On the Role of Policy Interventions in Structural Change and Economic Development: The Case of Japan's Postwar*

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Abstract

In this paper, we study the structural change occurred in Japan's post World War II rapid economic growth era. We use a two-sector neoclassical growth model with government policies to analyze the evolution of the Japanese economy in the postwar period, and to assess the role of such policies. Our model is able to replicate the behaviour in the data of the main macroeconomic variables for the postwar Japanese economy. Three findings emerge when we use our framework to analyze government policy interventions. First, price and investment subsidies to the agricultural sector and industrial policy, in the form of the Fiscal Investment and Loan Program, do not play a crucial role in the postwar rapid growth. Second, while a government subsidy to help families in the urban areas could have facilitated migration from agriculture to non-agricultural sector in the rapid growth era, such a policy does not improve the overall performance of the Japanese economy. Finally, with the counter-factual labor migration barrier, Japan's postwar GNP growth would have been lower and the negative long-run level effect would be substantial.

Keywords: Two-sector growth model; Structural change

JEL Classification: E1, O1, O4

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1 Introduction

Japan's postwar successful development experience has been a popular topic of investigation in a wide range of economic literature. On the empirical side, economic historians such as Ohkawa and Rosovsky (1973) made a significant contribution in constructing and analyzing long-term macroeconomic data of Japan following Simon Kuzunets' quantitative approach to the long-term economic growth. In the tradition of development economics, researchers such as Minami (1968) and Yasuba (1975) employ dualistic development models of Lewis (1954), Jorgenson (1961), and Ranis and Fei (1961), to identify the timing of the turning point of Japan from a labor abundant economy to the labor shortage phase. More policy-oriented studies can be found in the context of Japan and other high-performing east Asian economies including South Korea and Taiwan such as James, Naya, and Meier (1989) and World Bank (1993).

On the theoretical side, there are many studies from the 1960s and 1970s which formulated multi-sector economic growth models, starting from Shinkai (1960), Uzawa (1961, 1963), and Inada (1963). Indeed, Inada and Uzawa (1972) and Inada, Sekiguchi, and Shoda (1993) present a formal theory of economic development to explain the mechanism of aggregate industrial development pattern in Japan, which takes into account the important role of food and labor supply, as well as the performance of the subsistence sector.

While these works generate important findings, there is a lack of studies trying to reproduce the Japanese structural change and development experience in the post World War II period by using modern modeling techniques and which carefully choose the basic structural parameters of the model to match actual data. Moreover, there is almost no formal quantitative study which can be used to evaluate the effectiveness of actual policy interventions on the structural change in Japan in a rigorous manner. This is a serious omission in the literature because, for example, the importance of targeted industrial policies has been debated repeatedly in the context of the Japanese economic development (Johnson, 1982; Okuno et al., 1988). An exception is Hayashi and Prescott (2008) which employ a two-sector neoclassical growth model to investigate the reasons why the Japanese miracle did not take place until after World War II.

Following the model developed by Hayashi and Prescott (2008), and extending their analysis using postwar Japanese data, the objective of this study is to further fill the gap in the existing literature by building a two-sector general equilibrium growth model of the Japan's postwar era. By doing so, we aim to understand the forces underlying the rapid economic growth and structural change in employment from agriculture to the non-agriculture activities. We further use the model to formally evaluate the effectiveness of postwar Japan's unique policy interventions.

The model is a two-sector neoclassical growth model, where the driving force of the economy are innovations in technology, in the form of increases in total factor productivity (TFP), in both agriculture and non-agriculture sectors. We assume Engel's law, which as productivity grows implies a lower need for workers in the agricultural sector and a shift towards manufacturing and other non-agricultural industries. We incorporate several government policies aimed at protecting agriculture, while helping the development of both sectors. Such policies include price subsidies for agricultural goods, subsidies to the rental cost of capital for firms and subsidies to the families who live to urban areas and work in non-agricultural activities. The model is carefully calibrated to match the Japanese empirical evidence in the postwar period and then solved by using a perfect foresight shooting algorithm as in Hayashi and Prescott (2002).

Since the relative price of agriculture goods is determined endogenously in the model, and there is a variety of government policies in place, pure agricultural productivity growth may not be sufficient to explain the rapid structural transformation in Japan, as was pointed by Hayami et al. (1975) and Minami (1994).[1] Our results show, however, that it is the combination of TFP growth in the agricultural sector, together with very high TFP growth in the non-agricultural industries which is responsible for the structural transformation and the Japanese economic miracle. We also show that the government policies studied in this paper do not play a crucial role, and that other than changing the relative prices, they do not affect the overall behaviour of aggregate macroeconomic variables such as output per capital or the capital-output ratio.

Our model and solution method, while based on Hayashi and Prescott (2008), are also related to the analytical framework of two-sector growth models such as Matsuyama (1992, 2007), Banerjee and Newman (1998) and Eswaran and Kotwal (1993); it is also related to the numerical techniques of two-sector growth models of Casselli and Coleman (2001), Laitner (2000), Hansen and Prescott (2002), and Lucas (2004); and it also relates to the recent development accounting literature, such as Vollrath (2008), Gollin et al. (2002), and Restuccia, Yang and Zhu (2008).

The remainder of this paper is organized as follows. In the next section, we briefly describe postwar Japanese economy by looking at several time series macroeconomic variables. Section 3

[1] Solow (2005) criticized the two-sector growth models, which are constructed for a consumer-good-producing sector and an investment-good-sector for farm and non-farm sectors in the development context, by stating that too much in those models turned out to depend on differences in factor intensity between the sectors and that we have very little in the way of facts or intuition about that issue. Yet, we overcome this criticism by matching the postwar Japanese data and the model carefully.

explains the two-sector growth model and its equilibrium conditions which will be matched with data. In Section 4, we briefly present the data and calibration procedure. Section 5 shows the simulation results and a set of counter-factual policy experiments. In the final section, we conclude and discuss the direction of future research.

2 Postwar Japanese Economy

In order to understand the Japanese experience in the postwar era, and be able to build a model which can study the policies used by government, we now summarize the main stylized facts of the Japanese economy in the period between the end of World War II and the start of the Lost Decade, i.e., 1990. We also summarize some of the most important and discussed policies implemented by the government during this time. These policies are later included in the model to be able to understand their impact in the structural change and overall evolution of the economy.

2.1 Stylized Facts

We first show, with the help of Figures 1 and 2, the main stylized facts of the postwar Japanese economy, which the model presented below tries to reproduce. The description of the data and its sources can be found in Appendix A.

1. **Rapid Output Growth**

   Figure 1 (a) shows the well known fact that the Japan's economic recovery from the war was followed by rapid output increase in the 1950's and 1960's. This rapid growth process of Japanese economy, which has been studied widely in the existing studies such as Ohkawa and Rosovsky (1973), Minami (1994), Nakamura (1994), and Kosai and Kaminski (1986), continued until 1973, the year of global inflation and the first oil crisis. The average growth rate of GNP between 1956 to 1973 was a remarkable 7.4%. The oil crisis terminated Japan's rapid growth era, which was followed by a period of slower but stable growth, with an average per capita output growth of 2.8% between 1973 and 1990.

