A System Dynamics Investigation of Employment and Production in the Fars Province Agricultural Sector

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Abstract

This research analyzes agricultural employment and production in Fars Province while rural areas are taken into consideration. The researcher will face with some employment problems in rural areas as a separate problem from static viewpoint. On one hand, employment in rural areas may relate to labour supply and demand and on the other hand to the social challenges such as population growth rate and emigration in a systematic model. This study aims at considering the most measurable issues related to the agricultural employment and production along with econometrics estimations in the form of a formulated System Dynamics (SD) model. The overall results indicates that the unemployment problems rooted in rural areas will be aroused in the urban areas in near future and agricultural production, per capita income, labour demand and finally employment can be affected by increasing investment in the agricultural sector. Also, the effective policy in increasing employment is cultivated lands which are increased by development modern irrigation systems and improvement in agricultural production technology.

Keywords: System Dynamics, Rural Employment, Agricultural Production, Unemployment Problems, Agricultural Sector, Rural Emigration, Fars Province,

JEL Classification: J08, J21, J23, J64, Q13, Q18

Introduction

Over 80 percent of Fars Province (located in Iran country) agricultural activities are centralized in rural areas (comparative results of agricultural general census, Various Issues). In this respect, the rural employment should be a symbol of the employment in the agricultural sector in Fars province. Agricultural sector is risky and uncertain in comparison with the other economic sectors which affect income, emigration and even life of the farmers. All reforming plans in the agricultural sector have some weakness and strength points. In total, we cannot perform any policy without direct and indirect cost. For example, if the policy makers aim that reducing the production cost and increasing efficiency and exporting ability, they should use mechanization

in the sector more than ever. This issue not only cannot solve the unemployment and emigration problems but also it will intensify them. Thus, increasing employment and efficiency in the agricultural sector are among the main purposes of the country of Iran which are in contradiction. At last, the villages as centers of agricultural products and the farmers as one of the effective factors in the economic development will be more focused.

Villagers' emigration to the cities with the purpose of finding job, earning appropriate income and using urban facilities is an increasing and permanent phenomenon in Fars Province. Many officials and planners think about these issues in this sector. Thirty-year population statistics in Fars Province reveals that the emigration procedure is increased over time. On the other hand, job applicants entered the cities could not be employed in industrial sector (based on Major Industrial statistics in the country, Various Issues) and some of them are employed in other economic sectors and unfortunately the rest are unemployed. By taking into consideration the "labor surplus problem" (Fei and Gustav, 1964; Gustav, 2004) in the agricultural sector of Fars Province and based on the high fertility rate, particularly in rural societies of Fars Province, the labor supply and employment in the rural areas are significantly deserved to be paid attention. Thus, when unemployment increases the economics system will lose a considerable amount of its actual ability as a result of unused capacity of a major factor of production (unemployed worker).

In these cases, social and economic issues would be analyzed systematically and multilaterally. Therefore, it can be cited that one of the goals of SD Models is practical and scientific decision-marking before performing proposed policies. To this end, this research mainly aims at studying the employment challenges in rural areas of Fars Province in the form of a SD Model by focusing on socio-economic issues for solving the unemployment problem.

Review of related literature

Al-Jalaly (1992), in his study, "Agricultural sector employment and need for off-farm employment in Pakistan", found that the employment could not increase over time in the agricultural sector. Hence, the government should increase employment in other sectors to solve unemployment crisis.

Asali (1992) tried to identify the trend and function of the interaction effects of the principal variable in the Iranian agricultural system. The first section of this paper composed of a model containing three parts; demand, supply, and marketing. The main reason to make a model was to understand the interaction to offer controlling suitable polices and directing the system of agriculture in the country to a desired point. The economic variables, which were influential on the whole agricultural products' demands, were simulated on the basis of economic theoretical context. Using the target model, the result of continuing the contemporary situation, as well as the effect of the different modification polices were discussed.

Goldsmith and Dissart (1998) simulated their model based on a computerized analytical model with different scenarios due to privatization and mechanized cultivation during recent years and examined the role of industry sector in improving the agricultural researches.

Motaghi (1998) took account the employment demand in the agricultural, mine and industry, gas and oil services sectors in Iran from 1971 to 2006. He paid attention to this issue that long

term labor demand played very important role in micro policy making in the labor market since it was not elastic during long term. Thus, wages in labor market are resulted from the balance between labor demand and the form of supply function. So, in labor market, demand is considered as the main factor and determines the price. This study examined the process of labor demand modifications in different sectors of economics. After determining and providing the mentioned model, the labor demand was simulated as a part of course of 1996-2006.

