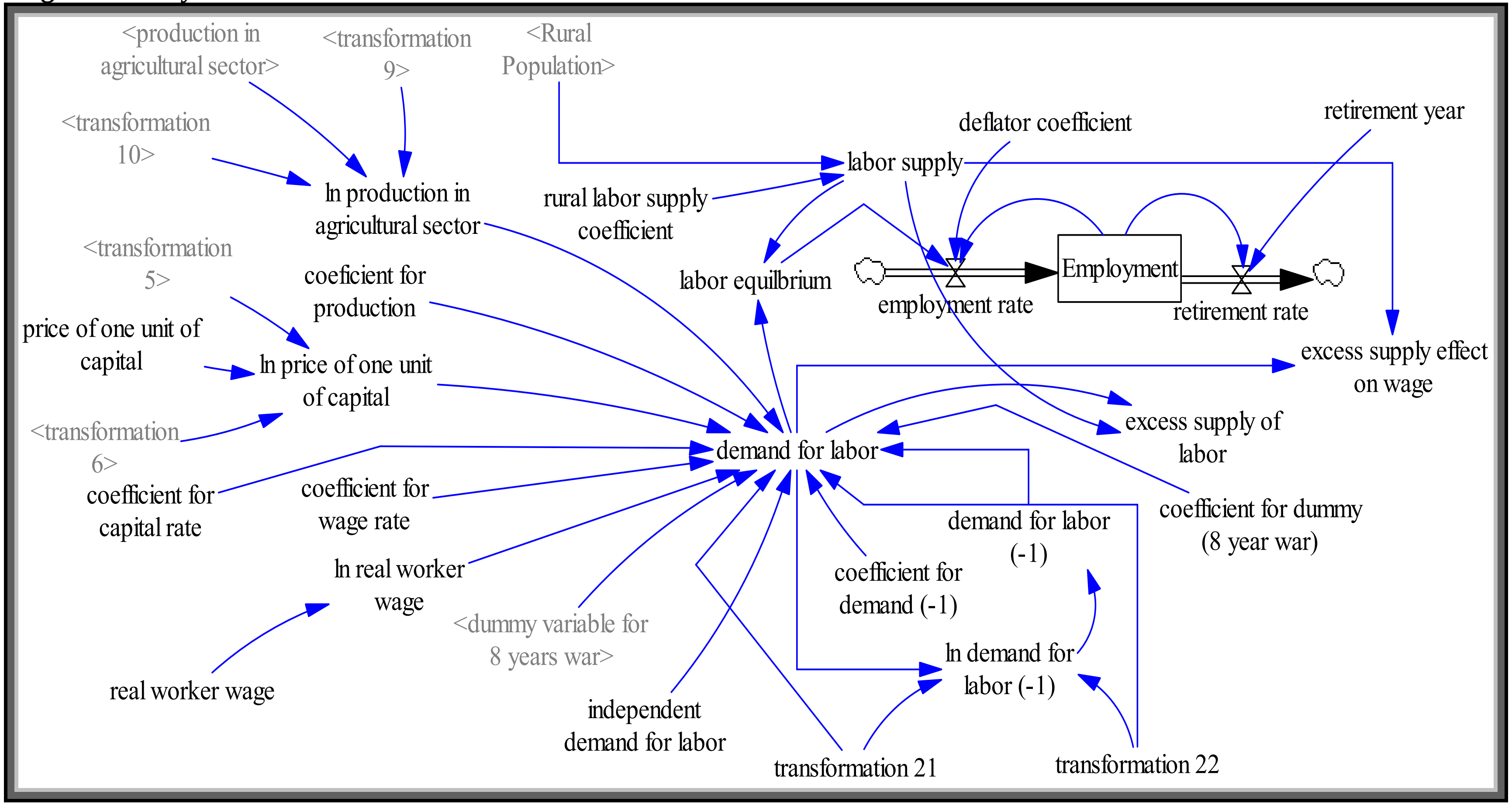


Figure E-7: Agricultural Wage Model