2. **Decrease in Agricultural Employment Share**

   Figure 1 (b) presents the share of employment in agriculture. As we can see, as Japan's rapid growth progressed, labor flowed from the agricultural sector into non-agricultural industries. We can see that such a trend started in the 1950s, when the share of employment in agriculture was close to 34%, and continued until the first oil crisis, when it was 12%. After the first oil shock, labor kept shifting towards the non-agricultural industries, but at a lower speed, stabilizing at around 6% in 1990.

3. **Increase in Capital-Labor ratio in Agriculture Relative to Non-Agriculture**

   The massive labor migration prior to the first oil crisis coincided with an increase in capital-labor ratio of agriculture relative to non-agriculture, as can be seen in Figure 1 (c). This pattern seems to arise from a sharp increase in capital inputs in agriculture after the war. In fact, a distinct feature of the postwar agricultural development of Japan was the spurt of farm mechanization through "mini-tractorization," i.e., a rapid introduction of small-scale tractors of less than 10 horsepower (Hayami, et al., 1975). This mechanization was paralleled by the spurt of industrial and economic development since the mid-1950s.

4. **Low Agricultural Wages**

   Figure 1 (d) shows the existence of a persistent wage differential between wages in the agricultural and non-agricultural sectors. In spite of this large wage gap, the adjustment of the economy through migration out of agriculture did not occurred rapidly, but continued for more than 15 years. At first sight, it seems to be puzzling why labor market adjustment did not take place in a shorter period of time. Indeed, this slow adjustment may be a reflection of a unique feature of Japanese farm households. After the war, farmers were finding it increasingly difficult to finance household expenses by farming alone and were forced to supplement their income by earnings from outside of agriculture. As industrialization gradually spread all over the country, farmers' sons and daughters started working in the industrial sector. In this way, it became common for agricultural households to combine farm earnings and nonfarm income. Accordingly, Japan experienced a growing shift from full-time farming households to part-time farming households since the 1950's. In fact, in Japan a significant portion of farmers are officially classified as part-time farm household of the second type, i.e., farm households with more than half of their total income coming from non-farm sources.[2] As a result, the gap between agriculture and non-agriculture, in terms of income per household, was reduced substantially (Hayami et al., 1975; Hayami and Godo, 2002, 2005).

[2]While the proportion of farm households out of total households in Japan declined by 40 percent between 1960 and 1995, part-time household of the second type increased by more than 20 percent (Hayami and Godo, 2002).

5. **TFP Increase in Agriculture and Non-Agriculture**

   Figure 2 (a) and (b) show the evolution of TFP in agriculture and non-agriculture sectors, respectively. Both TFP series increased significantly until the first oil crisis, although the growth rate of non-agricultural TFP was higher than that of agriculture. It has been argued that TFP growth in agriculture resulted as a consequence of the accumulation and diffusion of the potential in agricultural technology. In other words, this TFP improvement was the consequence of the implementation of many of the technological advancements that had been accumulated during the war period (Hayami, et al., 1985). In non-agricultural industries, TFP augmentation became possible through the adoption, imitation, and assimilation of the flows of technical know-how from advanced nations. Some theories state that the absorptive capacity, with which the gap between the technology frontier and the current level of productivity is filled, should closely depend on the level of human capital (Benhabib and Spiegel, 2005). Ohkawa and Kohama (1989) discuss that Japan is a typical example of borrowed technology-driven industrialization and Japan's success was attributable to its rapid human capital accumulation by which absorptive capacity of foreign technology has been built. Improvements in non-agricultural TFP in Figure 2 (b) can be understood as a realization process of potential of imported technologies.

2.2 Policy Interventions

It has been argued in the literature that the Japanese government implemented a variety of policies, both in the agricultural and non-agricultural sectors, to try to stimulate the growth and development of the economy (Ohkawa and Rosovsky, 1973, Okuno et al., 1988, Kosai and Kaminski, 1986, Minami, 1994, Nakamura, 1994, and Hayami and Godo, 2002). We describe here some of the most important policies[3].

In the agricultural sector, there were two major policy instruments. The first was the price subsidies to agricultural goods producers. The second, investment subsidies for the mechanization of the agricultural sector. The main policies for non-agricultural industries were related to promoting industrial development through investment and loan subsidies. Let us explain these policies in more detail.

[3] While we believe that we cover major policy interventions in our study, there were other policies that the government used during this period. In this study, we focus on the ones which are incorporated in the model and which effect we can quantify and study.

The agriculture pricing policy applied mostly to rice and other major crops. The price of rice was under the direct control of the Food Agency (Shokuryo Cho). Under this policy, the government purchased rice from rice producers at a predetermined procurement price, based on the parity price formula, and later sold it to consumers at a lower price. Since the rice price was remarkably stable, and the gap between rice procurement and sales prices was about five percent between 1957 and 1960, the deficit of the Food Control Special Account (Shokkan Kaikei) did not rise prior to that year. Yet, in 1960, due to strong political pressure from farmers' organizations, the procurement rice price formula was modified to reflect and cover the cost of production at the paddy field. With this new formula, the producer rice price rose rapidly and government rice purchase price became significantly higher than government sales price. The price gap rose to 25.55% on average between 1962-1980. Due to this price gap, the deficit of Food Control Special Account became one of the most serious sources of overall government budget deficits.

The second agriculture policy was the provision of production investment subsidies. There were two major forms of such subsidies, one by supplying direct investment transfers and the other by providing production loans at subsidized interest rate. Hayami and Godo (2002) estimated that about half of total farm investments was financed by government subsidies after 1970. The ratio of the amount of the investment subsidies to total agricultural investment was 26% in 1960, 45% in 1970, 58% in 1980 and 1990 (Hayami and Godo, 2002).

In the non-agricultural sector, during the period of rapid economic growth, the government promoted industrial development with various instruments within the framework of overall industrial policy. Particularly, it has been often argued that provisions of subsidized interest rate for targeted industries through the Fiscal Investment and Loan Program (FILP or Zaisei Tou Yuushi in Japanese) facilitated investments (Ogura and Yoshino, 1988; Cargill and Yoshino, 2003). FILP is organized and managed by the government using the surplus funds of the postal savings and social security funds. Through FILP, these surplus funds were employed to finance investments of infrastructure-related public enterprises such as the National Railways and the Nippon Telegraph and Telephone Corporation and private-sector investments through public financial institutions, such as the Housing Loan Corporation, Japan Development Bank, Export-Import Bank, and the Small Business Finance Corporation (Ogura and Yoshino, 1988). The targeted industries through this low interest rate policy included a wide variety of industries such as sea transport, electric power, shipbuilding, automobiles, machinery, iron and steel, coal mining, and petroleum refining (Ogura and Yoshino, 1988).

During the studied period, and up to the present, the government also implemented various taxation policies such as taxing labor income and corporate sector. While distortionary taxation is one of determinants of economic decision-making, we do not dwell on the details because they are fairly standard and they were not identified as major development related policies during the rapid growth era in Japan.

3 The Two-Sector Growth Model

The model we employ to try to account for the facts presented above is a neoclassical growth model, in the style of Cass-Coopmans, with two sectors, agriculture and non-agriculture. Time is discrete and there are three types of infinitely lived agents in the economy: Households, firms and the government. Let us study them in turn.