Kiresure et al. (2000) analyzed various factors/components/variables contributing to the future of oilseeds situation in India using the SD methods. The simulated scenario forecasted the demand for 15 million tones of edible oils. The model was developed and could be successfully used for a strategic planning, as the simulated data gave a close resemblance with the existing system. The model could also be used to test various policy options and their reaction in a complex system like oilseeds. The simulation results indicate that, with proper polices, the oilseed sector has the potential to meet the domestic demand in the coming decade.

Methodology

In systematic models the boundaries of the model should be specified in order to focus on the problem statement and objective of study. Dealing with details in systematic models keeps away the researcher from macro systems as the main purpose of this study is the consideration of the rural employment in the agricultural sector. Thus, emigration and its effect on the population and rural labor supply should be taken into account. This study attempted to divide the model into two parts and analyzed each part in the form of systematic model for audience s' better understanding and simplicity. Hence, the whole model is presented in economic and social sectors in this study.

- Economic Sub-model

In the first stage, two functions are estimated for specifying the relationships among main variables. In the next step, coefficients will be placed in the economic part of SD Model. Here two functions will be defined as the followings:

By estimating the production function, the coefficients of the relationship between production and its effective production factors will be determined. Production function indicates a process in which inputs will be changed to output through a process with a specified technology. Totally, production function provides a physical relationship between inputs and output.

Cobb-Douglas production function is a common and simple form of a production function.

$Q=AK^{\alpha}L^{\beta}N^{\gamma}T^{\mu}$

In this relation, T, N, L, K, Q, A are respectively considered as time (technological changes), land, labour, capital, agricultural production and intercept. By obtaining natural logarithm from both side, nonlinear will be changed to a linear form for estimation.

Wage index in the rural areas is one of the major variables that is required to be estimated. The results of estimation are used in determining wages levels in the SD model. Net change in rural wage (NCR), as dependent variable, is considered as function of price index (Indexinf) and

minimum supply and demand (RSRES). The RSRES calculated by "rural supply" (RS) is divided

$$NCR = C + \alpha_1 Index\inf + \alpha_2 \frac{RS}{\min(RS, EM)}$$

$$NCR = C + \alpha_1 Index\inf + \alpha_2 RSRES$$

$$Where \quad RSRES = \frac{RS}{\min(RS, EM)}$$

into minimum RS or employment (EM). The mathematical formulations come as follows:

The estimated coefficients are entered the model. Figure No. 1 indicates the relationship between production and investment. Agricultural labour along with related coefficient resulting from econometric estimation, are entered total production. This coefficient was based on figure -0.522 which indicated that marginal product of Labour (MPL) in this factor of Fars Province agricultural sector was negative. Other researchers confirmed the negative or zero of the MPL based on the labor surplus problem in the agricultural sector of Iran (Kahbazan and Gray, 1993; Khalilian and Yari, 2001; Akbari and Ranjkesh, 2003; Moosavi et al., 2008). In this study, it is supposed that time can affect the production by technological modifications or production methods change.
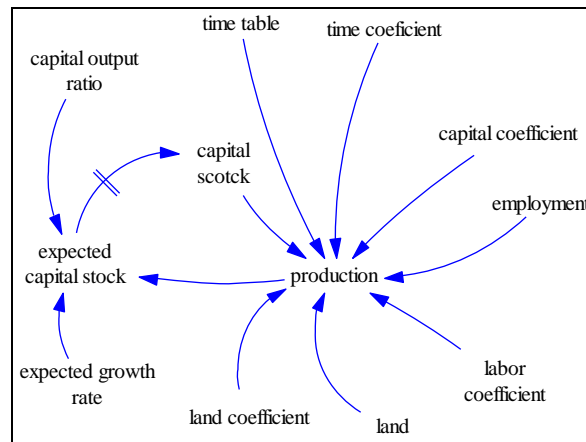

Figure 1: Influence diagram for production and investment in Fars Province Agricultural Sector

The "total production" affects "expected capital stock". "Expected capital stock" is affected by "expected growth rate" and "capital output ratio". "Expected capital stock" influences the "capital stock" by a delay and the "capital stock" affects production by a feedback loop mechanism.
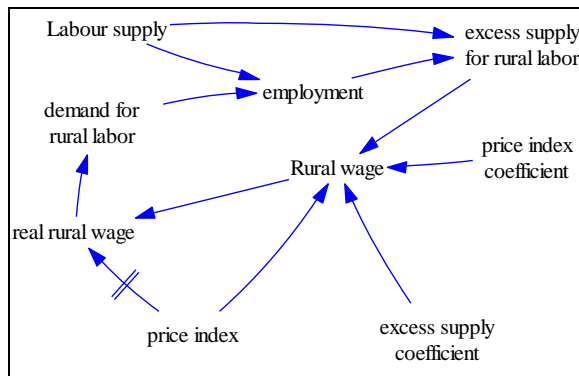
Figure 2: Influence diagram for rural wages determination in Fars Province Agricultural Sector

The estimated relationships of wages will be entered the Figure No. 2. Rural labor supply is one of the main variables of economic model relates to the social model by the rural population. In other words, "rural population" and "rural labor supply coefficient" will form this variable. As it is seen in the Figure, employment is determined by supply and demand. Demand for labor is one of the variables forms by employer of the agricultural sector. Thus, he/she employs labor based on the productions of the previous years and prediction of the current year. In the present model, since there is no "money illusion" for employer, so real wage index affects labor demand and then forms it.