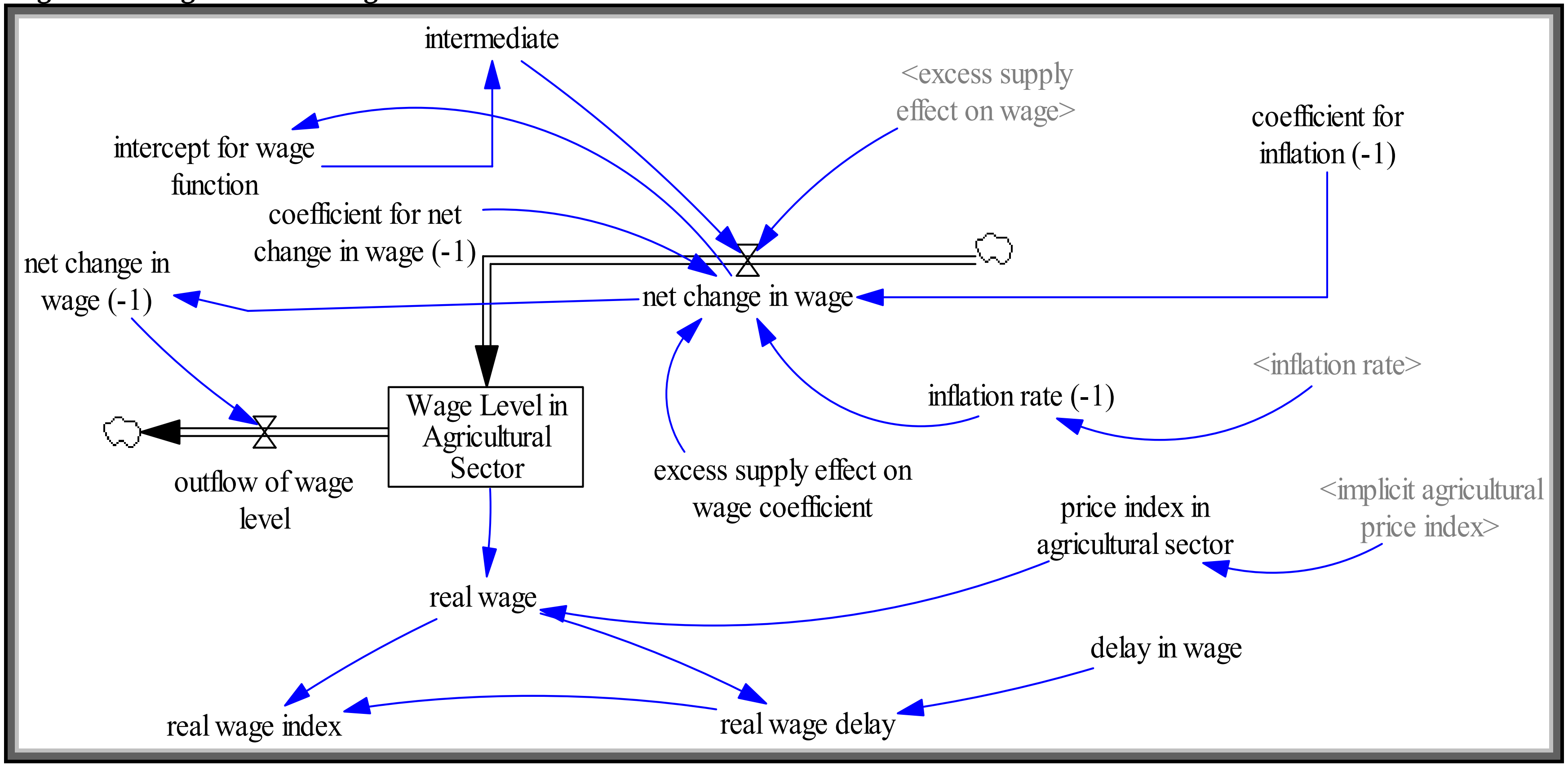


Figure E-8: Unemployment Model

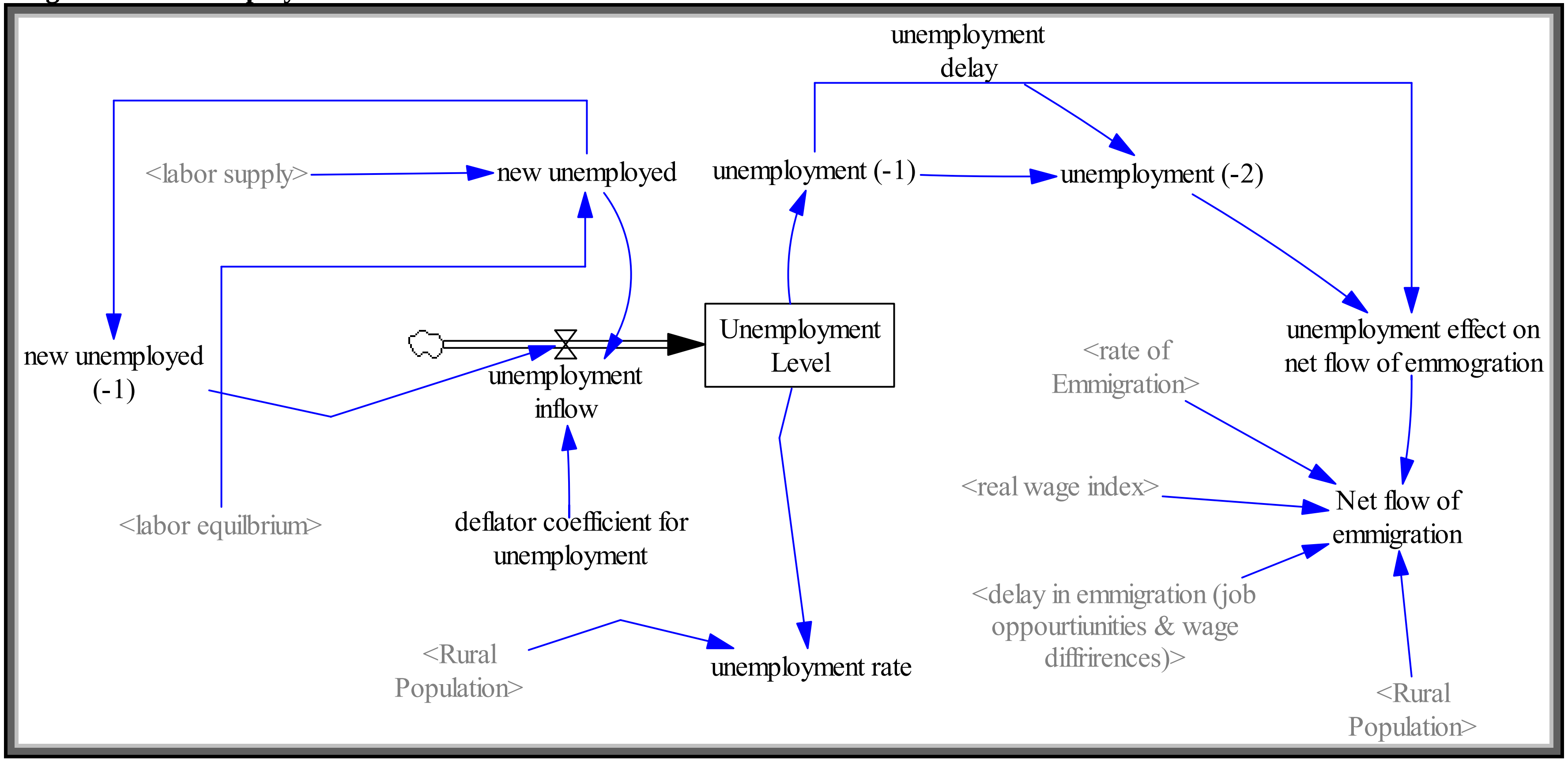