3.1 Household

Every period the household decides how much to consume and how much to save. It also decides how much labor and capital to supply to each sector. The supply of labor is in terms of persons and not hours, since hours, while entering the production function, are assumed to be exogenous to the household and firms in the model.

We make the assumption that the household is composed of smaller groups, which we call families, although these families do not have any decision power, since all decisions are made at the household level. Each family is composed of 4 members who live together in the same location. There are two locations in the model, the rural area, where the agricultural and some of the non-agricultural sectors are located, and the urban area, where most of the non-agricultural firms operate. In order to be consistent with the evidence presented in Hayami and Godo (2002, 2005) concerning the earnings of families in Japan, we assume that when a family lives in the rural area, only one member works in the agricultural sector and the other 3 work for non-agricultural firms. All members in the urban area work in the non-agricultural sector.

We further assume that in order to work in the urban area, workers must incur in a cost, Φ_t. This cost proxies for expenditures such as housing rent, commuting, or outside food consumption. In Japan, most of the farmers own their land and house, and self-produce an important fraction of their food consumption, and that is why we assume that this cost is zero for families members living in the rural area.

The household earns income from their labor and from renting capital to firms. The government taxes part of that income in two ways. It taxes the labor income of the non-agricultural workers[4] at rate τ_{lt}, and the return on non-agricultural capital at rate τ_{kt}.

The problem of the representative household is to choose $\{c_{at}, c_{nt}, K_{t+1}, s_{et}, s_{kt}\}_{t=0}^{\infty}$ to maximize

$$\sum_{t=0}^{\infty} \beta^t N_t u\left(c_{at}, c_{nt}\right) \tag{1}$$

$$\begin{aligned} s.t. \quad & q_t C_{at} + C_{nt} + T_t + K_{t+1} = \Pi_t + w_{at} h_{at} s_{et} E_t + \left(1 - \tau_{lt}\right) w_{nt} h_{nt} \left(1 - s_{et}\right) E_t \\ & -\Phi_t \left(s_{et} E_t - 3\left(1 - s_{et}\right) E_t\right) + (1 - \delta_t) K_t + r_{at} s_{kt} K_t \\ & + r_{nt} \left(1 - s_{kt}\right) K_t - \tau_{kt} \left(r_{nt} - \delta_t\right) \left(1 - s_{kt}\right) K_t, \end{aligned} \tag{2}$$

where $\beta \in (0, 1)$ is the discount factor; N_t is the working-age population in the economy; $c_{at} = C_{at}/N_t$ and $c_{nt} = C_{nt}/N_t$ are the consumption per capita of the agricultural and non-agricultural goods; q_t is the relative price of the agricultural good; Π_t is the return on land, which is one of the factors of production in agricultural sector; K_t is the aggregate stock of capital, which depreciates at a rate δ_t, and is supplied to agricultural and non-agricultural firms, with shares s_{kt} and $(1 - s_{kt})$ respectively; s_{et} is the share of employment supplied to the agricultural sector, where E_t is total employment, which is taken as given by the household; hours of work in each sector are respectively, h_{at} and h_{nt}; w_{at}, w_{nt}, r_{at} and r_{nt} are the pre-tax wages per hour, and the return on capital for each sector; the term $\Phi_t \left(s_{et} E_t - 3\left(1 - s_{et}\right) E_t\right)$ represents the expenditures associated with the non-agricultural workers who live in an urban area[5]; T_t is the total amount of lump-sum taxes levied by the government; we assume Engel's Law and impose the Stone-Geary utility function $u\left(c_a, c_n\right) \equiv \mu_a \log(c_a - \bar{a}) + \mu_n \log c_n$, where μ_a, μ_n and $\bar{a}$ are non-negative parameters.

There should be no arbitrage possibilities in the labor and capital markets, which means that the household chooses the fraction of employment and capital for each sector so that the after-tax return is equated. In the case of employment, what needs to be equalized is the income of the family in a rural area and in an urban area[6]. Assuming that the cost per worker of living in an urban

[4]It has been argued that in Japan a very high fraction of farmers evade taxes.

[5]Each family is composed of 4 member, and for families who live in rural areas, 3 of those members work in the non-agricultural sector. Hence $3\left(1 - s_{et}\right) E_t$ persons work in the non-agricultural sector, but do no pay the cost.

[6]This is due to the fact that when the household decides to assign a worker to the agricultural sector, it also assigns 3 workers to non-agricultural sector in the rural area, where they do not pay the cost Φ_t. Hence, the appropriate comparison is not between wages in the two sectors, but between the income of a whole family in the rural area and a whole family in the urban area, which as we know by Hayami and Godo (2005), equate over the postwar period in Japan.

area is proportional to the non-agricultural wage, $\Phi_t = \phi_t w_{nt} h_{nt}$, s_{et} is chosen so that the following condition holds

$$w_{at} h_{at} + 3 (1 - \tau_{lt}) w_{nt} h_{nt} = 4 (1 - \tau_{lt} - \phi_t) w_{nt} h_{nt}. \tag{3}$$

For capital, s_{kt} is chosen so that in equilibrium the following condition is satisfied

$$r_{at} = (1 - \tau_{kt}) r_{nt} + \tau_{nt} \delta_t, \tag{4}$$

and we define r_t as this after tax rate.

The savings and consumption decision for the household deliver the following optimal conditions

$$\frac{\partial u(c_{at}, c_{nt})}{\partial c_{at}} = \frac{q_t}{\lambda_t}, \tag{5}$$

$$\frac{\partial u(c_{at}, c_{nt})}{\partial c_{nt}} = \frac{1}{\lambda_t}, \tag{6}$$

$$\lambda_{t+1} = \beta \lambda_t [1 + r_{t+1} - \delta_t], \tag{7}$$

where $1/\lambda_t$ is the Lagrange multiplier associated with the household's budget constraint. Given the Stone-Geary utility function presented above, equations (5) and (6) deliver the following two Frisch demand equations

$$c_a (q_t, \lambda_t) = \mu_a \frac{\lambda_t}{q_t} + \bar{a}, \tag{8}$$

$$c_n (\lambda_t) = \mu_n \lambda_t. \tag{9}$$

3.2 Firms

Firms rent capital and labor from the household and produce output which is sold back to the consumers. In order to stimulate the use of capital, the government provides a subsidy to the rental cost of capital, where the subsidy rates are π_{kat} and π_{knt} for agricultural and non-agricultural sectors respectively. The government further protects the interests of the agricultural sector by providing a subsidy on the price of their goods. The consumer pays a price q_t for the agricultural good, but the price received by the producer is $(1 + \pi_{qt}) q_t$.

3.2.1 Firm in the Agricultural Sector

A firm in the agricultural sector rents capital and hires labor to maximize its profits[7]. Therefore, every period the firm chooses $\{K_{nt}, L_{nt}\}$ to maximize

$$(1+\pi_{qt})q_t Y_{at} - (1-\pi_{Kat})r_{at}K_{at} - w_{at}L_{at}, \tag{10}$$

$$s.t. \quad Y_{at} = A_{at}K_{at}^{\alpha_a}L_{at}^{\eta}, \tag{11}$$

where Y_{at} is agricultural output; A_{at} is total factor productivity (TFP) in this sector; L_{at} is labor input of the firm, which is a combination of hours and employees; and $\alpha_a, \eta \in (0,1)$, with $\alpha_a + \eta < 1$.