There are three states in labor supply and demand market. Supply and demand are equal (nonexistence of excess supply or demand in the market), demand is more than supply (excess demand), and supply is more than demand (excess supply). Rural employment variable is defined based on the minimum RS or EM and then "excess supply for rural labor" is determined.

- Social Sub-model

Villagers' emigration is one of the major problems of the country of Iran, especially in Fars Province. This phenomenon deprives the rural areas of the most efficient labour forces on one hand and increases the urban unemployed rate and consequently brings about social-economic dilemmas. Emigration from rural areas to the urban areas is considered as a desirable fact in the economic development texts from the past decades. It was assumed that internal emigration is a natural and pleasant process in which extra labors exists from the rural areas gradually move in order to provide the required labor for urban industry growth. The main assumption of this process is that the human resources are transferred from places with zero "social marginal productivity" to the ones with positive "social marginal productivity" and it will be grown as a result of high capital density and technology development. In fact, this process causes productivity increase in the agricultural sector. In contrast, emigration procedure from rural to urban areas exceeds the capacity of urban appropriate occupations and even providing urban job opportunity capacity cannot meet it. Thus, it seems that the desirability or undesirability of the villagers' emigration to the cities is a relative issue and it is completely different due to the time, place and environmental factors situations.

Michel Todarow and Smith (2003) state that emigration motivation is basically intellectual consideration of profit and relative transferred cost, although it relates to finance and may be a mental one. The previous studies on the emigration in Fars Province indicate that lack of the job

opportunities and differences income in these areas (rural and urban) are the main causes of the villagers' emigration. In the present study, these two factors are considered as the main reasons of the emigration in the model.

Emigration in this study is important since its effect on the rural population and employment is significant. Basically, there is a significant mutual relationship between rural emigration, employment and unemployment. Rural population is decreased by increasing the number of emigrants and then rural labor supply will be affected and the unemployment in villages would be decreased.
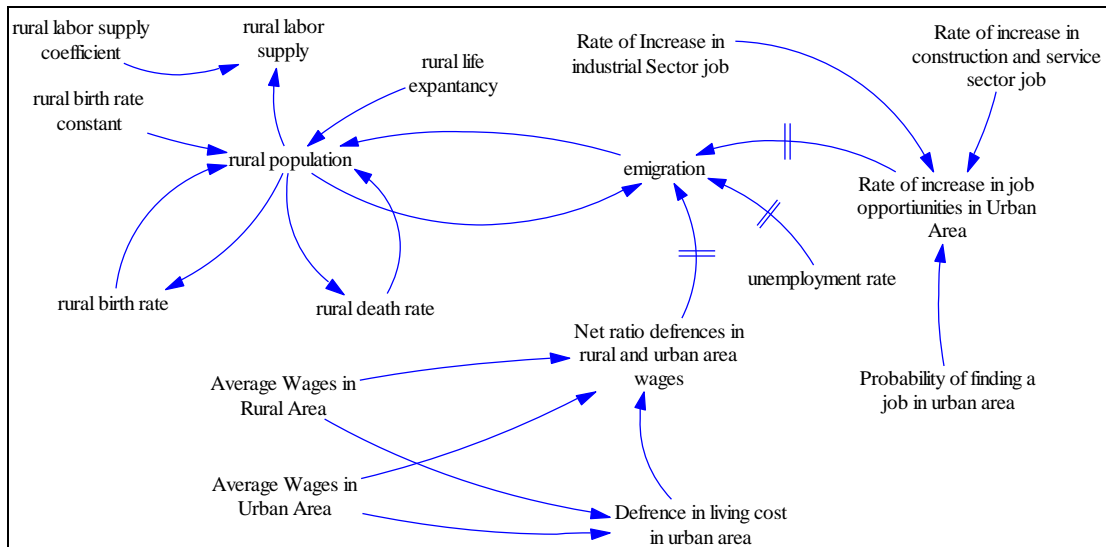

Figure 3: Influence diagram for the rural population and emigration in Fars Province

In Figure No. 3, job opportunities in rural areas are seriously limited since rural population is growing in Fars Province. Job opportunities are one of the factors which motivate the villagers to emigrate to the cities and it is directly related to the "probability of finding job in urban areas". These opportunities are existed in services, construction and industry sectors.

