Infrastructure Planning In A Dualist Agricultural Economy: A Search For A Policy Framework

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Abstract

Provision of adequate infrastructure has been a major responsibility of the state in many developing countries over the course of their development. However, various case studies indicate that infrastructure policies have not been very effective. Not only has infrastructure become a major bottleneck for economic development, infrastructure policies aimed at improving income distribution have also failed to achieve their objectives. Typically the poor subsidize the rich in the process of public infrastructure delivery, while such subsidization is more rampant in the agricultural sector that often dominates the developing country economies before a structural transformation has taken place, which is often the case in the initial economic development stages.

We attempt in this study to analyze the efficacy of public provision of infrastructure in the initial economic development stages where the agriculture is the dominant sector. A system dynamics model of a dual economic system pervasively found in the developing countries was originally developed by Saeed (1980) to search for fiscal and institutional policy instruments to affect income distribution. We have extended Saeed's model to include decision rules affecting infrastructure provision, so the efficacy of the infrastructure policy as a lever to improve income distribution could be evaluated. Computer simulation is used as an experimental process to examine the impact of the various policy options tested.

1. Introduction

Infrastructure investment is an important instrument employed by the developing country governments over the past forty years to affect economic development (Kreguer1992). A World Bank study examining a cross-section of developing countries shows that infrastructure typically represents about 20 percent of their total investment and 40 to 60 percent of their public investment (World Bank 1994). Since the governments in most developing countries do not have the necessary institutions to implement fiscal policies to influence income redistribution, infrastructure policy can be an effective tool to influence income distribution and affect economic growth (Hirschman 1958, van de Walle and Nead 1995 Boadway and Marchand 1995). In order to understand the potential for public provision of infrastructure as an effective policy instrument for development, it is necessary to understand the dynamic interaction between public infrastructure provision with the socio-economic structure in place.

In this study, we attempt to develop a framework to analyze the efficacy of public provision of infrastructure in the initial economic development phases where agriculture is the dominating sector, which is currently the case in a large number of developing countries. In fact, many scholars have considered agricultural development to be the foundation for further economic development, while governments have also used infrastructure investment as a major tool to achieve agricultural development (Mellor 1967). World Bank Development Report (1994) shows that during the early stages of the development, infrastructure resources are primarily invested in the agricultural sector - in irrigation and transportation. It has been observed, however, that the spread of the benefits of the infrastructure investment is limited and large farmers receive more benefit from infrastructure provision than small farmers in many developing countries (World Bank 1994, van del Walle and Nead 1995). We feel that the failure of the infrastructure policy to create a larger spread of benefits arises from the fact that the economic models underlying policy design do not exist in reality. While the economic models assume a homogenous socio-economic structure, in reality, the agricultural economy in the developing countries is characterized by the co-existence of a dual economic system consisting of a profit maximizing formal sector and a consumption maximizing peasant sector. Any infrastructure policies implemented by the government will create resource reallocation between these two sectors. Therefore, policies ignoring the dynamic interaction between these two sectors may not perform according to expectations.

A system dynamics model of public provision of infrastructure within a dualist agricultural economy is developed in this study. A formal system dynamics model offers an opportunity to experiment with the various infrastructure polices proposed and implemented in the past and to understand their performance under controlled conditions. Simulation experiments with the model help to understand the dynamics of reallocation of resources between the formal and the peasant production sectors

of the economy created by the infrastructure policies. Insights into the changing patterns of infrastructure service performance can be attained only after these detailed dynamic processes are understood. The model helps explain the variability in the performance of infrastructure policy experiences in the past, while also pointing toward critical elements for a successful policy framework. This model also helps resolve some of the debate on development policy. For example, Saeed (1980, 1994) suggests that the policy of imposing a tax on unearned income improves income distribution; whereas Nicholls (1971) argues that discouraging unearned income does less to improve income distribution than the expenditure of scarce public resources for infrastructure improvement. Experiments with our model show, however, that infrastructure improvement alone -even if targeted to the poor - will not accomplish income redistribution. Only, when this instrument is combined with the taxation of unearned income will the income distribution improve. Policy guidelines are outlined for an effective infrastructure based intervention. Technical details of the model, including a machines readable listing, for replicating the experiments discussed in this paper and for conducting further experimentation, are available from the authors on request.

2. A system dynamics model of public provision of infrastructure in a dualist agricultural economy

The information structure of the proposed model is adapted from a model of wage determination and income distribution developed by Saeed (1980), which he usesfor an experimental evaluation of development polices (Saeed 1987, 1988, 1994, 1997). Saeed's original model draws on neoclassical economics to construct a basic economic growth and market clearing system, he modifies the model by relaxing its simplifying assumptions about aggregation of sub-economies, saving and investment behavior, and wage determination. His model subsumes the concept of economic dualism first recognized by Boeke (1953) and developed further by Lewis (1954), Sen (1966), Bardhan (1973) and others to represent the multiple sub-economies coexisting in developing countries. In such a dual economic system two sub-economies function side by side. A formal production sector operating on the premises of profit maximization, and a peasant production sector attempting to maximize consumption for the labor are internalized. The two sectors interact with each other in that they bid for the resources of the economy and the surplus labor not hired by the formal sector is accommodated in the peasant sector, while surplus capital and land resources not employed by the formal sector can be rented out to the peasant sector.

