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ABSTRACT

The Farm, the City, and the Emergence of Social Security*

In this paper we study the social, demographic and economic origins of social security. The data for the U.S. and for a cross section of countries make it clear that urbanization and industrialization are strongly associated with the rise of social insurance. We describe a model economy in which demographics, technology, and social security are linked together. We study an economy with two locations (sectors), the farm (agricultural) and the city (industrial). The decision to migrate from rural to urban locations is endogenous and linked to productivity differences between the two locations and survival probabilities. Furthermore, the level of social security is determined by majority voting. We show that a calibrated version of this economy is consistent with the historical transformation in the United States. Initially a majority of voters live on the farm and do not want to implement social security. Once a majority of the voters move to the city, the median voter prefers a positive social security tax. In the model social security emerges and is sustained over time as a political and economic equilibrium. Modeling the political economy of social security within a model of structural change leads to a rich economic environment in which the median voter is identified by both age and location.

JEL Classification: H55, H3, D72

Keywords: social security, political economy, structural change, migration

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1 Introduction

In the United States, the 19th and early 20th centuries were characterized by a movement from a primarily rural and agricultural economy to a primarily urban and industrial economy. Figure 1 shows the geographic distribution of the U.S. population between 1800 and 1940.[1] In the beginning of the 19th century 94% of the population was living in rural areas. By 1940 the share of population living in rural areas was only 43.5%, while the share living on the farm was only 23%. Coincident with this immense shift in the structure of the economy came changes in the institutional needs of the population. The sorts of social care arrangements that were common place on the farm were harder to implement and enforce in the city, and the shifting population gave rise to new political coalitions with disparate views on social policy. Many prominent accounts of changing institutions of this period, e.g. Wiebe (1967), Sass (1997) and Schieber and Shoven (1999), emphasize the critical role that urbanization and industrialization played in the creation of new institutions: "The willingness of the U.S. to finally go the route of so many other countries in adopting a national social insurance program in 1935 was the result of three major forces. The first was the increased dependence on wage income that had arisen over the preceding half-century as the country had industrialized," (Schieber and Shoven 1999, page 17). Indeed, the Social Security Administration (2003) characterizes the year 1920 as "a historical tipping-point. In that year, for the first time in our nation's history, more people were living in cities than on farms."

In this paper, we propose that the rural (agricultural) to urban (industrial) shift is one possible explanation for the emergence of social insurance, more specifically, social security. There is a significant literature on the political economy of social security systems that analyzes the political sustainability of Pay-as-you-go (PAYG) social security.[2] The conclusion

[1] Appendix A provides data sources for all figures.

[2] There also exists a large literature that analyzes macroeconomic and distributional implications of the current social security system without political economy considerations (e.g. Imrohoroglu, Imrohoroglu and Joines 1985).

of most of this literature is that support for social security in democratic societies depends on the age of the median voter.[3] These papers are oriented toward explaining why an existing system can survive, expand or shrink.[4] They cannot address why such a system was started in the first place, or more precisely, why such systems have not always existed.[5] By allowing the identity of the median voter to include his geographical location, we overcome this shortcoming and provide a framework in which the emergence of social security is a response to the urbanization of the population.

The effects of urbanization and industrialization on social insurance has long been recognized by political scientists and sociologists. What are referred to as the prerequisites and the logic of industrialism explanations of the emergence of social security give prominent roles to urbanization and industrialization. According to Collier and Messick (1975, page 1303), "The prerequisites approach treats the development of social security as a result of the social and economic transformations associated with the transition from primarily agricultural to industrial economies. Within this perspective, one of the most important hypotheses is that the decline in the proportion of the workforce in agriculture increases the need for social security".[6] Figure 2 shows the level of urbanization and the fraction of the elderly (65+) population across U.S. states in 1930. About 23 states (those encircled) introduced a state pension plan before the 1935 Social Security Act. Of those, 18 states had

[3] Cooley and Soares (1999), Galasso (1999), and Boldrin and Rustichini (2000) build models in which non-altruistic median voters decide to keep an existing system. The median voter's decision depends on two factors in these models: First, there exists a reputational mechanism in place which eliminates all future benefits if the median voter deviates from the current arrangement. Therefore, a median voter cannot avoid taxes today and hope to get benefits in the future. Second, the median voter might want to keep an existing social security system in order to benefit from the high interest rates associated with a depressed capital stock.

[4] For example, Cooley and Soares (1996) study an economy in which the initial generation votes over a social security replacement rule that depends on the age structure of the population. Hence, as the population structure changes (e.g. as a result of the Baby Boom) a rule that was sustainable in the past can become unsustainable. Gonzalez-Eiras and Niepelt (2005) link the size of intergenerational transfers to the age structure of the population. Conesa and Krueger (1999) study how the status-quo bias is related to idiosyncratic uncertainty.

[5] Krueger and Kubler (2005) study how the introduction of an unfunded social security system can be Pareto improving in an economy with incomplete markets.

[6] Also, see Pryor (1968).

an urbanization rate higher than the U.S. average. The correlation between the fraction of elderly population and state pensions is also positive but smaller than that for urbanization (only 65% of states with higher than average elderly population had adopted pension plans). Although this picture provides only suggestive evidence, the basic relation seems to hold up to empirical scrutiny. Amenta and Carruthers (1988) look at the timing of old age pension plan adoption among U.S. states. They find a statistically significant effect of urbanization on the passage of old age pension plans. More compelling is that the relationship remains in cross-country data. Figure 3 shows the correlation between the fraction of the labor force in agriculture at the start of the 20th century and the date in which a social security system was introduced among European countries. Clearly, a larger labor force in agriculture is associated with later adoption. Kim (2001) investigates the timing of old-age pension adoption across O.E.C.D. countries in more detail and finds that the percent of labor not employed in agriculture is strongly associated with the adoption of old-age pensions.

What were the economic and demographic forces that led to this shift from rural to urban population? One obvious answer to this question is the increase in the city wage relative to the farm wage that arose from greater technical change in the city relative to the farm. GDP per person employed increased by a factor of 3.5 in the U.S. between 1870 and 1940 (Maddison 2001). While productivity in both the agriculture and the non-agricultural sectors grew rapidly during this period, the growth in non-agricultural sectors was faster than the growth in agriculture, leading to the transformation of the U.S. economy (see Greenwood and Seshadri 2002 and Greenwood and Uysal 2005). Figure 4 shows the change in total factor productivity (TFP) in agricultural and non-agricultural sectors in the U.S. Between 1800 and 1940, TFP grew by a factor of 1.92 in agriculture, while it grew by a factor of 4.21 in manufacturing.

Another possible impetus for rural-urban migration is the increase in life expectancy that took place over this time period. As life expectancy increased, two important changes occurred in the agricultural sector. First, the amount of farm labor relative to farm land rose, causing farm wages to fall. Second, as farmers lived longer, the transfer of land ownership via inheritance was delayed. Both events increased the relative attractiveness of living in the city for farmers, and encouraged rural-urban migration. Of crucial importance for this story is not that life expectancy at birth increased, but that life expectancy conditional on reaching or getting near retirement age increased. Figure 5 shows the changes in conditional survival probabilities from age 60 to 65, from 65 to 70, from 70 to 75, and from 75 to 80. Survival probabilities increased by about 5 percentage points between 1850 and 1900, and by another 2 percentage points between 1900 and 1940.

We propose a model economy in which structural transformation from a rural to an urban economy is modeled together with a political process that determines a social security system. In our model, the emergence of social security is intertwined with social changes, demographics, and technology. We merge two literatures: the political economy of social security and structural change (e.g. Laitner 2000 and Hansen and Prescott 2002). This allows us to study the set of demographic, social, and economic conditions that give rise to an economy without social security and the changes that could eventually lead to the introduction of publicly managed old age security. We argue that this major structural shift is important for thinking about the introduction of social security because the rural/urban shift has implications for the provision of income for those who survive to old age.[7] As people migrate from the farm to the city, they can no longer rely on land as a source of old-age security, and political support for social security increases.

We study an overlapping generations economy with two sectors, which we interpret as agricultural and industrial. Farm production requires capital, labor and land. Land is a fixed factor, so there are decreasing returns to labor. City production on the other hand requires capital and labor and exhibits constant returns to scale.[8] Agents in this economy live up to

[7] Although the Great Depression is often considered as a major force behind the social security legislation in the U.S., its effects are far from clear. Miron and Weil (1998) conclude their study on the origins of social security by stating that: "Regarding the lasting impact of the Great Depression, our conclusion is that there were surprisingly little." (page 321). On the macroeconomic effects of Great Depression, see Cole and Ohanian (2004).

[8] Hansen and Prescott (2002) model the industrial revolution as a switch from a (Malthus) production technology with a fixed factor of production, land, to a (Solow) production technology, with no fixed factors. Parente and Prescott (2005) use a similar framework to study the evolution of international income levels

three periods, as young, middle aged and old. They face an exogenous probability of dying at the end of the second period of their lives. Land is passed from one generation to another by inheritance. Each period young agents make a once and for all decision about where to live.[9] There is also a social security system that taxes the young and the middle aged and pays transfers to the old. The level of social security taxes is determined by majority voting.[10] In the initial steady state of this economy the relative productivity of the farm sector is high and survival probabilities are low. As a result, farm incomes are high relative to city incomes. All agents live on the farm, and land is an important source of income for the old. The median voter is a middle-aged farmer who prefers a zero social security tax. When the city becomes more productive, people start migrating, and the importance of land diminishes. Eventually, the median voter becomes a middle-aged city worker who prefers a positive social security tax. While the framework is relatively simple, it leads to a rich political economy environment. The identity of the median voter is not just age, but also location, which turns out to be critical for generating the emergence of social security. This is achieved by merging the structural transformation from farm to city with the political economy of institutions, in this case social security.[11]

In the next section we describe the economic environment. In Section 3 we discuss the economic equilibrium, given an exogenous political process. In Section 4 we describe how

since 1750. Laitner (2000) study a two-good, two-sector model in which, like Hansen and Prescott (2002), only the agricultural sector uses land. He studies why saving rate increases with development. Other well-known models of structural change are Echevarria (1997) and Kongsamut, Rebelo and Xie (2001). Greenwood and Seshadri (2002) and Gollin, Parente and Rogerson (2002) model the shift of labor from agriculture to manufacturing, and the associated pattern of rural to urban migration, that is associated with process of economic development.