"Net ratio difference in rural and urban areas wages" is one of the effective factors on the decision making of emigration. Lack of "job opportunities" and "difference in average wages in urban and rural areas" in the present model causes the rural labours' emigration due to a logical delay in decision making. Although, the wages differences are important, the main point is that rural and urban living levels should be considered in decision making of the villagers. For instance, the considerable part of difference in wages should be considered for living cost in the cities such as rental fee, commuting from villages to the cities, replacing initial charge, improper access to the rural agricultural products (self-consumption) and other unpredicted and luxurious charges in the cities. Thus, "net ratio differences in …." is affected by difference in living cost in urban area. In the last stage, "rate of increase in job opportunities…" , "net ratio difference in rural and urban areas wages" and "unemployment rate" are effective factors in forming emigration by logical delay. Finally, emigration mutually affects rural population and vice versa by feedback loop mechanism.

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Rural population in the <u>social model</u> would form the labor supply in the <u>economic model</u>. Difference in rural labor supply and employment specifies the unemployment, and affects the emigration level. In other words, the more increase in unemployment rate in a period of time the better positive effect on emigration rate in the social model. These two feedbacks are performed in the social and economic models.

Results and Discussion

The simulated agricultural products are indicated in Figure No. 4. Production value was approximately fixed at the beginning of the years 1990 to 1993 and oscillated from 1995 to 2002. Provided that the trend is smoothed during the mentioned years, there will be no more considerable changes. The production had a descending trend by fixing other conditions and production techniques from 2003 to 2025. This process will be put into practice due different reasons including underground water resources decrease[1], a high labors/land ratio, traditional production methods, etc.
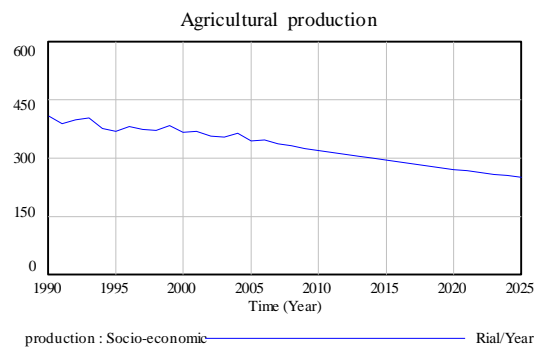

Figure 4: Simulated Production in the Fars Province Agricultural Sector

Labor demand is presented in Figure No. 5 and it is originated by the employer in the agricultural sector. Thus, it would be affected seriously by the production oscillations and real wages level. The demand between the years 1990 to 2010 had large oscillations during a 20-year period in the form of a dampened oscillatory. Then, it will have a fixed trend during the rest fifteen-year period from 2011 to 2025. Such a behavior is seen in goal seeking systems.
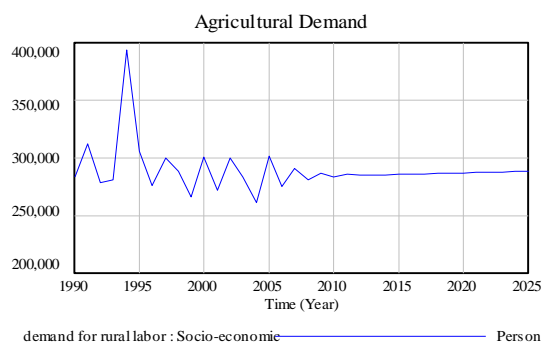

Figure 5: Simulated Labour Demand in the Fars Province Agricultural Sector

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[1] In Fars Province, underground water resources provide over 80 percent of the agricultural water usage.

It can be concluded in this Figure that the agricultural demand for rural labors will not be increased during the next years and the agricultural sector not only cannot solve the unemployment problem in the future but also it will spread it in the cities based on the increasing emigration rates and intensifying unemployment in cities suburbs.

Rural labor supply is increased by a decreasing rate, during the years 1990 to 2005 and it will be reduced from 2006 to 2025 as a result of villagers increasing emigration rate to the cities after a maximum point in 2005. There is 7 to 18 percent difference between simulated rural labor supply and actual data between the years 1996 to 2006 (based on Housing and Population of General Census, Various Issues), however their trends are the same. Based on simulated data in 2007, labor supply is less than 300000 and it will be reached to 260000 in 2012.
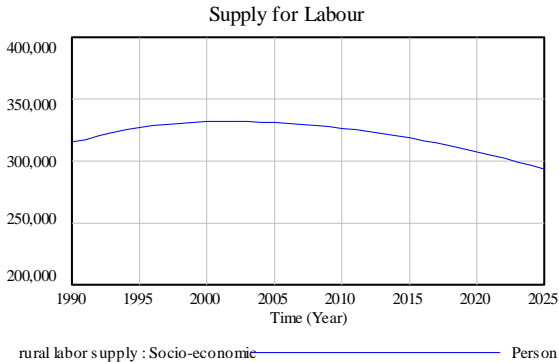

Figure 6: Simulated Labor Supply in the Fars Province Agricultural Sector

Excess Labor supply is demonstrated in Figure No. 7 as excess supply for rural labor. In case that this variable is less than one, it will be excess demand and if it is more than one, it will be excess supply.