Our revised model incorporates additional structure representing the government provision of economic infrastructure through taxation. Public infrastructure provision in the model is assumed to be rationally determined by the government depending on the infrastructure productivity, demand pressure and the financial capacity of the government. The revised model tracks the decisions of the government concerning infrastructure provision and their impact on resource

allocation and income distribution. An overview of the revised model is shown in Figure 1, with the newly created infrastructure sector added to the original model structure.

The original model incorporated the following behavioral assumptions governing the roles of its actors: Both the formal and peasant production sectors of the economy carry out production using capital, workers and land. Capital investment is driven by profitability, which is given by the marginal revenue product of capital and the interest rate, as well as the financial capacity. Workers can be wage earners or sel-employed. Wage workers are hired depending on the marginal revenue product of workers and the average wage rate. Workers unable to find employment in the formal sector are absorbed in the peasant production sector. The average wage rate is set not according to the average marginal revenue product of workers as postulated in the equilibrium models of economic growth, but according to the bargaining power of the workers which depends on the opportunity cost for a worker to leave self-employment, given the average consumption expenditure of workers (Sraffa 1960; Sen 1966).

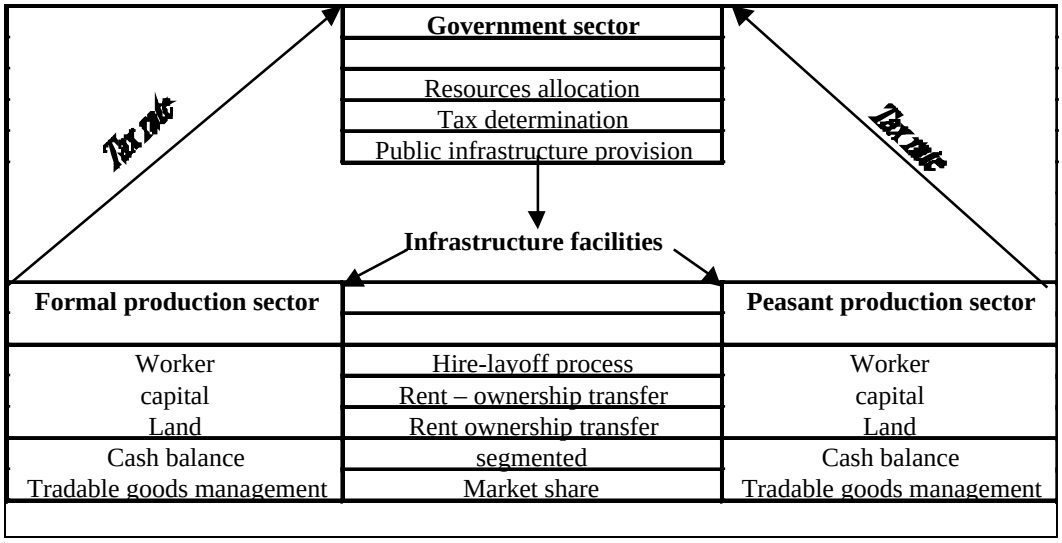

Figure 1. An overview of the model

The infrastructure sector we have added to the model includes three sub-sectors: allocation of resources by the government to its various service functions, including infrastructure; the development of infrastructure facilities consisting of transportation and irrigation services; and the product mix determination.

In the sector allocating government resource, it is assumed that government collects taxes and makes decisions to allocate collected funds to public expenditure. The government is the only provider of the infrastructure services in the model. Financial resources for infrastructure building are obtained by the government through general tax collection. Munnel (1990) points out that the price of infrastructure consumption is the tax rate.

Musgrave and Musgrave (1976) also argue that even though resources can be borrowed from banks, the payback would still be through taxation. However, this does not exclude building of infrastructure by the private sector. Public infrastructure provision only means that the public sector makes the investment decision and provides the resources for infrastructure building (Munnel 1990,Musgrave and Musgrave 1976)

The model also assumes that the resources allocated by the government to infrastructure building must compete against resources transferred out of the rural area and those consumed for government services delivery. The resources consumed for government services delivery are linked to the number of infrastructure projects and the stock of infrastructure in service as suggested by Hirschman (1967) and UNPAD (1977). The allocation of infrastructure resources is determined by the financial capacity of the government, infrastructure resources demanded to finance ongoing projects and the economic returns on infrastructure. Fraction of resources transferred out of the rural area is a fixed fraction based on the empirical studies conducted by Lipton (1977), Parker (1995), Shiff and Valdes (1992), and Winters, et al. (1996). The literature on the determination of infrastructure resource allocation is quite fragmented. The determination of the allocation of infrastructure resources by the financial capacity of the government is supported by the work of Dudley and Montmarquette (1992), Musgrave and Musgrave (1976), Raj (1993). The infrastructure resources allocation to finance ongoing projects is supported by the work of Hirschman (1967), UNDP (1977) and Mashiyaki 1996. Allocation based on the economic returns on infrastructure is supported by the work of Simon (1975), Frederiksen and Looney (1980); Frederiksen (1981), Munasinghe (1987), Kikuchi and Hayami (1979) and Clements (1995).

There are two categories of infrastructure facilities in the model: irrigation and transportation. The allocation of infrastructure resources between irrigation and transportation is assumed to be based on their respective productivity and the demand to finance the ongoing projects. The infrastructure subsector takes into consideration the long supply chain for infrastructure planning, design and construction before it is available for use. This long delay embodied in the supply chain of the infrastructure has been observed by many researchers (Rondinelli 1977 and Hirschman 1967, Saeed and Brooke 1996). The infrastructure project startup rates for planning are determined by the availability of infrastructure resources and the productivity of the infrastructure. Infrastructure project startup rates for construction are also affected by the availability of infrastructure resources. The rates for infrastructure projects to be completed are determined by the available infrastructure resources and the unit cost of infrastructure facilities. The unit costs of the infrastructure facilities are endogenously determined by the model. They are increased by resource scarcity, since the scarcity would create bottlenecks and delays, and decreased by the economy of scale (World Bank 1994, Hirschman 1967 and Mashiyaki 1996).