[9] Among recent models with an explicit location decision see Vandenbroucke (2008), Hassler, Rodríguez Mora, Storesletten and Zilibotti (2005), and Klein and Ventura (2006).

[10] The current paper follows the recent literature on dynamic models of political economy; see among others Krusell, Quadrini, and Ríos-Rull (1997), Krusell and Ríos-Rull (1999), Hassler, Rodríguez Mora, Storesletten and Zilibotti (2003), and Corbea, D'Erasmo and Kuruscu (2008).

[11] Graziella (2006) studies the long run decline in the importance of bequest taxes within a two-sector (agriculture and manufacturing) dynamic political economy model. In her model, land is easier to tax than capital. The decline of agriculture, which reduces the value of land, makes bequest taxes an unattractive option over time. Galor, Moav and Vollrath (2008) study the effects of the concentration of land ownership on human capital accumulation and growth within a political economy model.

taxes are determined. We provide some analytical results for a simplified version of the model in Section 5. In Section 6 we describe the results of our simulations. We conclude in Section 7.

2 Environment

Consider the following one-good, two-sector overlapping generations model. In the first sector (or location), which we will call the *farm*, labor, capital and land are combined to produce output. In the second sector (or location), which we call the *city*, the same good is produced using only labor and capital.

Agents live a maximum of 3 periods, which we refer to as young, middle-aged and old, and face a probability, π, of surviving from the second to the last period. The objective of a young person is to maximize

$$U(c_y, c_m, c_o) = u(c_y) + \beta u(c_m) + \beta^2 \pi u(c_o), \tag{1}$$

where c_i, $i \in \{y, m, o\}$, denotes age-i consumption, and u is continuous, strictly increasing and strictly concave.

Each period every middle-aged person has a child who is born into the same location. When an agent is born on the farm, he makes a once-and-for-all decision to stay there or move to the city. Those who are born in the city are not allowed to move to the farm. The middle-aged and old agents can't change their locations.[12] Let the fraction of young, middle-aged and old agents who live on the farm be denoted by λ_y, λ_m and λ_o, respectively.

In both locations young, middle-aged and old all inelastically supply one unit of labor.[13] Each agent is born without any assets (capital or land) and is endowed with location dependent efficiency units ε_i^j, $j \in \{f, c\}$ and $i \in \{y, m, o\}$. Since only a frac-

[12] The vast majority of migration from the farm to the city consisted of young workers. (Schieber and Shoven (1999), p. 18, and U.S. Bureau of the Census (1975), pp. 139, 465)

[13] We therefore abstract from the rise in retirement (i.e. decline in the labor force participation of old) since 1850s. See Kopecky (2005) for a model with endogenous retirement that links this rise to the technological progress in the production of leisure goods.

tion π of middle-aged people survive to old age, the total labor supply on the farm is given by $N^f = \lambda_y \varepsilon_y^f + \lambda_m \varepsilon_m^f + \lambda_o \varepsilon_o^f \pi$ and the total labor supply in the city by $N^c = (1-\lambda_y)\varepsilon_y^c + (1-\lambda_m)\varepsilon_m^c + (1-\lambda_o)\varepsilon_o^c \pi$.

Each period, agents are located either in the city or on the farm and can only work in that sector. There is a competitive labor market in each location. Let w^j denote the wages in sector j. Then, the labor income of an age-i agent in location j is $w^j \varepsilon_i^j$ for $i \in \{y, m, o\}$ and $j \in \{f, c\}$.

People are not allowed to borrow, but can accumulate capital and rent it to firms in either sector at a competitive rate, ρ. Capital moves costlessly between the farm and the city, so let $r = \rho - \delta$ be the common rate of return to capital, where $\delta \in [0, 1]$ is the common rate of capital depreciation. There is no market in which agents can buy and sell land. On the farm, when an agent dies (at the end of the second or third period), his land is inherited by the oldest surviving descendant. Therefore, a fraction of the land is owned by the $\pi\lambda_o$ surviving old, and the remainder is owned by the $(1-\pi)\lambda_m$ middle-aged who inherited land early. We normalize the total amount of land to 1, so each landholding farmer has $\frac{1}{\pi\lambda_o + (1-\pi)\lambda_m}$ units of land. Farmers rent their land to firms at a competitive rate q.

In a similar fashion, in both locations some middle-aged agents receive accidental capital bequests from their parents. As a result, middle-aged agents differ in their asset and land holdings on the farm, while they only differ by their asset levels in the city. If a young farmer chooses to move to the city, he gives up all claims on his parent's land, and that land, upon his parent's death, is divided equally among the remaining land owners. However, he still receives any accidental bequest his parent might leave, as we assume capital can freely move between the farm and the city.

Each sector is populated by a large number of production units (family farms in the agricultural sector and factories in the city sector) which have access to constant returns to scale production functions represented by

$$Y^f = \gamma^f F^f(K^f, N^f, L), \tag{2}$$

and

$$Y^c = \gamma^c F^c(K^c, N^c), \tag{3}$$

where variables Y^j, K^j, N^j and L, $j \in \{f, c\}$, refer to output, capital, and labor employed in each sector, and land used in the farm sector, respectively. The parameter γ^j, $j \in \{f, c\}$, is the total factor productivity (TFP) in sector j. Land is a fixed factor and used only in the farm sector. We normalize the stock of land to one, $L = 1$.

Given the wage rate in sector j, w^j, the rental rate for capital, ρ and the rental rate for land, q, the problem of a production unit in the farm sector is given by

$$\max_{N^f, K^f, L} \left\{ Y^f - w^f N^f - \rho K^f - qL \right\},$$

subject to (2), and in the city sector by

$$\max_{N^c, K^c} \left\{ Y^c - w^c N^c - \rho K^c \right\},$$

subject to (3).

Finally, there is an economy-wide social security system that collects a lump-sum tax, τ, from the young and the middle-aged and provides each old with an amount $2\tau/\pi$. The level of social security taxes are determined by majority voting in a way we detail below.

Discussion The model economy captures key features of the 19th century farm economy. First, the old in the 19th century had relatively more wealth than the old in the 20th century and land as an illiquid asset provided an important source of income and wealth for the elderly. In 1850, those 60 years or older had about three times as much real estate wealth as the 30-39 age group (see Williamson and Lindert 1980, Table 1.7) and an analogous picture emerges for total wealth in 1870 (see Soltow 1992, Table 3.2). It is therefore not surprising that Schieber and Shoven (1999) conclude that the over-65 age cohort controlled more wealth than any other group in the early 19th century.[14]

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[14] Rubinow (1913, pages 302 and 304-305) also notes that "The authority of the patriarch is paramount and lasts longer than his productive powers."

Second, inheritance, and in particular inheritance of land, played a key role in wealth accumulation. According to Soltow (1982) inheritance was the determining factor of wealth inequality in the U.S. during the 19th century. Inheritance was a much more significant factor than life-cycle savings in explaining the relationship between age and wealth in the U.S. in 1870. Moreover, land was the most important form of inheritance in the 19th century. In his study of Butler County (Ohio), Newell (1986) documents that for the 1803-1865 period, inheritance consisted almost exclusively of real property. Third, the farm population consisted mainly of workers and owner-farmers. Renting the land to others was not common. According to Yang (1992), about 90% of farmers were owners in 1860.[15] Finally, according to Greven (1970) and Newell (1986), inheritance was the main way to acquire land in settled areas.

In the model people on the farm wait until their parents' death to obtain land through inheritance, and land is a critical part of agents' life-cycle income profiles. Young and middle-age workers without land look forward to inheriting land when old and therefore see little need for other savings vehicles. As Sass (1997, page 5) points out "The family enterprise institution also vested the old with powerful property rights vis-a-vis their adult children. Elderly parents held first claim on the firm and its assets, while their offspring remained dependent for their incomes and inheritance... parents retained ownership over the main body of family assets and chose when they would transfer farms and businesses to their children." In the city, without land, the old are left to survive on wage income and savings from that income alone. In this scenario, social security can provide middle-aged-city voters with a relatively high return.

Before we move to a more detailed description of the economic environment and decisions, a few caveats are in order. First note that arrangements where the young and the middle-aged-landless farmers pay the landholder of the family to gain control over the land when the landholder dies would yield equivalent results to forced land bequests as long as the return to land is greater than the return to social security for the landless-middle-aged farmer, $2/\pi$.

[15] Even at the end of the 19th Century, most farmers were owners, see Barlowe and Timmons (1950).

Note also that it is possible to relax the assumption that young farmers who migrate lose all claims to land. Once these original migrants inherit and sell their land, their offspring will no longer have any land claims. As a result, this modification would delay the onset of social security at most a generation. Finally, since we abstract from population growth, it is also quite natural to treat land as a fixed factor in the model. Although large tracks of land were available in the West, the main impetus for East-West migration was the population pressure in the East. Indeed, creating productive land was quite expensive and these costs were only incurred due to population pressure (see Vandenbroucke, 2008).

3 Economic Equilibrium

At any point in time, the aggregate state in this economy consists of the distribution of capital across agents, the distribution of agents across the city and the farm, the last period's tax rate, and an indicator variable of whether or not the introduction of social security was ever optimal for a median voter in the past. The role of this indicator function will become clear once we define the political equilibrium below. In this section, we assume that agents take the political state as given.

Since agents are born without any capital, capital is owned by the middle-aged and the old. Furthermore, because they make different decisions, it is convenient to differentiate between the asset distribution of landed- and landless-middle-aged farmers. We represent the distribution of capital across old city and farm residents by ψ_o^c and ψ_o^f, and middle-aged city residents and farmers by ψ_m^c and $\psi_m^{f\kappa}$ with $\kappa = 1, 0$ indicating whether a middle-aged farmer is landed, $\kappa = 1$, or landless, $\kappa = 0$. In what follows we use $\Psi = (\psi_m^c, \psi_o^c, \psi_m^{f1}, \psi_m^{f0}, \psi_o^f)$ to represent the set of distributions. We represent the distribution of agents between the two locations, city and farm, by $\Lambda = (\lambda_y, \lambda_m, \lambda_o)$ where λ_j is the fraction of age-j agents who live on the farm. Finally, we use $S = (\Psi, \Lambda, \tau_{-1}, h)$ to represent the aggregate state, where τ_{-1} is last period's social security tax, and h is an indicator of whether or not the introduction of social security was ever optimal for a median voter in the past. If $h = 1$ it was, if $h = 0$, it wasn't.