The optimal conditions for this problem deliver the equilibrium factor prices

$$r_{at} = \frac{(1+\pi_{qt})}{(1-\pi_{kat})}\frac{\alpha_a q_t A_{at}K_{at}^{\alpha_a}L_{at}^{\eta}}{K_{at}}, \tag{12}$$

$$w_{at} = \eta\frac{(1+\pi_{qt})q_t A_{at}K_{at}^{\alpha_a}L_{at}^{\eta}}{L_{at}}. \tag{13}$$

3.2.2 Firm in the Non-Agricultural Sector

Similarly, a firm in the non-agricultural chooses $\{K_{nt}, L_{nt}\}$ to maximize

$$Y_{nt} - (1-\pi_{knt})r_{nt}K_{nt} - w_{nt}L_{nt} \tag{14}$$

$$s.t. \quad Y_{nt} = A_{nt}K_{nt}^{\alpha_n}L_{nt}^{1-\alpha_n}, \tag{15}$$

where Y_{nt}, A_{nt}, and L_{nt} are respectively, output, TFP and labor input in the non-agricultural sector; $\alpha_n \in (0,1)$.

The factor prices for this sector are found through the optimal conditions of the previous problem

$$r_{nt} = \frac{1}{(1-\pi_{knt})}\frac{\alpha_n A_{nt}K_{nt}^{\alpha_n}L_{nt}^{1-\alpha_n}}{K_{nt}}, \tag{16}$$

$$w_{nt} = (1-\alpha_n)\frac{A_{nt}K_{nt}^{\alpha_n}L_{nt}^{1-\alpha_n}}{L_{nt}}. \tag{17}$$

3.3 Government

The government collects lump-sum, labor and capital income taxes from the household, subsidizes the price of agricultural goods and the rental cost of capital for firms, and spends G_t units of

[7]The production function of the agricultural firms also includes land as a factor, but since it is assumed to be fixed it is not explicitly shown in the problem.

non-agricultural output as government expenditures. The government budget constraint, which is assumed to balanced every period, is as follows

$$\begin{aligned} & T_t + \tau_{lt} w_{nt} h_{nt} \left(1 - s_{et}\right) E_t + \tau_{kt} \left(r_{nt} - \delta\right) \left(1 - s_{kt}\right) K_t \\ & = \pi_{qt} q_t Y_{at} + \pi_{kat} r_{at} K_{at} + \pi_{knt} r_{nt} K_{nt} + G_t. \end{aligned} \tag{18}$$

3.4 Equilibrium

A competitive equilibrium, given a government policy $\{G_t, T_t, \tau_{lt}, \tau_{kt}, \pi_{qt}, \pi_{kat}, \pi_{knt}\}_{t=0}^{\infty}$, is a set of allocations for the household $\{c_{at}, c_{nt}, K_{t+1}, s_{et}, s_{kt}\}_{t=0}^{\infty}$ and for the firms $\{Y_{at}, Y_{nt}, K_{at}, K_{nt}, L_{at}, L_{nt}\}_{t=0}^{\infty}$, and a price system $\{q_t, w_{at}, w_{nt}, r_{at}, r_{nt}\}_{t=0}^{\infty}$, such that

- Agents optimize:
  - Given government policy and prices, the allocations solve the household's maximization problem, which solution is characterized by equations (3) to (7).
  - Given government policy and prices, the allocations solve the profit maximization of firms in each sector, solution characterized by equations (12), (13), (16) and (17).
- Markets clear:
  - Agriculture good:
$$Y_{at} = N_t c_{at}. \tag{19}$$
  - Non-agriculture good:
$$Y_{nt} - G_t = N_t c_{nt} + \left(s_{et} E_t - 3\left(1 - s_{et}\right) E_t\right) \phi_t w_{nt} h_{nt} + K_{t+1} - (1 - \delta) K_t. \tag{20}$$
  - Capital:
$$K_t = K_{at} + K_{nt}. \tag{21}$$
  - Labor:
$$L_{at} = h_{at} s_{et} E_t, \tag{22}$$
$$L_{nt} = h_{nt} \left(1 - s_{et}\right) E_t. \tag{23}$$
- Government has a balanced budget, as in equation (18).

3.5 Reduced Detrended Equilibrium

The equilibrium stated above is non-stationary since TFP in both sectors and population grow over time. We now define two trends, detrend the model and reduce it to a dynamic system of two equations.

Following Hayashi and Prescott (2008) we define $X_{Qt} \equiv A_{at}^{-1} (h_{at}E_t)^{-\eta} A_{nt}^{\frac{1-\alpha_a}{1-\alpha_n}} (h_{nt}E_t)^{1-\alpha_a}$ and $X_{Yt} \equiv A_{nt}^{\frac{1}{1-\alpha_n}} \frac{h_{nt}E_t}{N_t}$. X_{Qt} is the trend of the relative price of agriculture goods, q_t; X_{Yt} is the trend of the non-agricultural sector per-capita variables, and that of λ_t; and $\frac{X_{Yt}}{X_{Qt}}$ is the trend of the agricultural sector per-capita variables. Hence we can define the following detrended variables

$$\tilde{k}_t \equiv \frac{K_t}{X_{Yt}N_t},\ \tilde{y}_{nt} \equiv \frac{Y_{nt}}{X_{Yt}N_t},\ \tilde{c}_{nt} \equiv \frac{C_{nt}}{X_{Yt}N_t},\ \tilde{q}_t \equiv \frac{q_t}{X_{Qt}},\ \tilde{\lambda}_t \equiv \frac{\lambda_t}{X_{Yt}},$$

where

$$\tilde{y}_{nt} = \tilde{k}_t^{\alpha_n} (1 - s_{kt})^{\alpha_n} (1 - s_{et})^{1-\alpha_n}.$$

Similarly we can define

$$\tilde{q}_t\tilde{y}_{at} \equiv \frac{q_tY_{at}}{\frac{X_{Yt}}{X_{Qt}}N_t},\ \tilde{q}_t\tilde{c}_{at} \equiv \frac{q_tC_{at}}{\frac{X_{Yt}}{X_{Qt}}N_t},$$

where

$$\tilde{y}_{at} = \tilde{k}_t^{\alpha_a} s_{kt}^{\alpha_a} s_{et}^{\eta}.$$

Using these definitions into the equilibrium conditions, and plugging the factor prices into the Euler equation (7) and into the non-agricultural market clearing condition (20), we can reduce the equilibrium into a system of two equations in $\tilde{k}_t$ and $\tilde{\lambda}_t$:

$$\left(1 - \psi_t - \phi_t (1 - \alpha_n) \frac{1 - 4s_{Eat}}{1 - s_{Eat}}\right) \tilde{y}_{nt} \quad = \quad \frac{c_n\left(\tilde{\lambda}_t X_{Yt}\right)}{X_{Yt}} + \frac{N_{t+1}}{N_t}\frac{X_{Yt+1}}{X_{Yt}}\tilde{k}_{t+1} - (1-\delta)\tilde{k}_t, \quad (24)$$

$$\frac{X_{Yt+1}}{X_{Yt}}\tilde{\lambda}_{t+1} = \beta\tilde{\lambda}_t\left\{1 + \frac{1-\tau_{t+1}}{(1-\tau_{Knt+1})}\frac{\alpha_n\tilde{y}_{nt+1}}{(1 - s_{Kat+1})\tilde{k}_{t+1}} - (1-\tau_{t+1})\delta_t\right\}, \quad (25)$$

where $\psi_t \equiv \frac{G_t}{Y_{nt}}$.