Figure E-9: Effect of Production on Population

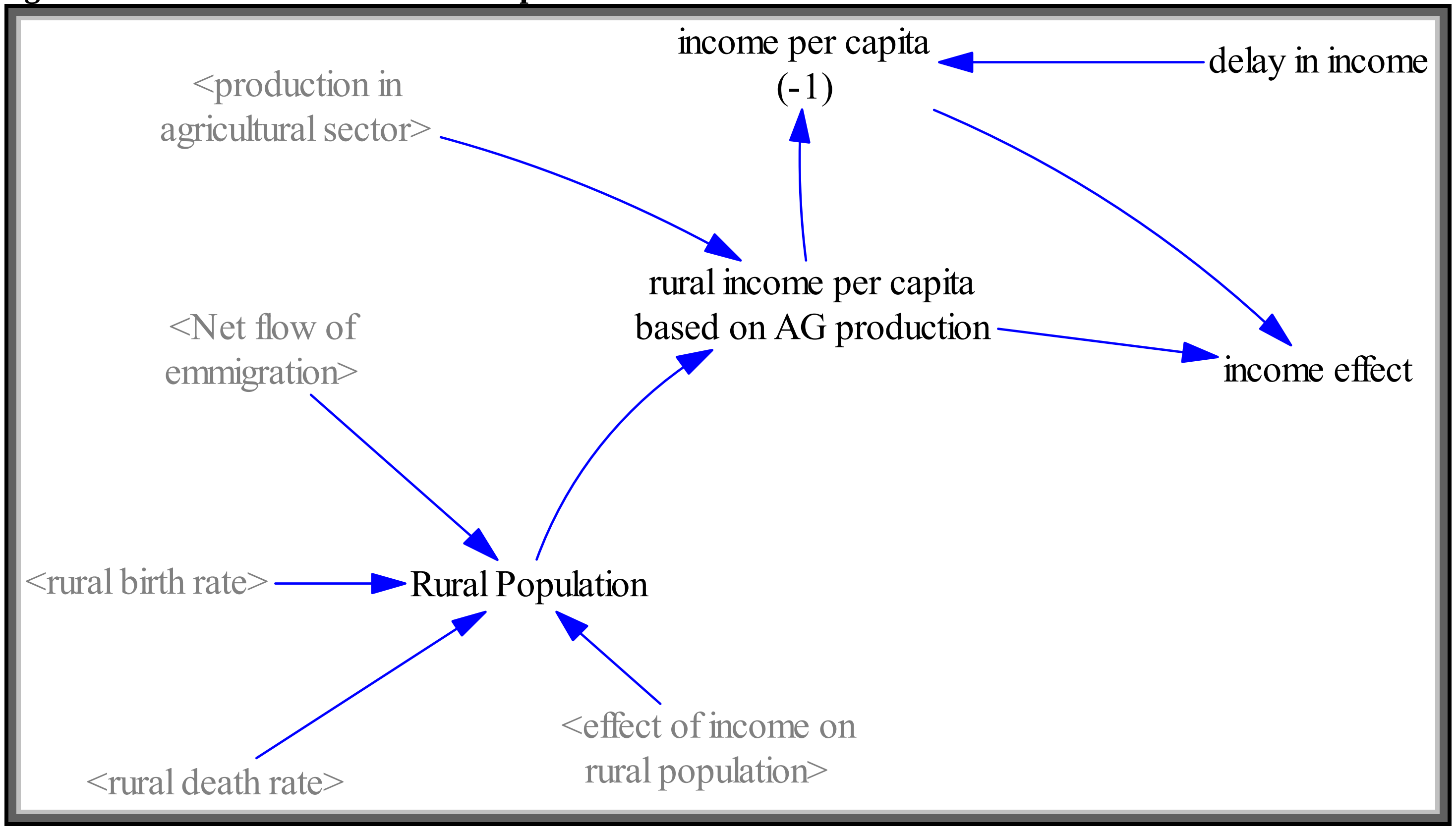