We represent the evolution of the aggregate state by three separate functions. First, we let $\Psi' = G(S)$ represent next period's asset distribution given the current state S. Second we let $\Lambda' = H(S)$ represent next period's distribution of agents across locations. In this section we describe the recursive competitive equilibrium given an exogenous policy rule that determines the current social security tax rate and updates the history h. In particular, we assume that the social security tax level for the current period, τ, and the history indicator for the next period h', are given by $(\tau, h') = P(\Psi, \Lambda, \tau_{-1}, h)$, and agents take the policy rule P as given when making their economic decisions. Note that a system with a social security tax τ that never changes is trivially defined by $(\tau, 1) = P(S)$ for all S. Let $P_\tau(S)$ represent such a system. Once we define a recursive competitive equilibrium for a given P and show how G and H are determined, we describe how P is determined by the political process.

3.1 City Problem

We start by describing the economic problem of agents in the city. We approach agents' problems recursively, starting from the problem of an old agent, whose state consists of the aggregate state, $S = (\Psi, \Lambda, \tau_{-1}, h)$, and his individual asset level a. An old agent in the city has three sources of income: labor income $w^c \varepsilon_o^c$, asset income ra, and social security income $\frac{2\tau}{\pi}$. Let $V_o^c(a, S)$ denote the value of being an old person with asset level of a. Since the old will simply consume their total resources, this is given by

$$\begin{aligned} V_o^c(a,S) &= u(w^c \varepsilon_o^c + (1+r)a + \frac{2\tau}{\pi}), \\ s.t.\ (\tau, h') &= P(S) \end{aligned} \tag{4}$$

where for expositional clarity we suppress the dependence of w^c and r on aggregate state S.

Next, we look at the decisions of middle-aged agents. Unlike the old, the middle-aged agents do not receive any social security payments, and they have to pay social security taxes. They also have to decide how much to save for their old age. Their decisions are determined by

$$
\begin{aligned}
V_m^c(a,S) &= \max_{a'} \left\{ u(w^c \varepsilon_m^c + (1+r)a - \tau - a') + \beta\pi V_o^c(a',S') \right\}, \qquad (5) \\
s.t.\ S' &= (G(S), H(S), P(S)),
\end{aligned}
$$

where next period's asset distribution, Ψ', and next period's distribution of agents between the two locations, Λ', are determined by transition functions $G(S)$ and $H(S)$, while the current tax rate τ is determined via $P(S)$. Let $a_m^c(a,S)$ denote the savings decision of a middle-aged-city person with individual asset level a that results from problem (5).

Finally, we consider the decisions of the young agents who are born in the city. They are born with no assets. They might, however, get an (accidental) bequest next period if their parent does not survive to old-age. Let $b(a,S)$ denote the bequest a young agent *expects* to get if his middle-aged parent has assets, a, and dies before reaching old age. The problem of a young agent is then given by

$$
\begin{aligned}
V_y^c(b(a,S),S) &= \max_{a'} \{ u(w^c \varepsilon_y^c - \tau - a') + \beta\pi V_m^c(a',S') \qquad (6) \\
&\quad + \beta(1-\pi) V_m^c(a' + b(a,S), S') \}, \\
s.t.\ S' &= (G(S), H(S), P(S)).
\end{aligned}
$$

Note that a young agent will get b only if his parent dies and that happens with probability $1-\pi$. Note also that the asset levels of middle-aged agents provides enough information to determine next period's asset choices since it determines both the middle-aged as well as the young agents' savings decisions. Let $a_y^c(b(a,S),S)$ be the savings decisions of a young agent who expects to get $b(a,S)$ as a bequest next period.

3.2 Farm Problem

The problem of an old agent on the farm is similar to the old agent's problem in the city, except the old farmer earns land income. His problem is given by

$$
\begin{aligned}
V_o^f(a,S) &= u\left(w^f\varepsilon_o^f + (1+r)a + \frac{q}{\pi\lambda_o + (1-\pi)\lambda_m} + \frac{2\tau}{\pi}\right), \\
s.t.\ (\tau, h') &= P(S) \qquad (7)
\end{aligned}
$$

where $\frac{1}{\pi\lambda_o+(1-\pi)\lambda_m}$ is the per capita amount of land on the farm, and as in equation (4), we suppress the dependence of prices, including q, on S.

The problem of middle-aged agents on the farm is similar to that of those in the city. The only difference is that the middle-aged farmers differ in land-holding status. They are either landed or landless. The middle-aged farmer's problem can be written, for $\kappa = 0, 1$, as

$$
\begin{aligned}
V_m^{f\kappa}(a,S) &= \max_{a'}\{u\left(w^f\varepsilon_m^f + (1+r)a + \frac{q\kappa}{\pi\lambda_o + (1-\pi)\lambda_m} - \tau - a'\right) \qquad (8) \\
&\quad +\beta\pi V_o^f(a', S')\}, \\
s.t.\ S' &= (G(S), H(S), P(S)).
\end{aligned}
$$

Let $a_m^{f\kappa}(a,S)$ be the decision rule for middle-aged farmers. Note that a middle-aged farmer who survives to the next period may have a different level of land holdings than he has today. Land per farmer may change due to migration, since migration alters the distribution of agents across locations, which is captured by $\Lambda' = H(S)$.

When considering the young farmer's saving decision, we need to do so jointly with his location decision. Some young farmers may stay on the farm, and some young farmers may move to the city. Their savings decisions will depend on where they choose to live. First consider a young farmer who stays on the farm. If his parent dies next period, he will receive an accidental bequest. The amount will depend on his parent's assets. He might also receive land if his parent is a land-holder. Hence, a young agent's decisions will depend on the land holding status of his parent as well. Therefore, although the young do not own any capital or land, we label them with their parents' asset and land holding status. In particular, let $b^\kappa(a,S)$ denote the capital bequest that a young agent expects to get from his parent who has a units of assets and land holding status $\kappa = 0, 1$. Then, a young agent who decides to stay solves

$$
\begin{aligned}
V_y^{f\kappa s}(b^\kappa(a,S),S) &= \max_{a'}\{u(w^f\varepsilon_y^f - \tau - a') + \beta\pi V_m^{f0}(a',S') + \\
&\quad \beta(1-\pi)V_m^{f\kappa}(a' + b^\kappa(a,S),S')\}, \\
s.t.\ S' &= (G(S),H(S),P(S)).
\end{aligned} \tag{9}
$$

Note that if his parent survives, with probability π, then the agent is landless and only has his own savings. If, on the other hand, his parent dies, then he will get $b^\kappa(a,S)$,and may also inherit land and become a landed middle-aged agent (if $\kappa = 1$). Let his savings decision be represented by $a' = a_y^{f\kappa s}(b^\kappa(a,S),S)$.

Next consider a young farmer who *goes* to the city. If his parent dies, he will only receive a capital bequest of $b^\kappa(a,S)$. He solves

$$
\begin{aligned}
V_y^{f\kappa g}(b^\kappa(a,S),S) &= \max_{a'}\{u(w^c\varepsilon_y^c - \tau - a') + \beta\pi V_m^{c}(a',S') + \\
&\quad \beta(1-\pi)V_m^{c}(a' + b^\kappa(a,S),S')\}, \\
s.t.\ S' &= (G(S),H(S),P(S)).
\end{aligned} \tag{10}
$$

Let his savings decision be given by $a' = a_y^{f\kappa g}(b^\kappa(a,S),S)$.

Finally, let $L(b^\kappa(a,S),S)$ be an indicator of whether the young farmer is a goer or a stayer, which is simply determined by comparing his expected lifetime utility in each location, i.e.

$$
L(b^\kappa(a,S),S) = \begin{cases} 1, \text{ if } V_y^{f\kappa g}(b^\kappa(a,S),S) \geq V_y^{f\kappa s}(b^\kappa(a,S),S) \\ 0, \text{ otherwise} \end{cases}. \tag{11}
$$

3.3 Updating and Aggregation

When individuals solve their problems, they take the transition functions G, H, and P as given. While we treat P as an exogenous function in this section, the other two transition functions, G and H, must be consistent with individual decisions in equilibrium. In this section we analyze how the savings and location decisions of agents determine the evolution of aggregate assets and the fraction of agents living in each location.

We begin with the evolution of aggregate assets in the economy. In this economy, assets are owned either by old or by middle-aged agents. Hence, given $\psi_m^c(a)$ and $\psi_o^c(a)$, the current level of aggregate assets in the city, A^c, is simply

$$A^c = (1-\lambda_m)\int a d\psi_m^c(a) + (1-\lambda_o)\int a d\psi_o^c(a). \tag{12}$$

Similarly, the aggregate asset level on the farm, A^f, is

$$A^f = (1-\pi)\lambda_m \int a d\psi_m^{f1}(a) + \pi\lambda_m \int a d\psi_m^{f0}(a) + \lambda_o \int a d\psi_o^f(a). \tag{13}$$

Given the particular demographic structure we have imposed, in order to determine the aggregate assets next period, all we need to know is the asset distribution of the middle-aged agents. To see this, note that next period's aggregate assets are determined by the savings decisions of young and middle-aged agents. Since the savings decisions of the young depend on the expected bequests and these bequests are determined by the savings of the middle-aged agents, in order to find next period's aggregate asset level $A^{c'}$, $\psi_m^c(a)$ and $\psi_m^{f\kappa}(a)$ provide sufficient information. In particular, next period's aggregate asset level in the city is given by

$$\begin{aligned} A^{c'} &= (1-\lambda_m)\int \left[a_y^c(a_m^c(a,S),S) + a_m^c(a,S)\right] d\psi_m^c(a) \qquad (14)\\ &\quad +\lambda_m[\int L(a_m^{f0}(a,S),S)a_y^{f0g}(a_m^{f0}(a,S),S)d\psi_m^{f0}(a) \\ &\quad + \int L(a_m^{f1}(a,S),S))a_y^{f1g}(a_m^{f1}(a,S),S)d\psi_m^{f1}(a)]. \end{aligned}$$

The first line in this equation is the portion of next period's assets that is determined by the savings decisions of the agents in the city. Here $\int a_m^c(a,S)d\psi_m^c(a)$ gives the total savings of the middle-aged agents. These savings are either carried to their old age, or left as accidental bequests and constitute part of the assets owned by middle-aged agents next period. The term $\int a_y^c(a_m^c(a,S),S)d\psi_m^c(a)$ is the other part of the assets owned by middle-aged agents next period. It captures the savings done by the young, who in equilibrium anticipate correctly that they will receive $a_m^c(a,S)$ as bequests. The next two lines capture the part of aggregate assets in the city that come from young agents who just moved to the city. The savings decisions of these newcomers depend on their parent's asset and land holding status, and are different from those of the young agents who are born in the city. Hence, if a young farmer whose parent has a units of assets and no land decides to go to the city, then $L(a_m^{f0}(a,S),S)=1$ and he saves $a_y^{f0g}(a_m^{f0}(a,S),S)$. The term $\int L(a_m^{f0}(a,S),S)a_y^{f0g}(a_m^{f0}(a,S),S)d\psi_m^{f0}(a)$ is the aggregation of such assets.