The other variables of the model can be found using the equilibrium conditions once we have solved for $\tilde{k}_t$ and $\tilde{\lambda}_t$. In particular, we solve for $(s_{kt}, s_{et}, \tilde{q}_t)$ given $\left(\tilde{k}_t, \tilde{\lambda}_t, X_{Yt}, X_{Qt}\right)$ through the following three equations

$$\tilde{q}_t\tilde{y}_{at} \quad = \quad \frac{\tilde{q}_t c_a\left(\tilde{q}_t X_{Qt}, \tilde{\lambda}_t X_{Yt}\right)}{\left(\frac{X_{Yt}}{X_{Qt}}\right)}, \quad (26)$$

$$\frac{1-\tau_{kt}}{1-\pi_{knt}}\frac{\alpha_n\tilde{y}_{nt}}{(1-s_{kt})\,\tilde{k}_t}+\tau_{kt}\delta_t \quad = \quad \frac{1+\pi_{qt}}{1-\pi_{kat}}\frac{\alpha_a\tilde{q}_t\tilde{y}_{at}}{s_{kt}\tilde{k}_t}, \tag{27}$$

$$(1-\tau_{lt}-4\phi_t)\,(1-\alpha_n)\,\frac{\tilde{y}_{nt}}{(1-s_{et})} \quad = \quad \eta\,(1+\pi_{qt})\,\frac{\tilde{q}_t\tilde{y}_{at}}{s_{et}}. \tag{28}$$

4 Calibration and Simulation Procedure

To simulate the model, we need to provide values for the parameters of the model and for the exogenous variables. The complete description of the data can be found in the Data Appendix. The next subsections explain the calibration and describe the exogenous variables used in the simulations.

4.1 Calibration

We use Japanese data for the period between 1956 to 1990 to calibrate the model parameters. The period in the model is one year.

The discount factor, β, is chosen to match the capital-output ratio of the economy in the final period of the simulation, 1990, and set to $\beta = 0.963$.

The per period utility function is of the Stone-Geary type and has the form $u(c_a, c_n) \equiv \mu_a \log(c_a - \bar{a}) + \mu_n \log c_n$, where $\bar{a}$ is the agriculture good subsistence level. We calibrate the value of $\bar{a}$ to be the average of the agriculture good consumption from 1956 to 1990, and set it to $\bar{a} = 63.2$. Combining the two Frisch demand equations (8) and (9), we can obtain the following relationship between μ_a, μ_n and $\bar{a}$:

$$\frac{\mu_a}{\mu_n} = \frac{(c_{at}-\bar{a})q_t}{c_{nt}}. \tag{29}$$

We normalize $\mu_a + \mu_n = 1$ and given $\bar{a}$ we choose μ_a to satisfy (29) for the average between 1956 and 1980[8], and set it to $\mu_a = 0.0025$.

The parameters in the technology function of the two sectors are chosen as follows. First we set $\alpha_n = 0.33$, as in Hayashi and Prescott (2008). Then we calibrate α_a so that the no-arbitrage condition on capital (4) is satisfied over the sample period, and set it to $\alpha_a = 0.36$. Finally, we

[8]Note that since $\bar{a}$ is chosen to match the average food consumption between 1956 and 1990, we cannot set μ_a to match the average of this same period, since it would imply a value of zero.

calibrate η following Hayashi and Prescott (2008) and using data from Hayami et al. (1975) and set it to $\eta = 0.45$ by using the following condition

$$\eta = (1 - \alpha_a) \times \frac{land\ share}{labor\ share + land\ share}.$$

Table 1 summarizes the choice of parameter values.

Table 1: Model Parameters

$\beta = 0.963$	$\mu_a = 0.0025$	$\bar{a} = 63.2$
$\alpha_n = 0.33$	$\alpha_a = 0.36$	$\eta = 0.45$

4.2 Exogenous Variables

The variables that are exogenous in the model, and which path we feed in order to solve the model are: TFP in both sectors, A_{at} and A_{nt}; Population, N_t; aggregate employment, E_t; hours in each sector, h_{at}, h_{nt}; capital depreciation rate, δ_t; government expenditure share of output, ψ_t; labor and capital income tax rate, τ_{lt}, τ_{kt}; agricultural price subsidy rate, π_{qt}; firm's capital rental cost in both sectors, π_{kat} and π_{knt} ; and the fraction of wages devoted to pay cost of living in urban area, ϕ_t.

The sources and construction of these variables for the sample from 1956 to 1990 can be found in the Data Appendix. After the final year of the simulation, 1990, we assume that these variables remain constant at the 1990 level[9], as is done in other studies who use the perfect foresight shooting algorithm solution technique (i.e. Hayashi and Prescott, 2002 and 2008, Chen et al. 2007).

4.3 Simulation Procedure

In order to numerically solve the model, we follow Hayashi and Prescott (2002, 2008) and impose that the economy reaches a steady state far enough in the future. Then, starting from the conditions of the Japanese economy in 1956, we use a perfect foresight shooting algorithm to find the path of the variables in the model from this initial condition to the final steady state. This path is

[9]This assumption may seem extreme, since Japan enter a long recession in 1991 and it has been argued that at least TFP decline sharply for almost a decade (Hayashi and Prescott, 2002). However, the focus of the paper is on the long-run structural change and development of the Japanese economy and by the year 1990 that was clearly finalized. Moreover, recent data suggests that the Japanese economy and in particular TFP are growing again at a healthy rate. Hence since we do not aim to explain the Japanese Lost Decade, we abstract from this period and stop our simulation in 1990, assuming constant values for the exogenous variables after that year.

conditional on the evolution of the exogenous variables which are fed to the model and which were stated before[10].

5 Results

As explained in Section (2) the Japanese postwar structural change experience was characterized by a high output growth period, accompanied by a decrease in the share of employment in the agriculture and an increase the capital-labor ratio of the agricultural sector relative to that of the non-agricultural industries. Other facts about this period related to variables in the model, and against which we test our theory, were the decline in the share of capital in agriculture, the increase in overall capital-output ratio and the relatively slow movement of the relative price of agricultural goods with a fairly constant mean over the whole sample period.

We now proceed to explain the performance of the model in terms of the previous facts. Later we present the effects of the counter-factual experiments performed to understand the role of the different government policies in the postwar structural change.

5.1 Simulation Results

As we can see from Figure 3 (a)-(f), our model can predict the actual time series data of postwar Japanese economy reasonably well. In particular, the model is able to reproduce the evolution of the main macroeconomic variables as well as the variables of our focus, such as per capita GNP, capital output ratio, and employment share. Specifically, as can be seen in Figure 3 (a), the model captures well the rapid decline in the share of agricultural employment in the period prior to the first oil shock, followed by a slower decline after this event. As shown in Figure 3 (e), the model also reproduces the high output growth from 1956 to 1973 and its slowdown thereafter, although it slightly over-predicts the growth rate in the first part of the sample. The movements of the capital-output ratio (Figure 3 (d)), variable which in the data is fairly stable until 1970, then increases over the 1970s and stabilized again with the arrival of the 1980s, are also captured by our model, although the level is slightly higher than in the data.