As suggested by Biehl (1986), Nadiri and Mamuneas (1994) the stock of public capital must be adjusted by an appropriate index to demonstrate the degree of their usage by the producers. In the model, the impacts of infrastructure on production are determined by the

infrastructure service level not by the infrastructure stock. The irrigation service level is the accessible irrigation facility per cultivated land. The irrigation service levels in the formal sector and in the peasant sectors can be different and controlled by irrigation accessibility parameters. The transportation service level is the market accessibility per unit of demand for tradable products. This structure is suggested by Liang [1981]. The transportation service levels in the formal sector and in the peasant sectors can be different and controlled by a transportation accessibility parameter. Literature has well documented the different accessibility to the infrastructure service for the formal sector and peasant sector and an the higher accessibility to the infrastructure service in the formal sector than in the peasant sector (Ahmad and Sampath 1994, FAO 1996, Broersma 1975, Hirschman 1967). In the model a high irrigation service level brings more land into cultivation as well as bringing a higher return on land, as suggested by Kichuchi and Hayami (1979), Oshima (1987) and Akino (1979)). A high transportation service level has an impact on the preference for tradable goods production and improves the marketability of tradable goods which, in turn, impacts on the total demand and sales in the two sectors, as pointed out by FAO (1996), Khan (1984) and Richards (1982).

The production mix sector determines the proportions of tradable and non-tradable goods. Both the formal and peasant sectors produce tradable as well as non-tradable goods. The non-tradable products are to meet the demand for government service consumption, rural traditional capital, and rural traditional service consumption. Tradable goods are the goods for infrastructure building and agricultural commodities.. Each sector maintains its own tradable products inventory, has it own tradable goods distribution system and its own market share. The allocation of the capacity to the production of the two types of goods depends primarily on their respective demands, but the preference for tradable goods rises with the availability of transportation facilities. The total sales revenue in each sector is generated by both the sale of the tradable goods and the sale of the non-tradable goods.

3. Model behavior and the history of infrastructure performance in developing countries

The first experiment is replicated from Saeed 1980 as a starting point for further analysis. In his original model, the same experiment was conducted to explain how economic duality functions in the absence of technological differentiation between the two sectors. Saeed's model shows that resources are concentrated in an absentee ownership mode creating the occurrence of what has been described in the literature as feudalism, which has been quite pervasive in the developing country agricultural economies before development effort was undertaken. However, the experiment conducted here incorporates the basic information linkages of tax determination and government expenditure which is not included in the original model. The experiment with the extended model should also replicate the occurrence of feudalism as observed in the real world because in a feudalist society there was an administration system collecting tax and consumed the taxed income. The implicit assumption about infrastructure in this experiment is that its supply is completely elastic. The second experiment repeats the first experiment with the extended model imposing limitations of infrastructure supply

depending on government financial capacity and infrastructure productivity. The behavior in this experiment is more or less similar to the first experiment except that there is a slight falling off in output due to the limitations of infrastructure supply. The third experiment assumes that the access to infrastructure for the producers in the two sectors is different, peasant sector having limited access as is often the case in reality. This experiment shows that production in the formal sector increases while production in the peasant decreases due to unequal access to infrastructure**.** This experiment also explains the experience of Japan when it embarked upon expanding rural infrastructure over the 19^{th} century (Akino 1979, Kikuchi and Hayami 1979). The fourth experiment shows the model behavior with a technological differentiation created between the two sectors by making modern capital available to the formal sector and maintaining the assumption of differentiation in the accessibility to infrastructure to the two sectors. This is the background in which many development policies have been implemented. Due to the combined influence of differentiation in capital and infrastructure access, the formal sector production gets a further impetus.

The fourth experiment is served as the base run for the policy design. It is used to replicate the development of the dual technological and economic systems widely experienced in developing countries after the process of economic development begins. The simulation is generated by supplying a certain quantity of modern capital to the rural area with the same assumptions as in experiment 3. The output elasticity of modern capital is assumed to be higher than that of traditional capital. To apply the possible effects of capital differentiation between the sectors, it is also assumed that the peasant sector is unable to employ any modern capital. Capital differentiation between the sectors develops as the capitalists sector starts meeting its additional and replacement capital needs by acquiring a mixture of modern and traditional capital inputs. Capital demand is met by modern capital to the extent that the fixed supply permits. The balance of the demand is met by acquiring traditional capital (Saeed 1980). This simulation run is given as a base run since the development process in many countries is dominated by the penetration of modern capital even without government intervention. The amount of modern capital can be effected by the government's development policies. All other parameters and behavioral relationships remain unchanged. The results of the simulation are shown in figure 2. From the simulation runs, we can observe that the dualist economic structure is distinct. The availability of modern technology and the availability of infrastructure services offer an opportunity to the formal sector to improve its productivity. Marginal returns on land and capital increase in the formal sector. It is more profitable for the formal sector to be engaged in production than to rent out the land and capital. The employment of land and capital in production also increases the marginal return on workers in the formal sector. Demand for workers is high in the formal sector. While production in the peasant sector declines, the average consumption level of the workers reduces to a lower level than the marginal return on the workers in the formal sector. Hence, wage rates fall and more workers are hired. Toward the end of simulation, the total production increases greatly compared to the initial equilibrium level. The relative size of the formal production sector expands while that of the peasant sector reduces.