In a similar fashion, next period's aggregate asset level on the farm is also determined by the asset distribution of landed- and landless-middle-aged agents and by the location decisions of the young. It is given by

$$\begin{aligned} A^{f'} &= \lambda_m[\int[(1-L(a_m^{f0}(a,S),S))a_y^{f0s}(a_m^{f0}(a,S),S)+a_m^{f0}(a,S)]d\psi_m^{f0}(a)+ \\ &\int[(1-L(a_m^{f1}(a,S),S))a_y^{f1s}(a_m^{f1}(a,S),S)+a_m^{f1}(a,S)]d\psi_m^{f1}(a)] \end{aligned} \tag{15}$$

Like equation (14), the terms $\int a_m^{f0}(a,S)d\psi_m^{f0}(a)$ and $\int a_m^{f1}(a,S)d\psi_m^{f1}(a)$ represent the total savings of the middle-aged-landless and -landed agents, respectively, while the terms $\int a_y^{f0s}(a_m^{f0}(a,S),S)d\psi_m^{f0}(a)$ and $\int a_y^{f1s}(a_m^{f1}(a,S),S)d\psi_m^{f1}(a)$ are the savings done by the young who choose to stay on the farm.

Next, we describe how G is determined. This entails updating $\psi_m^c(a)$, $\psi_o^c(a)$, $\psi_m^{f1}(a)$, $\psi_m^{f0}(a)$ and $\psi_o^f(a)$ in a manner that is consistent with the savings behavior of individuals. To this end, let $Q=[0,\overline{a}]$ be the set of possible asset holdings for an individual in this economy. First, consider next period's asset distribution among the old in the city. This distribution will be determined by the savings of the current middle-aged agents in the city who survive to the next period. Then, it must be the case that for all $\widetilde{a}\in Q$,

$$\psi_o^{c'}(\widetilde{a})=\pi\int_Q I\{a_m^c(a,S)=\widetilde{a}\}d\psi_m^c(a), \tag{16}$$

where $I(.)=1$ if $a_m^c(a,S)=\widetilde{a}$, and 0, otherwise. Similarly, the asset distribution of the old on the farm is

$$\psi_o^{f'}(\widetilde{a})=\pi\int_Q I\{a_m^{f0}(a,S)=\widetilde{a}\}d\psi_m^{f0}(a)+\pi\int_Q I\{a_m^{f1}(a,S)=\widetilde{a}\}d\psi_m^{f1}(a), \tag{17}$$

where, with some abuse of notation, we use I as the appropriate indicator function.

Next period's asset distribution among the middle-aged agents in the city is determined by the location and savings decisions of young agents. One complication is that not all young agents make the same savings decisions. While some of them are born in the city, others move to the city this period. Furthermore, some of those movers had landless parents and some had landed parents. The following equation lists each of these cases:

$$\psi_m^{c'}(\widetilde{a}) = \int_Q [\pi I\{a_y^c(a_m^c(a,S),S) = \widetilde{a}\} + (1-\pi)I\{a_y^c(a_m^c(a,S),S) + a_m^c(a,S) = \widetilde{a}\}]d\psi_m^c(a)$$

$$\begin{aligned} +L(a_m^{f0}(a,S),S)\int_Q [\pi I_\pi^0\{a_y^{f0g}(a_m^{f0}(a,S),S) &= \widetilde{a}\} \\ +(1-\pi)I_{1-\pi}^0\{a_y^{f0g}(a_m^{f0}(a,S),S) + a_m^{f0}(a,S) &= \widetilde{a}\}]d\psi_m^{f0}(a) \\ +L(a_m^{f1}(a,S),S)\int_Q [\pi I_\pi^1\{a_y^{f1g}(a_m^{f1}(a,S),S) &= \widetilde{a}\} \\ +(1-\pi)I_{1-\pi}^1\{a_y^{f1g}(a_m^{f1}(a,S),S) + a_m^{f1}(a,S) &= \widetilde{a}\}]d\psi_m^{f1}(a). \end{aligned} \tag{18}$$

The first line represents the total assets held by next period's middle-aged agents, who are young this period and were also born in the city. Their savings decisions are given by $a_y^c(a_m^c(a,S),S)$. If they do not receive any bequest, which happens with probability π, these are all the assets they have. There is however a $1-\pi$ chance that they receive a bequest. In this case, their total assets consist of their own savings and their parent's assets, and are given by $a_y^c(a_m^c(a,S),S) + a_m^c(a,S)$. The next two lines consider the same cases for young agents who go to the city and have landless parents, while the last two rows do the same for those who go to the city and have landed parents.

Finally, next period's asset distribution for middle-aged agents on the farm is given by the savings decisions of the young who choose to stay there. For the landless-middle-aged farmers we have,

$$\begin{aligned} \psi_m^{f0'}(\widetilde{a}) = \pi[(1 - L(a_m^{f0}(a,S),S))\int_Q I_\pi^0\{a_y^{f0s}(a_m^{f0}(a,S),S) = \widetilde{a}\}d\psi_m^{f0}(a) \\ +(1 - L(a_m^{f1}(a,S),S))\int_Q I_\pi^1\{a_y^{f1s}(a_m^{f1}(a,S),S) = \widetilde{a}\}d\psi_m^{f1}(a)]. \end{aligned} \tag{19}$$

And, for the landed-middle-aged farmers we have,

$$\psi_m^{f1'}(\widetilde{a}) = (1-\pi)[(1-L(a_m^{f0}(a,S),S))\int_Q I_{1-\pi}^{0}\{a_y^{f0s}(a_m^{f0}(a,S),S)+a_m^{f0}(a,S)=\widetilde{a}\}d\psi_m^{f0}(a)$$
$$+(1-L(a_m^{f1}(a,S),S))\int_Q I_{1-\pi}^{1}\{a_y^{f1s}(a_m^{f1}(a,S),S)+a_m^{f1}(a,S)=\widetilde{a}\}d\psi_m^{f1}(a)]. \qquad (20)$$

Next, in order to determine H, we consider how the location decisions are updated. Suppose the current location decisions of agents are given by $\Lambda = (\lambda_y, \lambda_m, \lambda_o)$. Since all young agents survive to middle age, it must be the case that $\lambda_m' = \lambda_y$. Similarly, since the survival probability, π, is identical in both locations, $\lambda_o' = \lambda_m$. The fraction of young agents who will be on the farm, however, depends on the location decisions of those agents who are born on the farm. A fraction λ_y will be born on the farm next period. Yet, according to equation (11), some of them will move to the city. Hence, for any S', the total fraction who stay, among those whose parent does not have any land, is given by $\int(1-L(a_m^{f0}(a,S'),S'))d\psi_m^{f0'}(a)$. The same expression for those whose parent has land is given by $\int(1-L(a_m^{f1}(a,S'),S'))d\psi_m^{f1'}(a)$. Putting these pieces together implies the following consistency condition for Λ'

$$\Lambda' = \left(\lambda_y\left[\int(1-L(a_m^{f0}(a,S'),S'))d\psi_m^{f0'}(a)\right.\right.$$
$$\left.\left.+\int(1-L(a_m^{f1}(a,S'),S'))d\psi_m^{f1'}(a)\right], \lambda_y, \lambda_m\right). \qquad (21)$$

3.4 Economic Equilibrium

Given a policy function $P(S)$, a *recursive competitive equilibrium* for this economy consists of a set of value functions, $V_y^c(b(a,S),S), V_m^c(a,S)$, and $V_o^c(a,S)$, for agents who live in the city and $V_y^{f\kappa s}(a,S), V_y^{f\kappa g}(a,S)$, $V_m^{f\kappa}(b^\kappa(a,S),S)$ $\kappa=0,1$, and $V_o^f(a,S)$ for agents who live on the farm; a set of decision rules $a_y^c(b^c(a,S),S)$ and $a_m^c(a,S)$ for agents who live in the city, and $a_y^{f\kappa s}(b^\kappa(a,S),S)$, $a_y^{f\kappa g}(b^\kappa(a,S),S)$ and $a_m^{f\kappa}(a,S)$, $\kappa=0,1$, for agents who live on the farm; a location rule for young farmers, $L(b^\kappa(a,S),S)$, $\kappa=0,1$; a set of pricing functions $r(S)$, $w^c(S)$, $w^f(S)$, and $q(S)$, and a set of aggregate laws of motion $H(S)$ and $G(S)$ such that:

- Given the transition functions $P(S)$, $H(S)$, and $G(S)$, and pricing functions $r(S)$, $w^c(S), w^f(S)$, and $q(S)$, the value functions and corresponding decision rules solve the appropriate household problems in equations (4), (5), (6), (7), (8), (9), (10), and (11), with $b(a, S) = a_m^c(a, S)$ and $b^\kappa(a, S) = a_m^{f\kappa}(a, S)$, $\kappa = 0, 1$.