For the other model variables of interest, such as the share of capital in agriculture shown in Figure 3 (b), the relative capital per worker across industries in Figure 3 (c) and the relative price of the agricultural good in Figure 3 (f), the model's prediction is less accurate. However, the model

[10]For more details on the simulation procedure see Appendix A of Hayashi and Prescott (2008).

is able to reproduce the overall downward or upward trends of these variables, and capture the changes in their levels from the mid 1950s to the end of the bubble period.

5.2 Effects of the Government Policies

We now show the results of the counter-factual experiments, where we change the values of the government policy instruments, leaving everything else the same, in order to study how crucial the different policies are in accounting for the evolution of the Japanese economy in this period.

The first counter-factual involves setting all the government subsidies on agricultural and non-agricultural sectors to zero, i.e. $\pi_{qt} = 0, \pi_{kat} = 0$, and $\pi_{knt} = 0$. As we can see in Figures 4 (a)-(f), the removal of these policies does not generate significant changes in the behaviour of most of the variables. However, we can observe that the agricultural employment share becomes slightly higher, both in the transition and in the long-run, than in the benchmark simulation. We can also see that the relative price of agricultural products substantially higher throughout the period, which seems to be a direct consequence of the removal of price subsidies and the cost increase in the capital utilization. These results indicate that, overall, subsidies affect the agricultural sector in a small measure, mostly by keeping prices low, but the aggregate impact is not necessarily large. We also perform policy simulations by sequentially setting each one of these subsidies to zero. However, we find that the overall impact of such policy changes are not significantly different from the results shown in Figure 4 (a)-(f).[11] The results of this counter-factual policy experiment may be seen as surprising results, since they seem to contradict many existing studies which point to the existence of serious inefficiencies in the Japanese economy generated by agricultural protection policies and the significance of industrial policies during the rapid growth era (Johnson, 1982, Kosai and Kaminski, 1986, and Hayami and Godo, 2002). Yet, as for the industrial policy, some researchers have argued that the mode in which the government intervened in Japan was through dialogue, persuasion, and signaling, since government-directed credits through FILP were less than ten percent of total loans made to industrial sector (Hayami and Godo, 2005). Komiya et al. (1998) also conclude that the contributions of industrial policies in Japan came from the sharing of information between the government and the private sector through dialogues in various committees and councils. The results of our paper are consistent with these views on Japan's industrial policy.

The second policy change we study is the inclusion of a government subsidy to help families in the urban areas with the cost associated with living there[12], Φ_t in the model. In particular

[11] These results are available upon request from the authors.

[12] While we are not aware that the Japanese government actively sought this policy, we perform this counter-factual

we perform a counter-factual experiment where the government covers a fraction of this cost. We set this fraction to be 30% of the cost. The results show an important decline in the share of agricultural employment, specially in the transition, although not in the long-run, but no significant change in behaviour of output or the capital-output ratio. In other words, while these costs are an important part of keeping workers in the agricultural sector, they do not improve the overall impressive performance of Japan in terms of output. The irrelevance of this subsidy in terms of changing the evolution of output, can be understood by looking at the behaviour of the share of capital in agriculture. Parallel to the lower employment share relative to the benchmark model, this subsidy produces an increase in the share of capital. This result hinges on two assumptions of the model. The first is Engel's law, which implies that there is so much agricultural good which needs to be produced. The second one is the free mobility of capital across sectors. With the inclusion of this subsidy, the household finds it optimal to assign less workers to the agricultural sector and produce the necessary food with more capital. Hence, for the non-agricultural output, which dominates GNP both in the data and in our model, there is an increase in labor input, but a decrease in capital, which leaves output and the capital output-ratio mostly unaffected.

Finally, we incorporate the key assumption that Hayashi and Prescott (2008) use to explain the delay in the Japanese miracle, namely the existence of a labor barrier that prevented workers from migrating out of agriculture. This barrier imposes a minimum number of workers in this sector of 14 million. Introducing this mobility friction in our model, results in a dramatic change in some of the variables. In particular, as would be expected, the share of labor in agriculture is much higher and decreases very slowly. However, as in the case of the subsidy to the cost of living in an urban area, this different evolution of the employment share is mirrored by an decrease in the share of capital in agriculture. In this case, since workers are not allowed to move out of agriculture, but the economy only needs a certain amount of food production, capital is shifted out of agriculture and into non-agricultural industries. In this case, however, the change in the evolution of output is significant. With substantially less workers in the non-agricultural sector, output grows fast, but less than in the benchmark case and this growth difference accumulates over time and becomes significant by the end of the sample. Therefore, our results may be seen as being consistent with those derived by Hayashi and Prescott (2008). With the barrier, Japan's postwar GNP growth would have been lower and the long-run level effect substantial. In other words, the elimination of the barrier can be seen as one of the important contributors of Japan's postwar economic miracle.

experiment to understand the effects of a policy of this type in the evolution of the economy.

6 Conclusions

In this paper, we extend the two-sector neoclassical growth model of Hayashi and Prescott (2008) to include government policies used by the Japanese government in the post World War II period, and study the structural change in Japan's postwar rapid economic growth. Our model is able to reproduce the actual time series data for the postwar Japanese economy reasonably well. Based on our model, three findings emerge from the policy simulations. First, price and investment subsidies on the agricultural sector and industrial policy in the form of the fiscal investment and Loan Program (FILP), have limited impact on the aggregate growth performance of Japan. Second, while a government subsidy to help families in the urban areas could have facilitated migration from agriculture to non-agricultural sector in the rapid growth era, such a policy would not have improved the overall performance of Japan. Finally, with the counter-factual labor migration barrier, Japan's postwar GNP growth would have been lower and the long-run level effect would have been substantial. In other words, the elimination of the barrier can be seen as one of the most important contributors to Japan's postwar economic miracle.

There are, however, two caveats of our study. First, while we believe that our policy simulations cover the major policy interventions in postwar Japan, there are other important interventions, such as other forms of industrial policy, i.e. special capital depreciation schemes (Ogura and Yoshino, 1988), and agricultural trade protection policies, which we do not consider. To integrate the latter in our model, we would need to extend the model to an open economy environment, since in a closed economy setting, we may not be able to evaluate the consequences of agricultural trade protection policies consistently. Second, we impose the assumption of exogenous TFP. While this exogeneity assumption delivers a close fit of our model to the data, it can be relaxed by endogenizing human capital investment in international technological transfers (Benhabib and Spiegel, 2005), considering firms' research and development decisions (Romer, 1990), or incorporating government's agricultural research and extension (R&E) activities (Rustichini and Schmitz, 1991). We leave the inclusion of these dimensions for future work.

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A Data

In this appendix, we describe sources and construction for the data employed in the analysis. Basically, we employ and extend the data set of Hayashi and Prescott (2008)[13] which compiled postwar data series for real GNP, its deflator, the size of working-age population, employment in agricultural and non-agricultural sectors, hours worked per week in the two sectors, and nominal private capital stock. The extensions we make to their data and the other variables used are explained below.