Figure 7: Simulated Excess Labor Supply in the Fars Province Agricultural Sector

As it is seen, this Figure is an oscillating and descending trend after 2011 in a way that the small excess demand will be later revealed because of increasing emigrations. The supply and demand would be structurally modified due to different reasons and the demand would exceed supply of rural labor. This is to say that if the system takes no action and unemployment problems in cities are ignored, the unemployment problem in villages will be solved as a result of several reasons including high emigration rate and even during next 14 years there will be a little excess demand for labor.

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Figure No. 8 shows the rural unemployment level. **T**his variable has serious oscillation with dampened oscillatory between the years 1990 to 2010. The difference between peak and unpeak points is 60000 persons. Some of these oscillations may relate to the randomness in agricultural production and they will have several cycles during different years.

Figure 8: Simulated Rural Unemployment in the Fars Province Agricultural Sector

These dampened oscillations have been finished since 2010 and the Figure will be completely decreased. This decrease is resulted from rural population reduction due to emigration rates during past years, rural labor supply decrease and increase in labor demand.

Right now different scenarios are taken into consideration in relation with progressing important variables. Each scenario will be performed based on a specified policy or combination of policies.

- Scenario 1: Considering the Effect of Progressing in "Capital Output Ratio"

In this scenario it is supposed that capital output ratio may be improved for two percent yearly by applying new technology in the agricultural sector and using a series of plans like ground laser leveling, using new machineries in cultivating and harvesting procedures. This policy would be continued from 2010 up to the end of simulation course. Figure No. 9 shows the effect of this policy on the agricultural production.
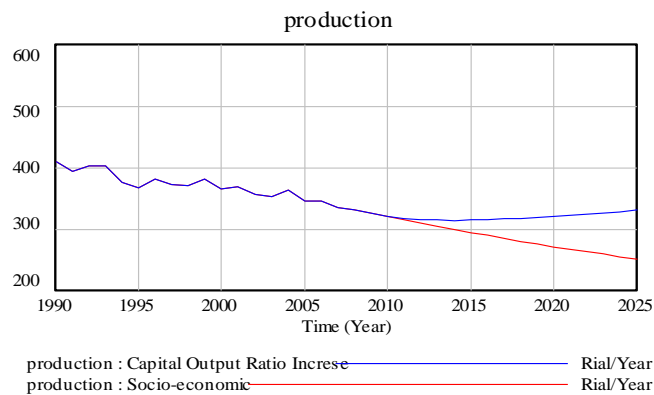

Figure 9: Scenario one, "Improvement in Capital Output Ration" and its Effect on Production in Fars Province Agricultural Sector

The effect of this policy on production is significant and it will stop the production descending process. But it has less effect on demand and employment. Therefore, it is considered as production increase policy, while, its effects on other variables such as emigration, population, unemployment etc. is not observed.

- Scenario 2: Considering the Effect of Increasing Investment Annually, 2.5 Percent yearly

Figure No. 10 and No. 11 reveal the effect of this policy on production and employment. It is supposed that the government would increase the present investment rate for 2.5 percent each year from 2010 up to the end of simulation course by granting capital to the agricultural sector continuously. The government would invest annually by a reforming polices. In a way that its credit is provided (by low interest rate loan or gratuitous loan) and the capital will be continuously raised in the agricultural sector. It is required to mention that performing this policy and providing financial support are difficult for the government since the governmental financial resources will be under pressure. As it is seen, the effect of this policy on the agricultural sector is significant and has no much effect on the employment.
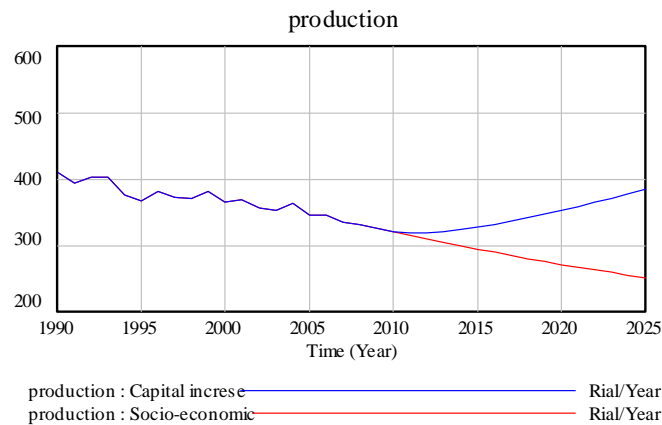