- The pricing functions, $r(S)$, $w^c(S), w^f(S)$, and $q(S)$, are determined by profit maximization of production units in each sector together with a no arbitrage condition for capital, i.e. $r(S)$, $w^c(S), w^f(S)$, and $q(S)$ satisfy

$$w^c(S) = F_2^c(K^c, N^c),$$

$$w^f(S) = F_2^f(K^f, N^f, L),$$

$$q(S) = F_3^f(K^f, N^f, L),$$

and

$$r(S) + \delta = F_1^c(K^c, N^c) = F_1^f(K^f, N^f, L),$$

with aggregate labor and capital in each sector given by

$$N^f = \lambda_y \varepsilon_y^f + \lambda_m \varepsilon_m^f + \lambda_o \pi \varepsilon_o^f,$$

$$N^c = (1 - \lambda_y)\varepsilon_y^c + (1 - \lambda_m)\varepsilon_m^c + (1 - \lambda_o)\pi \varepsilon_o^c,$$

and

$$K = K^c + K^f = A^c + A^f,$$

where A^c and A^f are given by equations (12) and (13), and K^c and K^f are determined by the no arbitrage condition.

- Aggregate transition functions are consistent with individual decisions: (i) The transition function G is consistent with individual savings decisions and is determined by equations (16), (17), (18), (19), and (20). (ii) The transition function H is consistent with individual location decisions and is determined by (21).

4 Political Equilibrium

So far we have taken the function P as given. The role of the function P is to determine a *state-contingent* social security system. We now focus on how the social security system is determined by equilibrium voting of successive generations. We assume sincere voting, i.e. that each agent votes for his most preferred alternative in each period. It is not obvious whether an equilibrium with social security can be supported as a political outcome in a democratic voting process with nonaltruistic agents. The current young and middle-aged do not benefit from the system, yet their support is critical. Indeed, the current young and middle-aged will always choose to pay nothing in the current period, as long as they believe that the system will be there for them in the future.

In this paper we consider a variant of *constant* social security taxes: (i) if a social security system has never been in place, it may start at any point, (ii) once a system is operating the tax remains constant, and successive generations take a simple yes/no vote whether or not to keep the existing system.

In order to induce the agents in this economy to vote for social security according to this simple rule, we introduce the following *reputational* mechanism: if a majority of voters deviate from the social security system, then the system collapses. Young and middle-aged workers balance the benefit of not paying into the system against the cost of not receiving anything from it in the future. As a result, if they eliminate an existing system (or if they fail to start a system when it is optimal for the median voter to do so), they take into account the fact that the system will not be there tomorrow. Although the reputational mechanism we use is quite stringent, we follow this route as it is the standard political economy approach in the literature (see Cooley and Soares 1999, Galasso 1999, and Boldrin and Rustichini 2000).[16] Finally note there can be many constant tax rates that are sustainable under the reputational mechanism we have just described. In the current analysis we focus on taxes that maximize the lifetime utility of the median voter.

[16] Two early papers that emphasized the political sustainability of social security were Browning (1975) and Sjoblom (1985).

Recall that $P(\Psi, \Lambda, \tau_{-1}, 1) = (\tau, h')$, where τ_{-1} is last period's social security tax, and h is an indicator of whether or not the introduction of social security was ever optimal for a median voter in the past. If $h = 1$ it was, if $h = 0$, it wasn't. In the following discussion when we say that the system has collapsed or has been dismantled we are referring to a situation where $h = 1$ and $\tau_{-1} = 0$.

Definition 1 *For any $\tau_{-1} > 0$ and $h = 1$, we will say that a policy function $P(S)$ is sustainable in state $S = (\Psi, \Lambda, \tau_{-1}, 1)$, if*

$$V^M(\Psi, \Lambda, \tau_{-1}, 1; P) \geq \mathcal{V}^M(\Psi, \Lambda),$$

where V^M is the remaining lifetime utility of the median voter in an economy with current aggregate state $S = (\Psi, \Lambda, \tau_{-1}, 1)$ and policy function P, and $\mathcal{V}^M$ is the remaining lifetime utility of the median voter if social security is eliminated forever.

The value $\mathcal{V}^M(\Psi, \Lambda)$ only depends on Ψ and Λ, i.e. the aggregate state (the distribution of physical capital and the distribution of agents between the city and the farm) in which the social security tax is eliminated. In other words, P is sustainable in S if a majority of voters vote "yes" for keeping it today with tomorrow's taxes determined by P, instead of moving to an economy with no social security. Let the indicator function $M(S; P)$ denote the yes/no decision of the median voter, i.e.

$$M(\Psi, \Lambda, \tau_{-1}, 1; P) = \begin{cases} 1, \text{ if } V^M(\Psi, \Lambda, \tau_{-1}, 1; P) \geq \mathcal{V}^M(\Psi, \Lambda) \\ 0, \text{ otherwise} \end{cases}.$$

Note that a median voter considering a future without social security takes into account the resulting rise in aggregate capital stock and the decline in the rate of return. The decline in the rate of return gives the median voter an additional reason (besides reputation) to keep an existing system.

To define the policy function P, we begin by noting that the history, h, of the social security system is important for its future evolution. Specifically, if the current tax level is zero, it is either because no median voter has voted for social security and a system is still a possibility, or the system was dismantled in the past and no possibility exists of a positive tax in the future.

If $\tau_{-1} = 0$, and $h = 1$, then the social security system collapsed sometime in the past and cannot be restarted. Therefore, $P(\Psi, \Lambda, \tau_{-1}, h) = (\tau, h')$ is given by

$$P(\Psi, \Lambda, 0, 1) = (0, 1), \tag{22}$$

i.e. once the system collapses, it can never be restored.

If today's political state is $\tau_{-1} > 0$ and $h = 1$, then sometime in the past a median voter instituted his most preferred tax and this tax has been in effect since then. In this case, the current generation simply takes a yes/no vote and the system either continues at the same tax level or ends because of a no vote. The result of this yes/no vote depends on whether state $S = (\Psi, \Lambda, \tau_{-1}, 1)$ is sustainable. Hence,

$$P(\Psi, \Lambda, \tau_{-1}, 1) = \begin{cases} (\tau_{-1}, 1), \text{ if } M(\Psi, \Lambda, \tau_{-1}, 1; P) = 1 \\ (0, 1), \text{ if } M(\Psi, \Lambda, \tau_{-1}, 1; P) = 0 \end{cases}. \tag{23}$$

Note that if $M(\Psi, \Lambda, \tau_{-1}, 1; P) = 0$, then the system moves to $\tau = 0$ and $h = 1$, and stays there forever.

The case that requires more careful attention is when $\tau_{-1} = 0$ and $h = 0$, since then a social security system has never been operative. It may, or may not start today, depending on the preferences of the median voter. If there has never been a social security system in the past, the current median voter can make a proposal of a tax rate for a yes/no vote. Let $\widehat{\tau}(S)$ be the proposal by the median voter at state S. Furthermore, let $\tau^* = \arg\max_\tau V^M(S; P_\tau)$ be the optimal tax rate chosen by the median voter under the constant policy rule P_τ, i.e. the optimal tax rate chosen under the assumption that it will be in effect forever. We specify P such that

$$P(\Psi, \Lambda, 0, 0) = \begin{cases} (0, 0), \text{ if } \widehat{\tau} = \tau^* = \arg\max_\tau V^M(S; P_\tau) = 0 \\ (\tau^*, 1), \text{ if } \widehat{\tau} = \tau^* = \arg\max_\tau V^M(S; P_\tau) > 0 \\ (0, 1), \text{ if } \widehat{\tau} \neq \tau^* \end{cases}. \tag{24}$$

Hence, if the median voter prefers a zero tax rate, then the social security system does not start. If the preferred tax rate of the median voter is positive, then this tax rate is proposed by the median voter for a yes/no vote, and, if the preferences are single-peaked, is accepted by the majority as the current tax rate. Any other proposal by the median voter results in the collapse of the system. It is important to note that the proposal by the median voter maximizes $V^M(S; P_\tau)$ — his lifetime utility under the constant rule. If $\tau^* > 0$, the tax rate will indeed remain constant as long as it is sustainable. Hence any sustainable τ^*, if proposed by the median voter, will initiate a system that will last forever. It might, however, be the case that $\tau^* = 0$, and the median voter does not initiate social security. He is allowed to do that if and only if his lifetime utility is maximized by $\tau^* = 0$ assuming that taxes will be zero next period. In particular, the median voter is not allowed to propose $\widehat{\tau} = 0$ hoping that a social security will start tomorrow. Such a proposal results in the collapse of the system. If such a proposal was allowed, social security would never get initiated since successive median voters would simply wait for the next generation to initiate the system.

A political equilibrium is then a recursive competitive equilibrium with the policy function P defined by equations (22), (23), and (24). Once a median voter sets $\tau^* > 0$, then future generations of median voters simply decide whether to sustain the system or not, knowing that once the system is dismantled, it is gone forever. Obviously, the median voter who chooses $\tau^* > 0$, takes into account the reputational mechanism that is in effect.

At a general level, not much can be said analytically about this model. In the following sections we choose functional forms, assign parameter values, and perform numerical evaluations. Some valuable analytical insight can be gained, however, by focusing on a steady state economy without capital. This is what we turn to next.

5 Steady State Economy without Capital

Consider a steady state version of the economy outlined above, i.e. let $\Lambda' = \Lambda, \Psi' = \Psi$, $h' = h$, and $\tau' = \tau$. In the steady state there is a constant fraction λ of population that lives on the farm, i.e. $\lambda_y = \lambda_m = \lambda_o = \lambda$. Suppose the farm sector uses only labor and land, while labor is the only factor of production in the city sector. In particular, let the production function in the farm sector be

$$Y^f = \gamma^f (N^f)^\mu (L)^{1-\mu}.$$

Hence, with $L = 1$, the rental rates are given by

$$w^f = \mu \gamma^f (N^f)^{\mu - 1}, \tag{25}$$

and

$$q = (1-\mu)\gamma^f (N^f)^\mu. \tag{26}$$

Since we are in a steady state, the aggregate labor on the farm is $N^f = (\varepsilon_y^f + \varepsilon_m^f + \pi \varepsilon_o^f)\lambda$. Note that since land is a fixed factor of production, there are decreasing returns to labor. As a result, when people live longer and the farm sector gets more crowded, i.e. when π increases, w^f declines and q increases. It is also the case that as people move out of agriculture the pressure on farm wages is reduced, since as λ declines, w^f rises and q declines.