4. Infrastructure provision: A strategy to improve economic efficiency and income distribution.

A formal system dynamics model provides an experimental tool to explore the effectiveness of proposed and implemented polices in achieving equitable income distribution and economic growth. The experiments in this section of the paper attempt to understand the variability of the performances of selected development policies with the interaction with public infrastructure provision, and also to identify guidelines for an effective infrastructure strategy that could serve as an alternative policy for economic development. The policies selected for the experiments are based on two considerations: 1). The performance of the system with realistic infrastructure constraints added needs to be understood. 2). The promise of infrastructure supply as a policy lever needs to be investigated. Three policies are selected for experimentation with the extended model to address the first consideration. These include taxation of unearned income, improving the working of the financial markets and organizing peasant sector into cooperatives. The first policy was proposed as a critical instrument to redistribute income and the later two as facilitators in Saeed (1980,1994). The second and third are facilitating policies. The facilitators were effective only when the critical policy was in place but did not help without it. In the absence of an explicit infrastructure supply process, Saeed's original model assumed in default that infrastructure supply is infinitely elastic, hence infrastructure could not be factored in as a policy lever. In the extended model, we provide policy space to control the magnitude, the supply delay, the mix and the targeting of infrastructure, so these attributes could be tested for their implications for meeting objectives of growth and equity laid out in the original model. Therefore, the next set of experiments addressing the second consideration explore the explicit infrastructure polices suggested by researchers or used by the infrastructure policy decision-makers. The proposed infrastructure policies are mobilization of funds to build more infrastructure (Hischman 1958, Hansen 1965) and targeting infrastructure supply for the poor (Besley and Kanbur 1993). The efficacy of each tested policy is evaluated by comparing the simulation patterns with the experiment 4 designated as base run.

4.1. Analysis of the individual policy

4.1.1.Policy 1 mobilizing resources for infrastructure building

Many policies over the past three decades have attempted to mobilize government funds for infrastructure investment. Policy makers usually refer to these funds as subsidies to the rural area. Based on base run at time 50, a policy is introduced to reduce the resources transferred to the urban area and use these resources to build infrastructure in the rural area. From the simulation run, it can be observed that this policy leads to an increase in output. Average wage rate rises to a higher level than the base run. Yet, the wealth distribution and the share of revenue in the formal sector representing the inequality in income distribution do not change. When policy is implemented, the land owned by the formal sector still grows but at lower rate than the base run. Towards the end of the

simulation run, the share of the land owned by the formal sector reaches a new equilibrium that is lower than the base run. The revenue share of the formal sector reaches an equilibrium level slightly lower than the base run. Rent payments from the peasant sector to the formal sector rise to a much higher level than the base run (see table 1). These changes are explained as follows:

When resources are mobilized to build infrastructure in the rural area, the total demand for rural products increases while the infrastructure facilities in service increase after a certain delay. Fueled by demand and increased infrastructure availability, the production in the peasant sector also increases. Hence, the average consumption expenditure per worker rises, which fuels the wage rate demanded that reduces the profitability of production in the formal sector. The formal sector begins to lay off workers, who enter the peasant sector. Formal sector also begins to sell out or rent out land and capital to the peasant sector. The demand for land and capital in the peasant sector remains high because of the crowding of workers into it and the growth in demand. However, its financial capacity constrains its ability to acquire more land and capital. As more and more workers are laid off and accommodated in the peasant sector, the financial capacity of the peasant sector worsens rapidly. The demand for land in the peasant sector is met more and more through renting land, hence, the total rent payment to the formal sector from peasant sector rises at an increasing rate. Due to infrastructure improvement, the income of the peasant sector lightly improves and it is able to buy more land. Therefore, compared with the base run, land owned by the formal sector is slightly lower towards the end of the simulation.

4.1.2.Policy run 2 equal access to the infrastructure

Although there are many technical difficulties on the design of infrastructure for the poor, in the model it is assumed that these difficulties can be overcome so both sectors can have equal access to infrastructure facilities. Compared with base run (see table 1), the rate for the formal sector to acquire land slows down. The share of land owned by the formal sector and revenue shared by the formal sector reach new equilibrium levels slightly lower than in the base run. However, land owned by the formal sector still increases after the implementation of the policy. The rent payment to the formal sector keeps on rising to a level higher than the base run.

It is interesting to compare this run with the previous policy run. In previous run, when government increases investment in infrastructure it takes a long time for infrastructure projects are planned and constructed. Therefore, there is a long delay before the infrastructure facilities are put into service. Production and revenue in the peasant sector do not increase as rapidly in the former run as in this run. In this policy experiment, production in the peasant sector rises rapidly since there is a sudden improvement of the infrastructure service level. Hence the average consumption expenditure per worker in the peasant sector rises more rapidly in this run than in former run. Also, the building of the new infrastructure directly benefits the two sectors in the former simulation run, production in the formal sector also increases. Therefore, marginal revenue return on

workers in the formal sector also increases. Demand for worker in the former sector keeps high. The laying off of workers in the formal sector proceeds at a slower rate. Overall, workers are laid off more slowly in the previous run than in this run. Therefore, in the formal run, demand for rented capital and land rises slowly when at the policy is implemented initially. Thus financial burden in the peasant sector due to rent burden and consumption pressure of unemployment workers crowded into the peasant sector is lower in the former run than in this simulation run. The peasant sector has financial capacity to buy the land and capital.