Figure 10: Scenario Two, "The Effect of Increasing Investment" and its Influence on the Production in Fars province Agricultural Sector
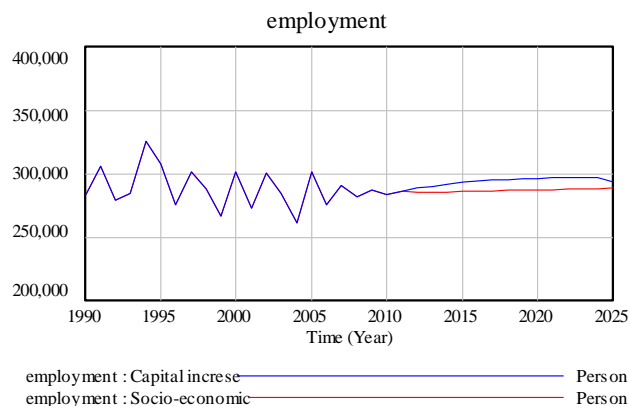

Figure 11: Scenario Two, "The Effect of Increasing Investment" and its Influence on the Employment in Fars Province Agricultural Sector

- Scenario 3: Equality in Wage Rate in Rural and Urban Areas

As other conditions are unchanged (no change in other parameters and constants of the model) the model is simulated based on this scenario and its results as the scenario (policy) No. 3 for rural population and unemployment are presented in Figure No. 12 and 13. In this case the government would nullify the difference in rural and urban area wages during 15 years. For instance, this policy can be applied in the agricultural sector by increasing rural emigration expenses or continuous increase in agricultural wages. As it is seen, the application of these policies would have unpleasant effect on unemployment level in the rural areas.
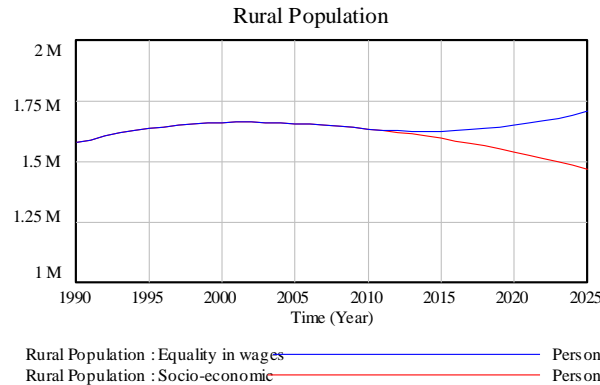
Rural Population

Rural Population : Equality in wages ———————————— Person
Rural Population : Socio-economic ———————————— Person

Figure 12: Scenario Three, "The Rural and Urban Wages Equality" and its Effect on Rural Population of Fars Province Agricultural Sector

unemployment level

unemployment level : Equality in wages ————————————
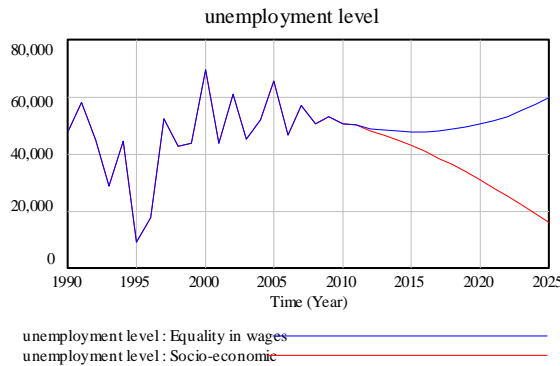unemployment level : Socio-economic ————————————

Figure 13: Scenario Three, "The Rural and Urban Wages Equality" and its Effect on Rural Unemployment of Fars Province Agricultural Sector

- Scenario 4: The Differences in Rural and Urban Area Wages are Doubled

This scenario is shown in Figure No. 14 and its main effect will be on emigration and increases it from 2010 to 2025. Also it would influence rural population, labor supply and employment in the agricultural sector. As it is cited before, the unemployment rate in cities is seriously increased and causes other problems.

Net flow of Immigration

Net flow of Immigration : Inequality in wages ———— Person/Year
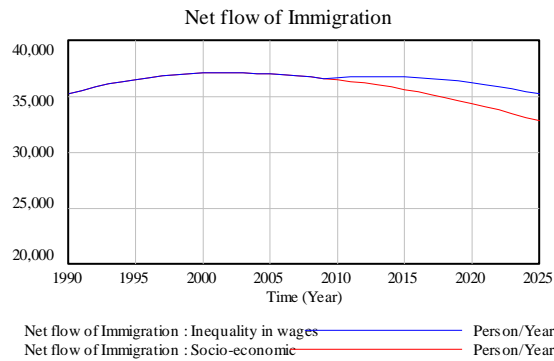Net flow of Immigration : Socio-economic ———— Person/Year

Figure 14: Scenario Four, "Increasing Inequality of Rural and Urban Area Wages" and its Effect on Rural Net Emigration of Fars Province Agricultural Sector

Other scenarios such as consideration of the effects of under cultivated lands increase due to irrigation systems improvement[2], combination of scenarios No. 1 and No. 2 (2.5 percent growth in annual investment along with technological changes), job opportunities and the probability of finding jobs in cities (increase/decrease) are taken into account and analyzed and their overall results will be presented in conclusion.