- K_{at} (agricultural capital stock): We extrapolate postwar agriculture capital stock data by the following procedure. 1956 to 1962, we extrapolate the data using agricultural real net capital stock in Long Term Economic Statistics (LTES). Specifically, we use their "net capital stock in agriculture in million yen, 1934-36 prices" in LTES, Vol.3, Table 3. From 1963 to 1970, we extrapolate the data using agricultural real gross capital stock in Ohkawa and Shinohara (1979) ("gross capital stock in agriculture in million yen, 1934-36 prices" in Ohkawa and Shinohara, 1979, Table A18). As for the data after 1971, we extrapolate the series using agricultural real net capital stock in the database called JIP2008, which is taken from RIETI's web page <http://www.rieti.go.jp/en/database/JIP2008/index.html>. This real net capital stock in JIP2008 is the sum of "rice, wheat production," "miscellaneous crop farming," "livestock and sericulture farming," and "agricultural services" (in million yen, 2000 prices) in JIP2008.

- A_{at} and A_{nt} (agricultural and non-agricultural TFP): We use the the production functions on both sectors (11) and (15), and data on output, capital, employment and hours in each sector to calculate the TFP as the Solow residual:

$$A_{at} = \frac{Y_{at}}{K_{at}^{\alpha_a} \left(E_{at} h_{at}\right)^{\eta}}\ ,\ A_{nt} = \frac{Y_{nt}}{K_{nt}^{\alpha_n} \left(E_{nt} h_{nt}\right)^{1-\alpha_n}}.$$

- δ (depreciation rate of capita): Data on the depreciation rate of capital is taken from Hayashi and Prescott (2002) database, which is downloadable from Fumio Hayashi's web page <http://fhayashi.fc2w Prescott1_data.htm>.

- C_{at} and C_{nt} (consumption of agriculture and non-agriculture goods): Nominal aggregate consumption is also taken from Hayashi and Prescott (2002) database. Since from the model,

[13] The dataset used for the 2006 working paper version of their paper can be found in Fumio Hayashi's website <http://fhayashi.fc2web.com/Hayashi-Prescott2.htm>.

$p_{at}C_{at} = p_{at}Y_{at}$, where $C_{at} \equiv N_t c_{at}$, nominal non-agricultural consumption can be calculated by $PC_t - p_{at}C_{at}$ where PC_t is nominal aggregate consumption.

- ψ_t (ratio between government consumption and non-agricultural value added): Nominal government consumption is taken from Hayashi and Prescott (2002) database. We divide this government consumption, G_t, by nominal non-agricultural value added, Y_{nt}, to derive the ratio, ψ_t.

- τ_{kt} (tax rate on capital income) and τ_{lt} (tax rate on labor income): Tax rates on capital and labor incomes are taken from Mendoza, Razin, and Tesar (1994) and its further update are extracted from Enrique Mendoza's web page <http://www.econ.umd.edu/~mendoza/pp/newtaxdata.pdf>.

- π_{qt} (subsidy rate on agricultural output price): Subsidy rate on output price in agricultural sector is based on the gap between the government's procurement and sales prices of rice. This price gap is further adjusted for transaction costs which is estimated by the absolute price gap in year 1988 to 2000. Then the adjusted price gap is multiplied by the proportion of rice controlled by the government. The government procurement prices are taken from Statistics on Rice Price (Beika Ni Kansuru Shiryo) of Food Agency (Shokuryo Cho) for the years 1951 to 1992. The sales price is from the Statistics on Rice Price (Beika Ni Kansuru Shiryo) of Food Agency for the years 1966 to 1992. Data on the shares of government controlled rice is from the statistical appendix of White Paper on Agriculture (Shokuryo Nogyo Nouson Hakusyo Sanko Tokei Hyo) for 1960 to 1995.

- π_{kat} (subsidy rate on agricultural capital investments): Subsidy rate on capital investment in agricultural sector is derived from dividing total amount of capital subsidies by a product of the return on capital and capital stock of the agricultural sector. For the total amount of capital subsidies, we employ direct capital subsidy transfers in the agricultural sector extracted from the Social Accounting of Agriculture and Farmers, Ministry of Agriculture, Forestry, and Fishery, for the fiscal years Showa 37 (1962), Showa 50 (1975), Showa 55 (1980), Showa 60 (1985), Heisei 2 (1990), and Heisei 7 (1995).

- π_{knt} (subsidy rate on agricultural capital investments): We employ the interest rate subsidy rate through the Fiscal Investment and Loan Program (FILP) to proxy for the interest rate subsidy rate in the non-agricultural sector. Time series data on the subsidy rate is taken from Ogura and Yoshino (1988) and Cargill and Yoshino (2003).

- ϕ_t (fraction of wages devoted to living cost in urban area): ϕ_t is obtained from the equalization of incomes for families in rural and urban areas, equation (3)

$$w_{at}h_{at} + 3\left(1-\tau_{lt}\right)w_{nt}h_{nt} = 4\left(1-\tau_{lt}-\phi_t\right)w_{nt}h_{nt},$$

which implies

$$\phi_t = \frac{1}{4}\left(1-\tau_{lt}-\frac{w_{at}h_{at}}{w_{nt}h_{nt}}\right).$$