Let the production function in the city be

$$Y^c = \gamma^c N^c, \tag{27}$$

which implies $w^c = \gamma^c$. Finally, let

$$u(c) = \log(c). \tag{28}$$

Furthermore, suppose agents have access to a storage technology that transfers resources from current to future periods. In particular, suppose a unit of goods not consumed today becomes $1 + r$ units of goods tomorrow.

5.1 Saving Behavior of Middle-Aged Agents

We start by characterizing the behavior of middle-aged agents who are most likely to be median voters in equilibrium. It turns out that the amount a middle-aged person chooses to store depends critically on the social security tax. For each middle-aged agent there exists a threshold tax level that depends on his wealth. If the existing social security tax is greater than this threshold, then a middle-aged agent stores nothing, while if it is strictly less than this threshold, he stores a positive amount. Intuitively, a person's threshold tax level reflects how much of his resources he would like to transfer from today to tomorrow. If the actual tax level is lower than what he wants to save, then the agent saves. Furthermore, if a person saves, his savings decision is decreasing in the social security tax, increasing in his wealth, and increasing in the survival probability.

These results are formalized in the next proposition. All proofs are in Appendix B. To streamline the presentation it is helpful to define middle-age and old-age income variables. Let $I_m^j,\ j \in \{c, f0, f1\}$, be pre-tax total labor and land incomes of the middle-aged. So, $I_m^c = \varepsilon_m^c w^c$, $I_m^{f0} = \varepsilon_m^f w^f$, and $I_m^{f1} = \varepsilon_m^f w^f + q/\lambda$. Let $I_o^j,\ j \in \{c, f0, f1\}$ be total labor and land incomes of the old-age. So, $I_o^c = \varepsilon_o^c w^c$, $I_o^{f\kappa} = \varepsilon_o^f w^f + q/\lambda,\ \kappa \in \{0, 1\}$. Note that all old farmers have the same labor and land incomes, regardless of their middle-age land status. However, it is easier in terms of exposition to separate them.

Proposition 1 *Let $p = (r, w^c, w^f, q)$. Given p and τ, for any middle-aged person of type $j \in \{c, f0, f1\}$, there exits a threshold tax level $\hat{\tau}_m^j(a; p, \tau) \geq 0$ such that: (i) If $\hat{\tau}_m^j(a; p, \tau) \leq \tau$, then $a_m^j(a; p, \tau) = 0$. (ii) If $\hat{\tau}_m^j(a; p, \tau) > \tau$, then $a_m^j(a; p, \tau) = \frac{\beta\pi(1+r)(I_m^j+(1+r)a-\tau)-(I_o^j+2\tau/\pi)}{(1+r)(1+\beta\pi)} > 0$; and $\frac{\partial a_m^j(a;p,\tau)}{\partial \tau} < 0$, $\frac{\partial a_m^j(a;p,\tau)}{\partial a} > 0$, and $\frac{\partial a_m^j(a;p,\tau)}{\partial \pi} > 0$.*

The next proposition provides a characterization of the threshold tax level $\hat{\tau}$. This threshold is increasing in the middle-aged agent's wealth, since an agent with higher wealth has more incentive to transfer his resources to old age. More importantly, if the non-social security income of the old is sufficiently high relative to the pre-tax income of the middle-aged, then the reservation tax is zero.

Proposition 2 *Given p and τ, for any middle-aged person of type $j \in \{c, f0, f1\}$: (i) $\hat{\tau}_m^j(a; p, \tau) = \max\{0, \frac{\beta\pi(1+r)(I_m^j+(1+r)a)-I_o^j}{2/\pi+\beta\pi(1+r)}\}$; (ii) If $\hat{\tau}_m^j(a; p, \tau) > 0$, then $\frac{\partial \hat{\tau}_m^j(a;p,\tau)}{\partial a} > 0$.*

A middle-aged agent prefers to save a positive amount as long as $\beta\pi(1+r)(I_m^j+(1+r)a) > I_o^j$, i.e. he has relatively more resources when he is middle-aged then he has when he is old. If a middle-aged agent has relatively high income when he is old, he does not want to transfer more resources to old age via social security. In this environment it is the middle-aged-landless farmers who face the steepest age-earnings profiles since they have wage earnings today, but will have wage plus land earnings tomorrow. The city worker (who only has wage earnings), and the middle-aged farmers (who have land income both today and tomorrow) face flatter age-earnings profiles than the middle-age-landless farmer. As a results, as long as a middle-aged-landless farmer is the median voter and faces a steep age-income profile, he would prefer not to have social security. In our simulation exercise in the next Section, a middle-aged-landless farmer indeed turns out to be the median voter in the initial (1800) steady state and he does not want to implement a social security system. Once the median voter is in the city, a social security system emerges. We first, however, focus on this transition within this simple framework.

5.2 How Can a Social Security System Emerge?

We now consider the decision of the middle-aged median voter. If the return to social security, $2/\pi$, is less than the return to storage, $1+r$, the median voter chooses a zero tax, and any agent who wants to save, saves entirely through storage. Suppose $2/\pi > 1+r$. Then, if the median voter wants to save, he chooses a positive tax, saves entirely via social security, and stores nothing. All middle-aged agents who have higher wealth than the median voter, store positive amounts, since they want to save more than the median voter. In both cases, the key is whether or not middle-aged agents want to save. If they do not, then neither social security nor storage will be operative in equilibrium. This implies that in order for the social security tax to be zero in equilibrium, either the return to social security must be less than the return to other vehicles of saving, or the median voter must prefer not to save. These results are outlined in the following proposition.

Proposition 3 *Given p, let a be the stored assets of the median voter, let a_m^j be the storage decision of the middle-aged median voter of type $j \in \{c, f0, f1\}$, and let τ^* denote his preferred tax rate. (i) If $\frac{2}{\pi} < (1+r)$, then $\tau^* = 0$, and $a_m^j(a; p, \tau^*) = \max\{0, \frac{\beta\pi(1+r)(I_m^j+(1+r)a)-I_o^j}{(1+r)(1+\beta\pi)}\}$. (ii) If $\frac{2}{\pi} > (1+r)$, then $\tau^* = \max\{0, \frac{2\beta(I_m^j+(1+r)a)-I_o^j}{2(\beta+1/\pi)}\}$, and $a_m^j(a; p, \tau^*) = 0$. (iii) If $\frac{2}{\pi} = (1+r)$, then $\tau^* \in [0, \hat{\tau}^j]$, and $a_m^j(a; p, \tau^*) = \max\{0, \frac{\beta\pi(1+r)[I_m^j+(1+r)a-\tau^*]-(I_o^j+\frac{2\tau^*}{\pi})}{(1+r)(1+\beta\pi)}\}$.*

To highlight the implications of Proposition 3 for the emergence of social security, consider the following example. Suppose everyone is living on the farm. Furthermore to avoid the trivial outcome, suppose that the return to social security is greater than storage ($2/\pi > 1+r$). Finally, let the efficiency units of labor be identical over time and across sectors and set to 1.

In this simple world, old farmers want as much as they can get in terms of a social security tax, while the young always prefer to have zero social security tax.[17] That leaves the middle-aged farmer's decision to consider, which depends on their asset level. Middle-aged farmers fall into one of two groups: those who have land and those who do not. It is easy to show that middle-aged-landless farmers are more likely to have a steeper age-earnings profile than middle-aged-landed farmers, and so are more likely to prefer a lower tax level. Consider a landless farmer with assets a^0 and a landed farmer with assets a^1. Part (ii) of Proposition 3 suggests that the tax level chosen by the landless farmer will be smaller than the one chosen by the landed farmer as long as

$$w^f(2\beta - 1) + 2\beta(1+r)a^o - q \; < \; w^f(2\beta - 1) + 2\beta(1+r)a^1 + 2\beta q - q, \tag{29}$$

which reduces to

$$(1+r)a^o < \; (1+r)a^1 + q.$$

As a result, all landless farmers prefer a lower tax level than all landed farmers as long as the landless farmer with the highest asset level has an asset income that is lower than the asset plus land income of the landed farmer with the lowest asset level. This is likely to hold since the landless farmers receive no bequests while the landed farmers do. For the purposes of this example, suppose this condition holds. Therefore, one can rank preferred tax levels in the following way: $\tau_y^f < \tau_m^{f0} < \tau_m^{f1} < \tau_o^f$.

Then, the question is who is the median voter. The measure of the young population is 1, and the measure of the old and middle-aged-landed populations is also 1, since $\pi + (1-\pi) = 1$. This leaves the measure of the population that is middle-aged and landless, π, in the middle. So, in this simple example, when everyone lives on the farm, the median voter must be the

[17] One can show, in an environment with no storage, that the young always prefer a zero social security tax. Including storage only allows another alternative to social security and therefore should only bolster this result.

middle-aged-landless farmer. If the middle-aged-landless farmer who is the median voter prefers no social security, social security will be inoperative. This will happen as long as

$$w^f(2\beta - 1) + 2\beta a(1 + r) < q. \tag{30}$$

Clearly, this condition is dependent on parameters, but it is more likely to happen when β is small, q is big, w^f is small, and r is small. If a person discounts the future highly, he won't want to save, and will be opposed to social security as well. If the land return is high relative to the farm wage, this implies that the age-earnings profile for the landless farmer is steep, and he is less likely to want to save. And lastly, if a farmer has low asset income when middle-aged, he is less likely to want to save for old age. Overall it is more likely to happen if the middle-aged landless farmer faces a relatively steep age-income profile.