Conclusion and Suggestions

This study simulates the future prospects of labor status and production based on SD socio-economic model in Fars Province Agricultural Sector. To this end, chronological trend of other important variables (population, emigration, unemployment, labor supply and demand etc.) is simulated. Afterward, the following conclusions are reached by performing the reforming scenarios (policies) and their comparison with current trend of the system (system without reforming policy).

1- Due to the villagers' emigrations to the cities the rural population is continuously decreased and the percentage of urban population in compare to the rural population is significantly increased. Thus, the unemployment is rooted out from rural areas and is gradually extending to cities. In contrast, unemployment problem in rural areas is not important in near future.

2- In case of executing the policy of "equality wages in rural and urban areas", "decreasing the probability of finding jobs in urban areas" and providing the "job opportunities in rural areas", the emigration will be controlled in a long term period to some extent. Of course, performing the effect of policies of rural incomes improvement would be more successful than rural job opportunities. In contrast, when "difference in rural and urban area wages" are increased based on governmental policies or structural changes, the

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[2] It is supposed that under cultivated lands in Fars Province are annually increased about 10000 hectares. This policy will be continued for a period of ten years from 2012 to 2021 after that stopped. Also it can be performed in different ways (like Laser Land Leveling, constructing dams, Conservation Tillage, Canal water Supply System, Convey Canal, Implementation Ground Water Recharge Pound, Drought Resistance Varity and Compatible Species with Dry Land) and leads to cultivate the fertilized lands confronted with water shortage in the past.

rural emigration and population will be seriously affected and consequently, the rural population will be decreased.

3- Emigration to the cities will be certainly reduced by performing the policies of rural incomes improvement and balancing income and facilities between rural and urban areas. In this case, rural population is increased and the policy makers should consider some systematic plans for decreasing unemployment in rural areas.

4- As the capital has a positive marginal product (MPK>0)[3]. Investment in agricultural sector may be an efficient policy in increasing production in SD model. This policy can influence total production in the agricultural sector, per capita income, total capital, labor supply and demand and employment by increasing investment suddenly in a short term period or investment rate continuously increase in long term period.

5- The under cultivated lands in Fars Province can be increased by improving irrigation systems and changing production technology and it will affect better the employment increase (because of fertilized under cultivated lands faced serious water shortage) in compared with other policies.

6- Performing the country's macro policies in controlling inflation rate and wages has no considerable effect on production and employment in agricultural sector in a short term period. And they will be effective in preventing the spread of unemployment in rural areas when this policy can be used as a complementary one along with other policies.

7- Other suggested policies may be presented and examined by policy makers. Since the policy makers have more precise information of the executive system abilities and they can better do "policy evaluation"[4]. In addition, policies in short term and long term periods have different effects and should be taken into consideration.

8- Finally, it is required to mention that there is reverse relationship between simulation period and the validity for policies effects as structural changes may be occurred in long term periods. This is to say that, the more simulation period the less care in commenting suggested policies.

Each research can respond limited questions and provide the new ones more than the responded questions. This is one of the research specifications, particularly the social-economic researchers. Therefore, there is no claim that Fars Province rural unemployment problems are solved and all social and economic issues are considered in this study. This model only will help the policy makers and planners in practical and scientific decision making.