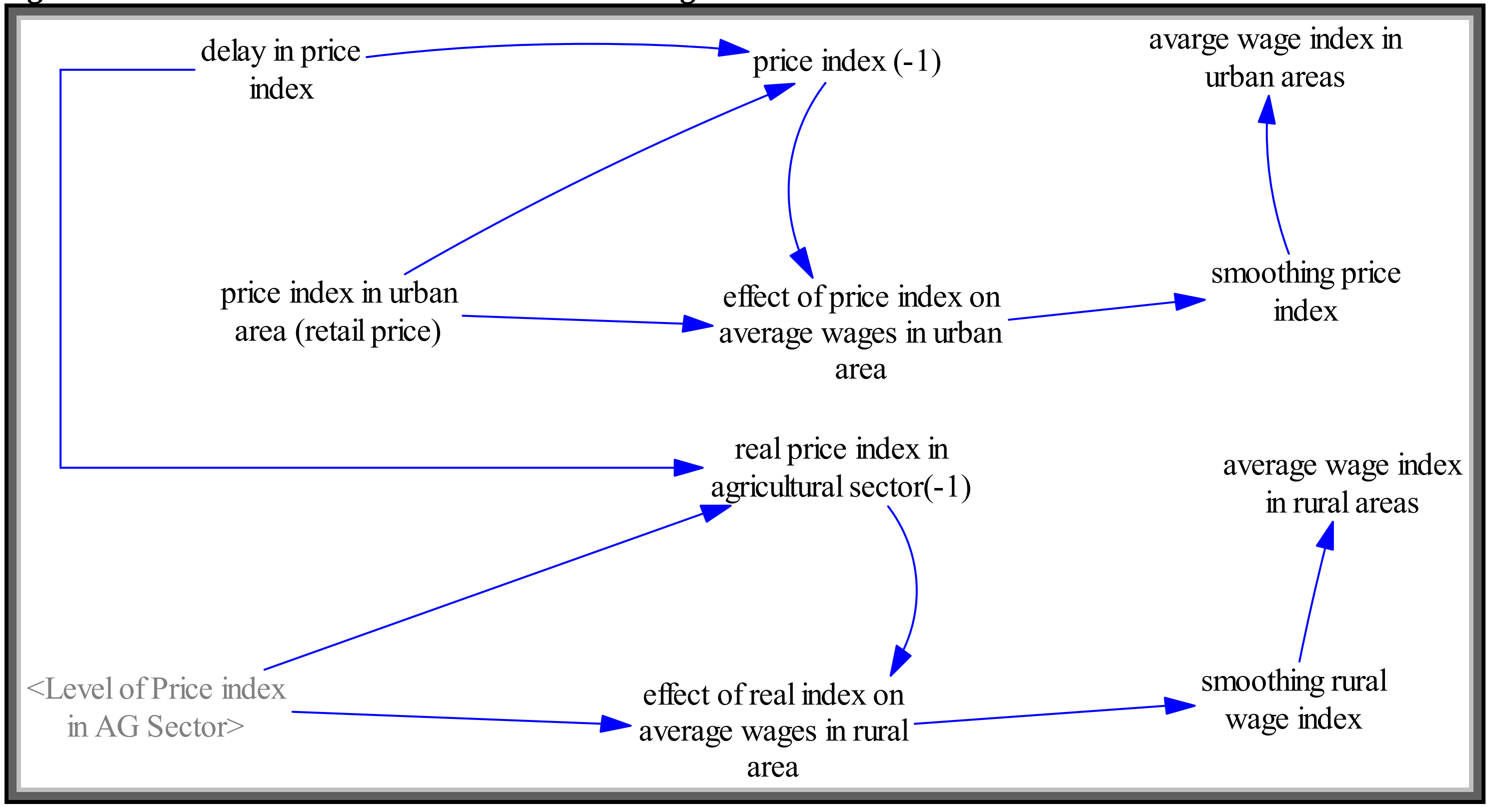


Figure E-10: Role of Economic Factors on the Wage Differences



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