4.1.3.Policy 3 Cooperative policy

The cooperative policy allows the peasant sector to compete with the formal sector for modern capital. The availability of modern capital to the peasant sector re-enforces the growth feedback of production in the peasant sector. Demand for land and capital for production in the peasant sector increases. The formal sector begins to transfer land and capital from production to renting. The rent payment from the peasant sector to the formal sector rises. Compared with base run**,** the rate for the formal sector to acquire land is slower. The share of land owned by the formal sector and the revenue share of the formal sector reach new equilibrium levels slightly lower than the base run but still higher than the policy starting point.

There are many similarities between policies 3 and 2. Reynolds (1975) points out that in agricultural production, infrastructure investment is a kind of modern capital investment. Therefore, both the cooperative policy and accessibility to infrastructure policy are intended to improve the production conditions for the peasant sector. The cooperative policy is a policy to be carried out through market mechanism, while the policy of improving the accessibility to infrastructure is carried out through the distribution of public goods. In both cases, production in the peasant sector increases and the wage rate also increases. In both cases, the asset ownership of peasant sector and the share of revenue of peasant sector are not improved very much and the total rent payment from peasant sector to the formal sector is increased. However, it seems that the policy which improves the infrastructure service access to the peasant sector is more effective in inducing economic growth in the peasant sector and overall output than the cooperative policy. Cooperative policy is crippled for the following reasons: (1) The peasant sector is labor intensive. A labor saving technology is not as effective in the peasant sector as in the formal sector. (2) Although the production potential in the peasant sector is increased with modern capital, due to the low infrastructure service level, the production potential in the peasant sector is not fully realized. On the other hand, since the production in the peasant sector is low, the average wage rate is also low. Fewer workers are laid off. Less land and capital are rented and less rent is paid to the formal sector.

Policy 1, policy 2 and policy 3 are effective in promoting economic growth through promotion of production in the peasant sector. However, they all fail to change the asset ownership pattern and revenue share between the formal and peasant sectors. All the three policies lead to increased rent payments from the peasant sector to the formal sector.

When the policies are implemented to promote the production in the peasant sector, the average consumption expenditure in the peasant sector increases. The average wage rate rises. It becomes less profitable for the formal sector to produce. The land and capital which are employed in production in the formal sector will be either sold out or rented out. However, financial capacity in the peasant sector limits the peasant sector to acquire land and capital. The financial capacity is largely determined by the unemployment rate in the peasant sector. When the workers are laid off too rapidly, financial capacity in the peasant sector are worsened even the overall production and revenue in the peasant sector are improved. In the end, little land and capital can be acquired by the peasant sector. The inefficiency of the policy run 2 and 3 are due to the rapid layoff of workers after the implementation of the policy. In the policy experiment 1 where the layoff workers are much slower due to long delay of infrastructure supply chain and the general improvement of production in both sector, the peasant sector can acquire some land and capital when the policy is implemented initially. However, as more and more workers are gradually laid off and enter the peasant sector, the financial capacity in the peasant sector worsens. Demand for land and capital in the peasant sector rises rapidly. The formal sector rents more and more land and capital to the peasant sector. In each case, the peasant sector ends up paying a higher rent to the formal sector. Therefore, in order to change the pattern of asset distribution, renting activity should be discouraged and financial assistance should be provided with policies to promote production in the peasant sector.

4.1.4. Policy 4 financial policy

The financial policy requires that the constraints of cash balance on the acquisition of land and capital be reduced. The financial policy reduces the dependence of the bidding for land and capital on internal savings in each sector. However, the segmentation of the financial market is still existing. Each sector has to finance the acquisition of land and capital. We find that financial policy improves income distribution slightly. After implementing the policy, land owned by the peasant sector shows a slight trend to rise, and land owned by the formal sector shows a slight trend to decline. Rent payment to the formal sector reduces. Yet, the improving rate is very slow. Overall, land ownership in the peasant sector improves but only slightly. There are two reasons for the inefficiency of the financial policy. First of all, the formal sector acquires land and capital mainly because it is profitable to produce. The profitability to produce in the peasant sector is low due to the low productivity of traditional capital and to the limitation of infrastructure service. The desire for the peasant sector to invest on land and capital acquisition is low. Improving the financial capacity of the peasant sector does not help the peasant sector to gain more land. Second, the financial policy only reduces the dependence of the peasant sector on internal savings. However, the segmentation of the financial market is still existing and the financial capacity in the peasant sector is still weak. The ability to acquire land and capital is limited in the peasant sector.

4.1.5.Policy 5 Rent tax policy

Experimenting with the original model, Saeed (1980, 1994) has found that a fiscal policy to levy tax on rent income will be a critical policy in changing the income distribution pattern. A rent income tax depresses renting activities. The formal sector has to either transfer the rented land and capital for self-production or to sell the surplus land and capital to the peasant sector. When there is no capital differentiation, the formal sector tends to sell the land and capital to the peasant sector. Income distribution is improved in terms of asset ownership and rent payment. He also shows that this policy is diluted when modern capital differentiation is incorporated into the model. When the formal sector can adopt highly productive capital, a profitable alternative to renting has been already created. Further discouragement of renting activity does not help to change the income distribution pattern.