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[3] Marginal product of capital (MPK) is equal to 0.659
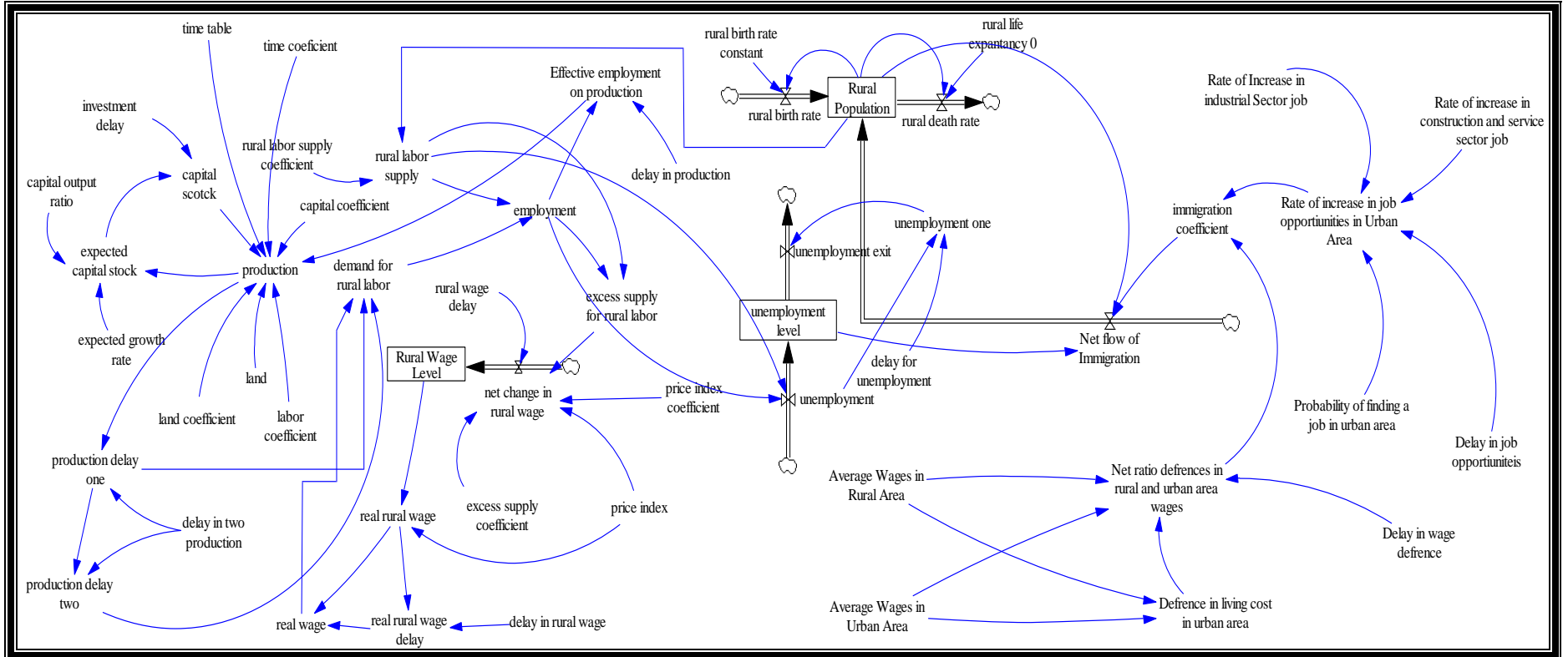[4] Refer to situation in which a decision maker must choose one policy, called "plan", from a given set of alternative policies.

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Appendices

Appendix A- Flow Diagram for the Socio-Economic System Dynamics Model
in Fars Province Agricultural Sector
(Model Structure)

Appendix B- Econometrics Estimations Results

Cobb-Douglass production function estimation results by taking time factor into consideration is presented as follows:

$$LnQ_t = -0.522LnL_t + 0.659LnK_t + 1.307N_t + 3.56*10 - 10LnT_t$$
$$\quad\quad (-10.394) \quad\quad (5.707) \quad\quad (12.709) \quad\quad (2.604)$$

$$R2 = 0.93 \quad , \quad\quad R2 = 0.93$$
$$D.W.Stat. = 2.23 \quad , \quad F-Stat. = 129.715$$

Respectively, T,Q,N,K,L are time, total production, under cultivated lands level, capital and labor in the agricultural sector. T-statistics are presented in the parenthesis and these estimation results indicate that all estimated coefficients in 0.99 levels are significant. The model will structurally have no autocorrelation, multicollinearity and heteroskedasticity problem. Estimated Durbin-Watson (DW) statistics checked with relevant statistics in the table and placed in the area that autocorrelation hypothesis is rejected. F statistics is acceptable in 99% level .As it is seen, this regression is increasing return to scale. Time affects production positively but effect is so small. Unfortunately, it reveals that technological changes happen through a weak trend in the past years.

In the next estimation net change in rural wage (NCR) a function of inflation rate (indexinf) and excess labor supply (RSRES) is considered. Here, as it is expected the inflation rate and labor supply would respectively have positive and negative effects on wage rate.

$$NCR = 19.75775 + 0.488028 * Indexinf - 16.46264 * RSRES$$
$$\quad\quad (14.79) \quad\quad\quad (3.030) \quad\quad\quad\quad (-2.93)$$

$$\text{where } RSRES = \frac{RS}{Min(RS, EM)}$$

All coefficients in 99 percent level are significant. Adjusted R^2 is equal to 0.995 placed in a suitable level; DW statistics indicates the nonexistence of positive and negative autocorrelation problem. Although, time series data is used but DW equal to 1.97 which is near to figure 2. EM and RS respectively show employment and labor supply.

$$\text{If } RS > EM \rightarrow RSRES \uparrow \text{then} \rightarrow NCR \downarrow$$

$$\text{If } RS < EM \rightarrow RSRES \downarrow \text{ then} \rightarrow NCR \uparrow$$