Now consider a new steady state with a significant fraction of the population living in the city, so that the median voter is a city worker. The middle-aged city worker's preferred tax level is strictly positive as long as

$$w^c(2\beta - 1) + 2\beta a(1 + r) > 0, \tag{31}$$

Condition (31) will hold as long as $\beta > 1/2$. If city workers do not discount the future too heavily, or they have enough asset income when middle-aged, then they vote for a positive amount of social security, and the economy will move from a steady state without social security to one with social security.

Discussion Land plays an important role in this framework for two reasons. First, it is a fixed factor on the farm, so increasing survival probabilities reduces farm wages. This crowding of land encourages young farmers to migrate to the city. Second, land provides insurance for farmers. The promise of land upon survival to old age for middle-aged-landless farmers creates a steep age-income profile that discourages saving. [18] A key to this result

[18] The steepness of the age-income profile depends on the return to land relative to the return to farm labor. With a higher share to farm labor, land plays a smaller role, causing the age-income profile of the landless farmer to flatten. See the example following Proposition 3.

is that there is no market for land. The inherited nature of land creates the wedge in age-income profiles. However, if there were a market for land, as long as the return to land is greater than the return to social security this result would still hold.

The political economy aspect of the environment is simple, yet critical. Middle-aged agents only pay into the system one period, while their benefits are based on two periods of payments. This encourages support for social security, even when age-income profiles are flat. Land is not available for city workers as old age security. They earn only labor income when middle-aged and old. Therefore, they have age-income profiles that are relatively flatter than that of landless farmers, and thus are more likely to support social security. An important feature of this framework is that as the fraction of people living on the farm falls, the identity of the median voter shifts from the farm to the city and support for social security can emerge. As was highlighted in the last section, in order for social security to arise at all, the returns to the middle-aged voter, $2/\pi$, must be greater than the returns to saving, $1+r$. But, even if $2/\pi > 1+r$, a middle-aged agent might choose not to implement social security if he does not want to save.

6 Economy with Capital

We are now ready to carry out our quantitative exercise and evaluate if a calibrated version of our model is consistent with the historical experience of the U.S. economy. Consider the general setup from Section 2 and assume that young and middle-aged agents save in the form of risk-free, productive capital. Although the basic intuition from the analytical results of the previous section remains valid, there are now general equilibrium effects at play as well. This is critical for two reasons. First, the changes in relative productivity levels and survival probabilities will not only determine farm wages and land returns via migration, but will also affect all prices via changes in individual capital accumulation decisions. Therefore, it is fundamentally a quantitative question if the exogenous forces we consider and the general equilibrium effects that follow can generate a farm-to-city migration that is in line with the data. Second, in their decisions about the social security system, agents still compare the return to capital with the return to social security, but the return to capital is now an endogenous variable. This is important because while higher TFP levels after 1800 push the interest rate up, higher capital accumulation associated with longer lives pushes it down. Since, as we have emphasized above, the lower capital stock and higher interest rate associated with social security can play an important role in the median voter's decision to keep an existing system, general equilibrium effects on the interest rate are of fundamental importance to the question at hand.

In this section we show that a calibrated version of this economy can generate an initial steady state in which a majority of the population lives on the farm and the median voter chooses not to introduce a social security system, and a transition to a new steady state along which the median voter chooses a positive and sustainable social security tax. We interpret the initial steady state as the U.S. economy in 1800 and the final steady state as the U.S. economy in 1940. Computing the transition is non-trivial. Not only do the capital stock and location choices (and hence prices) have to be consistent with individual asset accumulation and migration decisions, but the sequence of tax levels that individuals expect must be those that the median voter in each generation chooses. In order to develop quantitative implications of this model economy, we first choose functional forms for utility and production functions and assign parameter values.

As in the previous section, let the utility function be $u(c) = \log(c)$. Since the production side of our model economy closely follows Hansen and Prescott (2002), we borrow both functional forms and parameter values from them. In particular, we assume that the production function on the farm sector is given by

$$Y^f = \gamma^f \left[N^f\right]^{\mu} \left[K^f\right]^{\phi} [L]^{1-\mu-\phi},$$

and in the city sector it is

$$Y^c = \gamma^c \left[N^c\right]^{1-\theta} \left[K^c\right]^{\theta}.$$

These choices imply that

$$w^c = (1-\theta)\gamma^c (N^c)^{-\theta} (K^c)^{\theta}, \tag{32}$$

$$w^f = \mu\gamma^f (N^f)^{\mu-1}(K^f)^{\phi}, \tag{33}$$

$$q = (1-\mu-\phi)\gamma^f (N^f)^{\mu}(K^f)^{\phi}, \tag{34}$$

and

$$r = r^c = \theta\gamma^c (N^c)^{1-\theta}(K^c)^{\theta-1} - \delta = \phi\gamma^f (N^f)^{\mu}(K^f)^{\phi-1} - \delta = r^f. \tag{35}$$

The parameter values we use are $\mu = 0.6$, $\phi = 0.1$, and $\theta = 0.4$.[19] We set the length of a model period to 20 years. We also assume that capital depreciates completely, i.e. $\delta = 1$, which is not critical for any of the results.

Next we select the values for relative TFP levels and survival probabilities. We borrow TFP numbers from Greenwood and Uysal (2005). For the 1800 economy we set $\gamma^f_{1800} = \gamma^c_{1800} = 1$. Since the relative TFP values are the key determinants of migration decisions in the model, we keep $\gamma^f_{1940} = 1$ and set $\gamma^c_{1940} = 2.19$. These choices imply that the relative TFP growth is as reported by Greenwood and Uysal (2005) and reproduced in Figure 4. Historical estimates for age-specific-mortality rates and life tables do not go back further than 1850 (see Haines 1988). In 1850, a 60 year-old man had about a 47% chance of living to his 80th birthday. Since available evidence does not indicate any significant improvement in mortality between 1800 and 1850, we set $\pi_{1800} = 0.47$.[20] In 1940 the chances that a 60 year old man saw his 80th birthday increased to about 56%. Therefore, we select $\pi_{1940} = 0.56$.

Finally, we assume that agents have flat age-earning profiles both on the farm and in the city, i.e. $\varepsilon^j_i = 1$ for $j \in \{f, c\}$ and $i \in \{y, m, o\}$. Age-earning profiles in the 19th century did indeed differ from the usual hump-shaped pattern. According to Kaelble and Thomas (1991), incomes of working class household heads increased slightly between ages 20 and 40, but were pretty much flat after age 40. These flat profiles were a common feature of

[19] The value for capital share in the city (industrial) technology, $\theta = 0.4$, is the standard value for the postwar U.S. economy. The labor share is assumed to be the same for both sectors, $\mu = 1 - \theta = 0.6$. Finally, $\phi = 0.1$ is picked to be consistent with historical evidence on agricultural incomes. See Hansen and Prescott (2002) for details.

[20] According to Haines (1988), the crude death rate in New York City was as high in 1850 as it was in 1804 (see Figure 1, page 150). In many New England towns there was not much improvement in life expectancy at age 20 either (see Table 1, page 151).

agricultural workers as well as low skilled non-agricultural workers.[21] We make the strong assumption that age-earning profiles were also flat in the city. We consider this to be a conservative assumption for our results, since a hump-shaped profile for city workers would simply increase the incentives of middle aged workers to shift resources to their old age and increase the political support for social security even further.

Note that we fix all these parameter values prior to running our simulations. We are left with only one more parameter to pick, β. We set $\beta = 0.818$ (a yearly value of 0.99). This value implies that the yearly return to capital in the 1940 steady state is about 5.8%.[22] Table I summarizes our parameter choices.

Table I — Parameter Values

β	μ	ϕ	θ	δ	γ^f_{1800}	γ^c_{1800}	γ^f_{1940}	γ^c_{1940}	π_{1800}	π_{1940}
0.818	0.6	0.1	0.4	1	1	1	1	2.19	0.47	0.56

6.1 Results

Table II shows the results for the initial steady state in 1800. In our 1800 economy everyone lives on the farm, $\lambda = 1$. This is consistent with the U.S. experience. At that time, about 94% of population lived in rural areas, and the fraction of population working on the farm was possibly even higher (see Figure 1). In the 1800 steady state, the median voter is a landless-middle-aged farmer, who does not want social security, so the equilibrium value of τ is zero. Notice that this happens even though $2/\pi$ (about 4.25) is larger than $1 + r$, so

[21] Doepke and Zilibotti (2005) contrast relatively flat wage profiles of agricultural workers and land owners with steep wage profiles of entrepreneurs in the 19th century. They model the emergence of capitalism within a model of structural transformation in which entrepreneurs influence their children's preferences in an attempt to make them more patient.

[22] Hansen and Prescott (2002) target a 4-4.5 percent rate of return on capital for post-war period. Cooley and Prescott (1995) report a higher value, 6.9 percent. The value for the return on capital in our new steady state is right between these two values. See Gomme and Rupert (2005) for a recent discussion.

the return to social security is greater than the return to capital. However, the middle-aged-landless farmer prefers to save nothing due to his steep age-income profile.

It is important to note that farmers participate both in the social security system and in the political process in the model economy, and the behavior of middle-aged-landless farmers determines the fact that social security is not implemented in 1800 steady state. While farmers were indeed part of the political process (as laws regarding social security had to be passed in both the Senate and the Congress), they were not included in the 1935 Social Security Act. A simple modification of the model in which social security taxes and benefits only affect the city workers, while they are voted at the national level can deliver the same results as long as social security implies some (however small) administrative cost that the farmers have to bear.

TABLE II - Initial Steady State

	1800
τ	0
λ_y	1
$1+r$	2.449
w^f	0.311
q	0.384
q/λ	0.384
K	0.052
K^f	0.052
N^f	2.470
Median Voter	middle-age-landless farmer

Table III and Figure 6 illustrate the transitional dynamics from the following exercise. We assume that the economy is at its 1800 steady state initially (period 0) and suddenly and unexpectedly productivity and life expectancy increase to their 1940 values. In the period of the change (period 1), the capital stock is fixed at its initial steady state level. However, due to the higher productivity in the city and the higher survival probability, the city is a much more attractive location for young farmers and many choose to migrate, $\lambda_y = 0.66$. This population shift alters the labor supply on the farm and in the city. Indeed, since a large fraction of population migrates in the first period of the transition, both farm and city wages rise. Given the rise in productivity levels, the return to capital, which is fixed at its old steady state value, increases significantly from 2.449 to 5.718. As people start moving away from the farm, the return to land starts to fall as well.