A rent income tax is simulated in the model by deducting a tax equal to 20% of the rent income at time 50. Rent tax policy is not effective in changing the wealth distribution pattern (see table 1). However since this experiment is conducted with modern capital differentiation, it is difficult to understand whether the reason for the dilution of effectiveness is only due to modern capital differentiation or if it is also effected by the public provision of infrastructure. Therefore, a comparative policy is conducted with the assumption of equal access to infrastructure in both sectors. The assumption is relaxed at the beginning of the simulation run. The other parameters stay the same as in the experiment conducted above. In this comparative run, since the production of the peasant sector is not especially constrained by infrastructure service, the bargaining power of the worker is higher and wage rate is higher accordingly. Workers are laid off to the peasant sector. The profitability for the formal sector to produce is reduced. Meanwhile, the demand for renting land and capital in peasant sector are higher. Capital and land rent are active in this comparative run. Therefore, the policy which reduces rent income depresses renting activities and changes the asset distribution pattern radically. It can be concluded that the rent tax policy is effective when renting is an important economic activity in the economy.

But implementation of the rent tax policy also brings a side effect. The overall output is reduced. The reduction of the output is due to two reasons: (1) Allocation inefficiency. When the rent tax is implemented, in order to maintain the same level of allocation efficiency, all available land should be bought by the peasant sector to be put into production. However, due to lack of financial capacity, peasant sector can not afford to buy the land. The land and capital, which are formerly rented out, are thus forced to be employed in the formal sector production. This creates a low efficiency of production. (2) Constraint on production in the peasant sector. The production in the peasant sector is heavily constrained due to the lack of availability of modern capital and accessibility to infrastructure, the total production can not be much improved.

5.2. Analysis of the policy package

Many infrastructure researchers and policy makers have realized that individual policies are not effective. Policy packages are suggested. Typically, there are two kinds of policy packages. The first category of infrastructure policy package is to mobilize government

funds for infrastructure investment implemented along with the other policies. The second category of infrastructure policy package is to improve the accessibility of infrastructure targeting to the poor implemented along with the other policies. However, many policy packages have failed to recognize the dynamic change in the role of renting activities when the policies are implemented. The effectiveness of these policies is not satisfactory.

5.2.1 Policy package 1: Resource mobilization of the government fund and targeting of the poor through equal access to infrastructure.

The first package is to mobilize the government funds for rural infrastructure building and design the infrastructure facilities in such a way that equal access is obtained by the two sectors. The simulation result is the same as policy one. Compared with base run, policy 1 and policy 2, it can be observed that the output increases at a higher level. The policy package has little effect on the improvement of asset ownership distribution. The average wage rate rises to a higher level. The production in the peasant sector increases and the production in the formal sector reduces. However, the share of revenue received in the peasant sector rises only lightly compared with the base run but stays at the same level as the policy starting point. This infrastructure policy benefits the formal sector who receives a higher level of rent payment.

5.2.2. Policy package 2: Implementing resource mobilization policy with financial policy

The individual policy analysis in the former sector demonstrates that financial constraint is also one of the limiting factors for the peasant sector to buy land when the formal sector decides to transfer land either for self-cultivation or sell it. Therefore, this policy package suggests that when resources are mobilized for infrastructure investment, a financial policy to improve the financial capacity of the peasant sector should be implemented at the same time. When the policy package is implemented, revenue in the peasant sector increases. The average wage rate also increases. The formal sector begins to lay off workers who then enter the peasant sector. The formal sector also begins to sell or rent out the land and capital formerly employed in production. The improved financial capacity in the peasant sector allows it to buy land. Within a short time, production increases because of the general improvement of infrastructure, less rent payment to the formal sector and a higher wage rate paid by the formal sector. Therefore, revenue received by the peasant sector increases. More workers are laid off to the peasant sector. The financial capacity in the peasant sector worsens. The capacity for the peasant sector to buy land is reduced. Toward the end of simulation run, the improvement of land ownership is small.

5.2.3. Policy package 3: Implementing resource mobilization policy with the rent tax

From previous individual policy analysis, it is clear that when renting is an important economic activity in the dualistic economy, a rent tax is an effective tool to radically change the income distribution pattern. This policy suggest that when resources are

mobilized for infrastructure investment and the peasant sector has a chance to increase its production, a rent tax should be implemented at the same time to enable the peasant sector to get a larger share of benefits during the course of the development effort. This policy is satisfactory in suppression of the renting activity and radically changes the income distribution. After implementing the policy, not only the formerly rented land and capital are gradually transferred to the peasant sector, the formal sector even begins to sell the land which has been employed in the formal sector production to the peasant sector when average wage rate rises. Yet, when the policy is implemented, the total output does not increase as much as when the resource investment policy is implemented alone.

5.2.4. Policy package 4: Resource mobilization, targeting of the poor through equal access to infrastructure, and implementation of rent tax policy

Implementation of policy package 1 has little effect on the improvement of asset ownership distribution. When the package 1 is implemented, rent payment from the peasant to the formal sector rises very rapidly. The improvement of income in the peasant sector is very limited. When the rent tax policy is implemented with package 1, there are radical changes in the land ownership pattern. Rent is depressed. Production is mainly carried out in the peasant sector and the share of revenue of the peasant sector in the economy rises.

5.2.5. Policy package 5: Implementing resource mobilization policy with financial policy and rent income tax policy.

This policy attempts to reduce the inefficiency of resource relocation induced by the rent tax policy; it is suggested that when the rent tax policy is implemented, a financial policy should also be implemented simultaneously. Simulation runs show that the patterns are the same as the policy package 3, with further improvement of the total output, improvement of wealth distribution in the peasant sector and a reduced rent payment to the formal sector.

5.2.6. Policy package 6: Implementing the resource mobilization policy with the financial policy, equal access to the infrastructure, cooperative policy and rent tax policy.