Figure 1: Japan's Postwar Experience

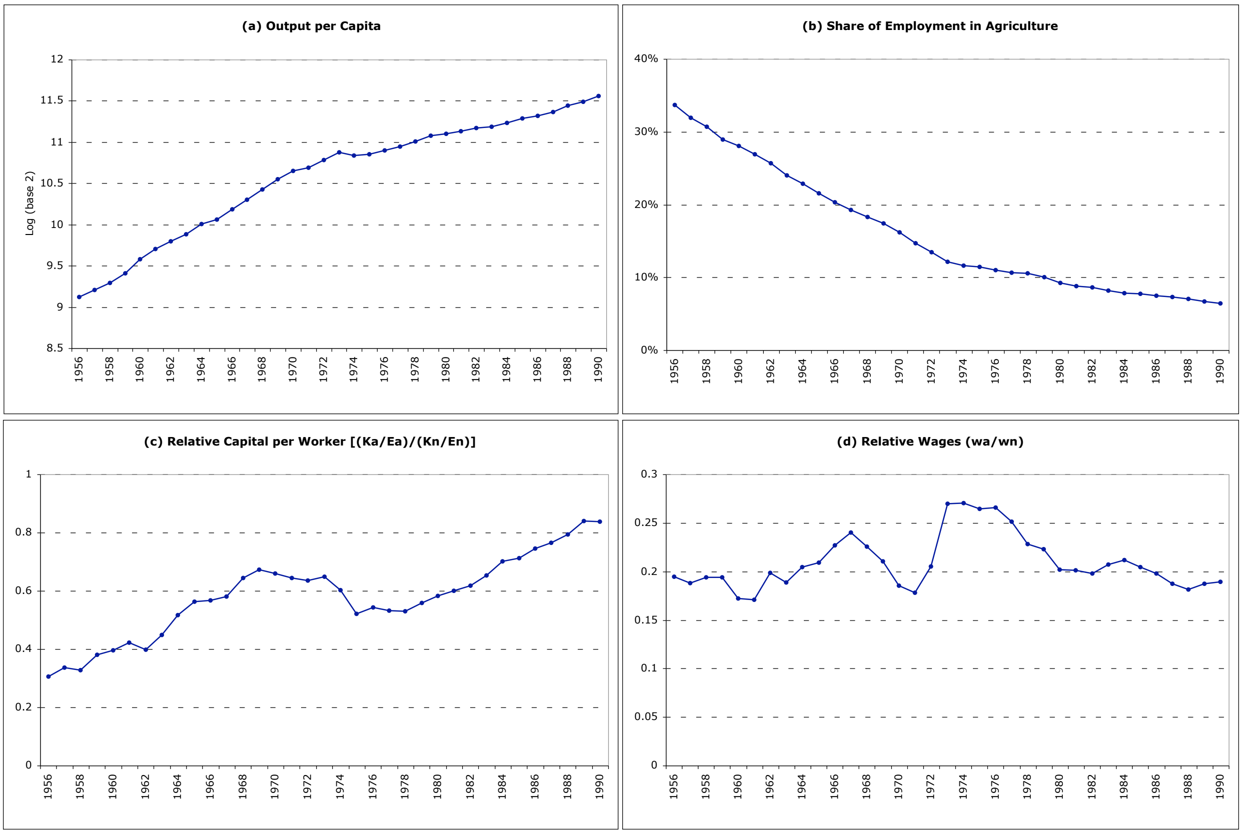

Figure 2: Evolution of Total Factor Productivity

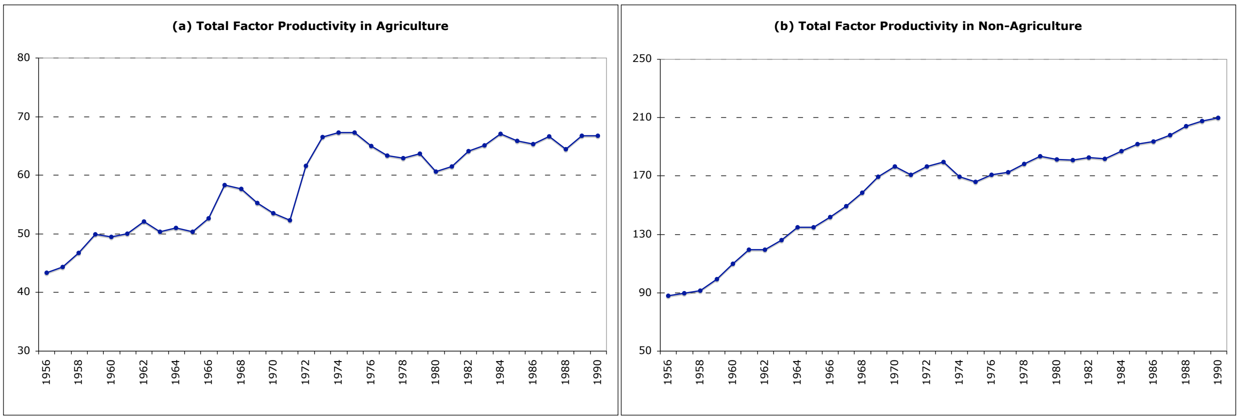

Figure 3: Benchmark Model Simulation Results

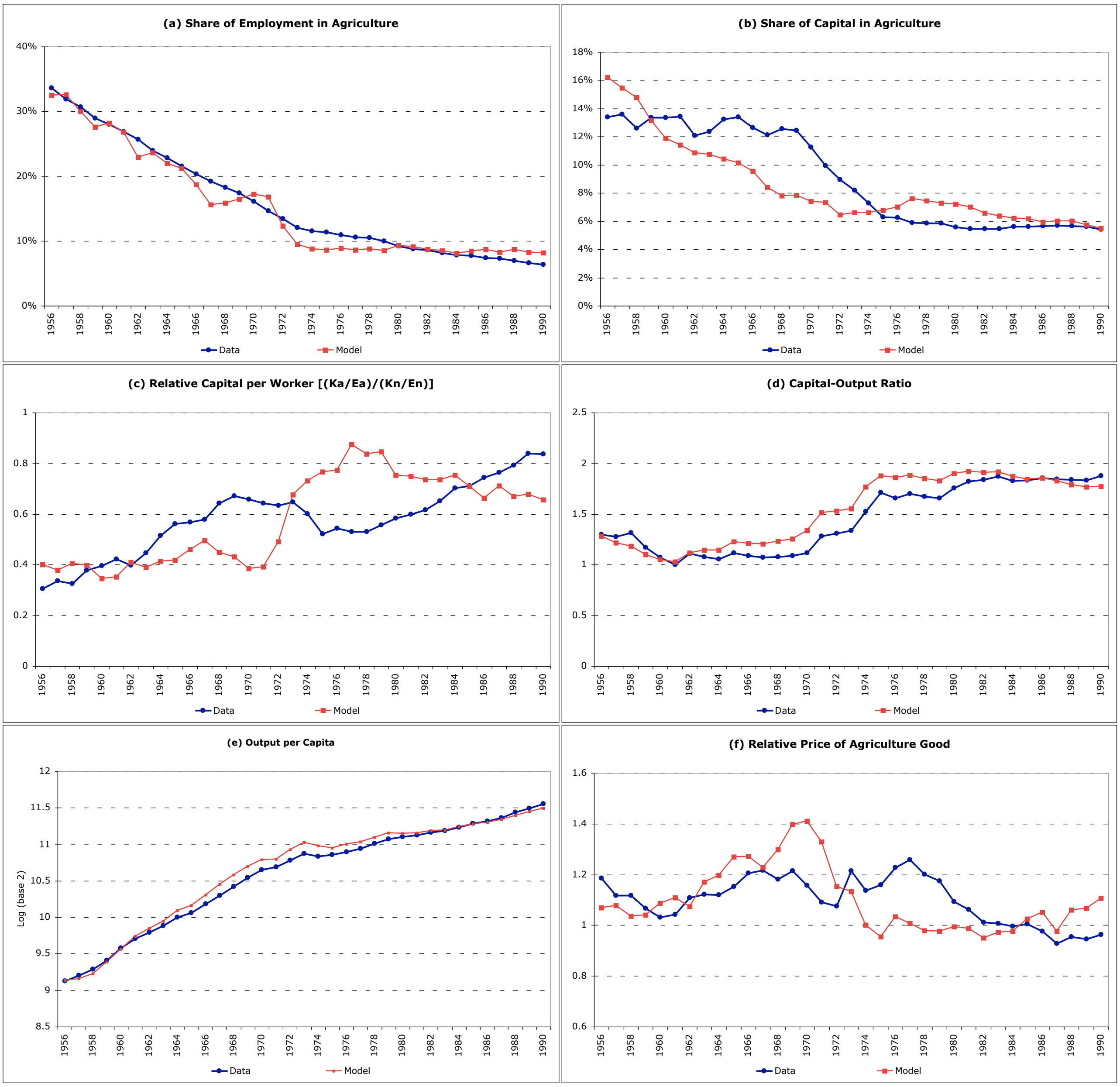

Figure 4: Policy Counter-Factuals Simulation Results