When these police are implemented at the same time, simulation runs show the patterns are the same as the policy package 5, only higher economic growth and a better income distribution can be achieved. The rent tax policy eliminates the source for the unequal share of income. The financial policy improves the reallocation efficiency. When the production in the peasant sector is encouraged, a higher level of infrastructure service and accessibility to modern technology will sustain the economic growth in the peasant sector and the overall economy.

5.2.7. Alternative policy packages without mobilizing resources to build infrastructure

Usually mobilizing financial resources is difficult and involves a long time delay. A policy package without mobilizing resources for infrastructure investment can also achieve the development goal. Both cooperative policy and equal access to infrastructure can promote production in the peasant sector. When either of the policies is implemented with the rent tax policy, an equal share of development effort can be achieved. If the policy can be implemented with the financial policy the inefficiency during the transaction period will also be reduced. Three more experiments are conducted. Policy package 7 is the combination of rent tax policy and equal access to infrastructure policy. Policy package 8 is the combination of tax rent policy, equal access to infrastructure policy and financial policy. Policy package 9 is the combination of rent tax policy, equal access to infrastructure policy, financial policy and cooperative policy. The three policy packages lead to a pattern of radical changes of asset distribution pattern and increasing wage rates. However, the total production reduces slightly in the three simulation runs (see table 1). Comparing policy package 7, the additional financial policy in policy package 8 does not contribute much to the improvement of land ownership since the rent activities are already depressed. Compared with package 7 and package 8, package 9 increases the production and revenue received in the peasant sector at the fastest speed and reaches the highest level.

5.3. Policy conclusion

The formal model provides us a tool to explore the major policy efforts for development in the dualistic agricultural economy. We have found that a single development policy either targeting the economic growth or targeting income distribution is not effective to achieve the development goal which is to improve income distribution pattern and promote economic growth. While there are many policy instruments to promote economic growth, the rent tax policy is a critical policy to change the income distribution pattern especially effective when it is implemented with a policy which is targeted to improve the production of peasant sector, such as the policy to increase infrastructure investment and the policy to improve infrastructure accessibility to the poor.

We also make comparisons between the policy packages without and with mobilizing resources for infrastructure building. All the policy packages which mobilize resources for infrastructure building result in higher output and a better income distribution. When infrastructure resources are mobilized in the rural area, both sectors benefit from the policy. The marginal return on workers in the formal sector is higher. Demand for workers in the formal sector stays high. Therefore, more workers remain in the formal sector engaged in formal production. The peasant sector can steadily increase its production and accumulate more financial capacity and gain more land. This shows that reducing urban subsidy and earmarking these resources for infrastructure investment helps the rural development .

5. Conclusion

The economies of the developing countries have been observed to incorporate two equally significant production modes: a profit-maximizing formal sector and a consumption-maximizing peasant sector. Most policies, especially the infrastructure polices described in this paper, have not differentiated between the two production sectors, therefore, their performance is varied. This paper has attempted to explore the efficacy of infrastructure policy for developing countries dominated by a dualist agricultural economy by using a system dynamics model of economic growth, income distribution and public infrastructure provision based on an earlier model developed by Saeed (1980 1994). The focus of the study is to show the impact of the dualist economic structure on the efficacy of public infrastructure policies. Experimentation with this model shows that public infrastructure provision can be a promising facilitating policy to achieve economic growth and income distribution when it is implemented in conjunction with other policies, especially with a rent tax. A policy package which reduces the urban subsidy, relieves the constraints to the peasant sector through the establishment of cooperatives, allows equal access to infrastructure, and discourages rent income can bring the fastest growth with equality.

In the developing countries, government provision of infrastructure has been a traditional instrument to deliver social welfare. Although the empirical evidence has provided many counterintuitive behavior patterns, this policy can still be effective when it is implemented with other policy instruments. Since the developing countries have limited tools to improve their income distribution patterns, the authors argue that policies in favor of privatization of infrastructure delivery only attempt to shift the burden to achieve equitable income distribution with growth away from the government. Whether an equitable share of economic benefit can be achieved through privatization is unknown.

While our analysis deals with economic duality in the agricultural sector, our conclusions and their policy implications can be extended to other contexts of dualist economies, for example, between the agricultural sector and industrial sector, between economically growing areas and lagging areas, and between industrialized countries and developing countries. The underlying structure in other forms of duality is not fundamentally different from that elaborated in this model. Saeed and Prankprakma (1997) used a system dynamics model to explore technological policy in the industrial sector in developing countries. Saeed (1998) considers the global economic structure as having the characteristics of a dual economy in which free movement of production factors and commodities might be poised to create global feudalism. Further exploration with the dualist structure can result in more insights.

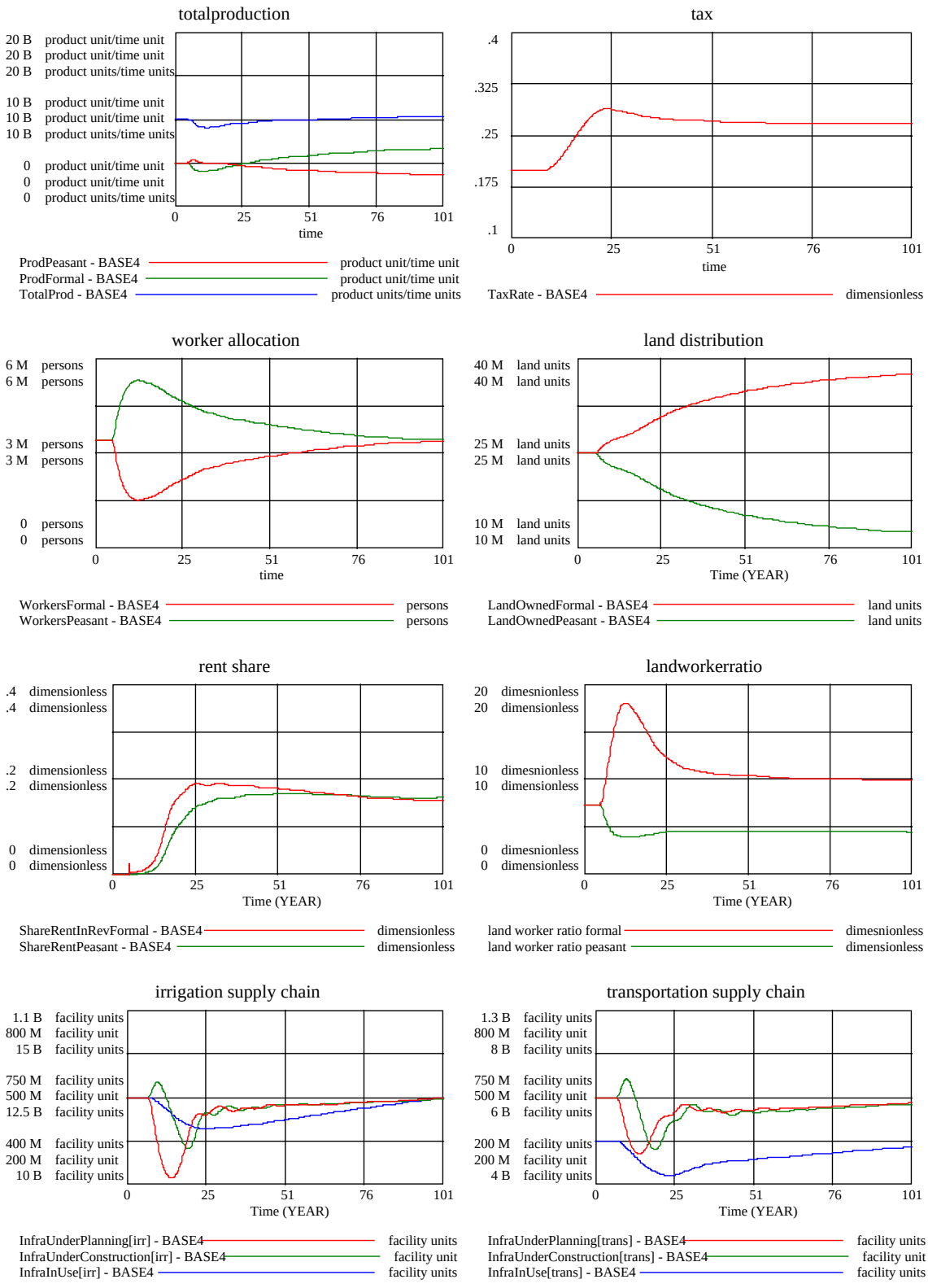

Figure 2. Base run

	Total Production	Production Formal	Production Peasant	Fraction Revenue Formal sector	Land Owned by Formal sector	Rent Burden of peasant sector	Effective Land Worker Ratio in peasant sector	Average Wage Rate	Irrigation facility level	Transportation facility level
BASE	1	1	1	1	1	1	1	1	1	1
More resource for infrastructure investment	1.05	0.76	1.85	0.92	0.92	4.41	1.31	1.43	1.2	1.39
Equal access to infrastructure	1.02	0.83	1.53	0.98	0.96	3.38	1.37	1.02	1	1
Cooperative policy	1	0.91	1.24	0.99	0.98	1.9	1.1	0.98	0.99	0.98
Rent tax policy	0.97	0.87	1.26	0.84	0.88	0	0.99	1.09	0.98	0.96
Rent tax policy with assumption of equal access to infrastructure	1	0.54	2.25	0.51	0.53	0.17	1.42	1.51	1.04	1.07
Financial policy	1	0.99	1.01	0.99	0.99	0.94	1	1	1	1
Resources for infrastructure investment +equal access	1.1	0.6	2.44	0.93	0.9	8.52	1.64	1.53	1.22	1.44
Resources for infrastructure investment +equal access + rent tax	1.04	0.52	2.43	0.48	0.52	0.56	1.44	1.98	1.2	1.4
Resources for infrastructure investment +financial assist	1.05	0.75	1.86	0.9	0.9	4.02	1.3	1.43	1.19	1.38
Resources for infrastructure investment +rent tax	1	0.67	1.9	0.6	0.68	0.22	1.15	1.67	1.17	1.34
Resources for infrastructure +rent tax + financial assist	1.01	0.66	1.94	0.59	0.66	0.18	1.18	1.65	1.17	1.34
Resources for infrastructure +rent tax + financial assist + cooperative + equal access	1.05	0.3	3.06	0.39	0.35	1.39	1.6	1.87	1.18	1.37
Rent tax +equal access	0.98	0.66	1.86	0.63	0.67	0.06	1.29	1.23	0.98	0.97
Rent tax + financial assist + equal access	0.99	0.66	1.86	0.63	0.67	0.05	1.29	1.23	0.98	0.97
Rent tax + financial assist + cooperative +equal access	0.98	0.38	2.59	0.44	0.46	0.52	1.45	1.26	0.96	0.92

Table 1 Simulation results of alternative policies

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