TABLE III - Transition

	0	1	2	3	4	5	6	7
τ	0	0	0.08	0.08	0.08	0.08	0.08	0.08
λ_y	1	0.660	0.349	0.160	0.160	0.160	0.160	0.160
$1+r$	2.449	5.718	3.718	3.443	3.203	3.126	3.088	3.072
w^f	0.311	0.325	0.416	0.544	0.548	0.549	0.550	0.551
w^c	-	0.376	0.501	0.528	0.554	0.563	0.567	0.569
q	0.384	0.265	0.187	0.112	0.113	0.114	0.114	0.114
K	0.052	0.052	0.168	0.232	0.262	0.272	0.278	0.280

Because the migration only affects the location of the young, in period 1 the median voter is still a middle-aged landless farmer, who prefers no social security.[23] So, in the initial period of the change, the tax remains unchanged at 0. However, agents are aware that the mass migration of young farmers to the city will shift the identity of the median voter in the next period, and alter support for social security.

In the second period of the transition, the initial young migrants now become middle-aged-city workers, who support a positive (sustainable) level of social security, $\tau = .08$.[24]

[23] We computationally verify that preferences are single peaked.

After the third period, migration stops and the fraction of young farmers remains at 0.16. However, the new steady state farm population takes five periods to attain, as the initial young migrants age. As the population reallocates between the two locations and people start accumulating capital, the return to capital falls to 3.718, and then converges to 3.072 in the new steady state.

Next, consider the 1940 economy, which is found in Table IV. Now about 16% of the population lives on the farm, a value close to the 23% observed in the U.S. at that time (see Figure 1). This is quite remarkable since nothing in our parameter choices targets directly the fraction of agents living on the farm.

TABLE IV - Final Steady State

	1940
τ	0.080
λ_y	0.160
$1+r$	3.072
w^f	0.551
w^c	0.569
q	0.114
q/λ	0.710
K	0.280
K^f	0.012
K^c	0.267
N^f	0.413
N^c	2.167
Median Voter	middle-aged city worker

[24] Again, we computationally verify that preferences are single peaked in the period of the vote for a positive tax.

Consistent with historical experience, the return on capital is much higher in the new steady state, despite a more than fourfold increase in aggregate capital stock. In 1940, about 16% of the population lives on the farm, but a much smaller (about 4.3%) fraction of aggregate capital stock is allocated to farm production. Also consistent with historical evidence, the rental value of land declines significantly. In 1940 it is about one third of its 1800 value.[25] Lastly, note that while the returns per unit of land, q, fall, the returns to land for landholders, q/λ, actually rise, .38 to .71, which keeps them on the farm despite rising city wages.

In the new steady state, even though total labor supply in the city rises due to the increases in life expectancy and in city population, because of the increases in technological progress and in the aggregate capital stock, the city wage rises. There is no technological advance on the farm. But the out migration of farmers causes labor supply on the farm to fall, and so farm wages rise. And, while there is a large increase in the aggregate capital stock, the technological advance in the city, coupled with the increase in labor supply in the city, leads to an increase in the return to capital.

It is worth noting that the demographic changes alone would not lead to the rural-urban transition that the U.S. experienced. When we only change survival probabilities, social security does not emerge, because the change does not induce enough migration. Indeed, everybody remains on the farm. The key effect of this change is an increase in the capital stock because people save more anticipating a longer life.

When only TFP changes social security does emerge but the rural/urban migration is not nearly as pronounced. Roughly 33% continue to live on the farm (in the data it is 23% and in our economy with changes in both survival probabilities and the TFP we get 16%). Furthermore, the social security tax is considerably higher than in the economy with both factors at work. This underscores the conclusion that the interaction between technology and demographics is a powerful impetus for social change.

[25] According to Hansen and Prescott (2002), the value of U.S. farmland relative to GDP declined from 88% in 1870 to 20% in 1950 (see Table 2, page 1209).

7 Conclusion

In this paper we offer one possible explanation for the emergence of pay-as-you-go social security systems. Our story ties this development to the population shift from rural to urban areas, a migration that has its roots in increased life expectancy conditional on reaching age 60, and in technological progress in the city that outpaced that on the farm. This story fits the experience of the United States very well. We show that there is an initial steady state consistent with the United States in the 1800s, with most people living on the farm and no social security system. Changes in life expectancy and technological progress in the city that are in line with those observed in the data initiate a transition to a new steady state. Along this transition path, a generation votes a social security system into place, which is supported throughout the transition and in the new steady state.

The current framework can be used to shed light on two issues of fundamental importance. First is the question of why did different countries follow such different strategies in constructing their social safety nets, choosing different degrees of reliance on state versus the market.[26] The current model provides a natural framework to link demographics, geography, and differences in the structural transformation of countries to differences in social insurance institutions. Second is the dramatic transformation that is taking place in China. Currently, there is no national pension system(nor much in the way of social insurance) in China, but as the world's largest ever peacetime flow of migration continues, and the traditional support systems via the family are dismantled, we would expect the demand for such institutions to grow. We leave these questions for future research.

[26] Perotti and Schwienbacher (2008) study how large inflationary shocks in the first half of the XX century, which devastated middle class savings in some countries, affected their reliance on state versus market institutions.

8 Appendix A

Figure 1: Hernandez (1996), Table 4.

Figure 2: The urbanization rates are from the 1930 Census, Table 6, page 10, available at http://www2.census.gov/prod2/decennial/documents/16440598v2_TOC.pdf. The elderly population is calculated from Hobbs and Stoops (2002), Table 7, page A-19. The dates for state old age assitance laws are taken from ElderWed, http://www.elderweb.com/home/node/2896.

Figure 3: The fraction of the labor force in agriculture is based on Mitchell (2003), Table B1 Economicaly Active Population, by Major Industrial Groups, page 147. The adoption of social security dates are from the Social Security Administration (2006).

Figure 4: Greenwood and Uysal (2005), Figure 9.

Figure 5: The data for 1850 and 1900 are from Haines (1988) and for 1950 are taken from the U.S. Department of Health, Education and Welfare (1964). They are the average of the conditional survival probabilities from age 60 to 65, from 65 to 70, from 70 to 75 and 75 to 80. The 1850 numbers are for white males only.

9 Appendix B

Proof of Proposition 1: The problem of a middle-aged agent is

$$\max_{a'} \left[\log(I_m + (1+r)a - \tau - a') + \beta\pi \log(I_o + (1+r)a' + \frac{2\tau}{\pi}) \right].$$

The first order condition for a' is given by

$$\frac{-1}{I_m + (1+r)a - \tau - a'} + \frac{\beta\pi(1+r)}{I_o + (1+r)a' + \frac{2\tau}{\pi}} \leq 0.$$

Solving for an interior a' yields

$$a' = \frac{\beta\pi(1+r)[I_m + (1+r)a - \tau] - (I_o + 2\tau/\pi)}{(1+r)(1+\beta\pi)},$$

which is positive iff

$$\beta\pi(1+r)[I_m + (1+r)a - \tau] - (I_o + 2\tau/\pi) \geq 0. \tag{36}$$

Since the right hand side of this inequality is decreasing in τ, there exists a threshold tax level below which saving decision is positive and above which saving decision is zero. Finally, if $a' > 0$, then

$$\frac{\partial a'}{\partial \tau} = \frac{-(\beta\pi(1+r) + \frac{2}{\pi})}{(1+r)(1+\beta\pi)} < 0,$$

$$\frac{\partial a'}{\partial a} = \frac{(1+r)\beta\pi}{1+\beta\pi} > 0,$$

and

$$\frac{\partial a'}{\partial \pi} = \frac{\beta(1+r)[I_m + a - \tau] + (1+\beta\pi)\frac{2\tau}{\pi^2} + \beta(I_o + \frac{2\tau}{\pi})}{(1+r)(1+\beta\pi)^2} > 0.$$

Proof of Proposition 2: In order to compute the threshold tax level at which the savings decision becomes strictly positive, we solve for τ in Equation (36). This yields

$$\hat{\tau} = \max\left\{0, \frac{\beta\pi(1+r)[I_m + (1+r)a] - I_o}{2/\pi + \beta\pi(1+r)}\right\}.$$

If the threshold tax level is strictly positive, i.e. if $\hat{\tau} > 0$, then

$$\frac{\partial \tau}{\partial a} = \frac{\beta\pi(1+r)^2}{2/\pi + \beta\pi(1+r)} > 0.$$

Proof of Proposition 3: Consider now the problem of the middle-aged median voter. His optimal tax problem is given by

$$\max_{\tau}\left[\log(I_m + (1+r)a - \tau - a'(\tau)) + \beta\pi\log(I_o + (1+r)a'(\tau) + \frac{2\tau}{\pi})\right].$$

The first order condition for τ is

$$\frac{-(1 + \frac{\partial a'}{\partial \tau})}{I_m + (1+r)a - \tau - a'(\tau)} + \frac{\beta\pi[(1+r)\frac{\partial a'}{\partial \tau} + \frac{2}{\pi}]}{I_o + (1+r)a'(\tau) + \frac{2\tau}{\pi}} \leq 0. \tag{37}$$

Remember that each agent has a threshold tax level. Above this level, the agent chooses to save zero assets, and below this level the agent chooses a positive amount of assets, and the derivative of this asset choice with respect to the tax level is strictly negative. Therefore, it is useful to think of the two different cases, first, when the tax level is over the reservation tax and second, when the tax level is below the reservation tax.

Case 1: Suppose the optimal tax level of the median voter is greater than or equal to his reservation tax, $\tau^* \geq \hat{\tau}$ and as a result his savings decision is zero, i.e., $a' = 0$, and $\frac{\partial a'}{\partial \tau} = 0$.Then Equation (37) implies that the optimal tax level is given by:

$$\tau^* = \max\{0, \underbrace{\frac{\beta\pi\frac{2}{\pi}[I_m + (1+r)a] - I_o}{\frac{2}{\pi} + \beta\pi\frac{2}{\pi}}}_{A}\}.$$

Recall that the reservation tax level is given by:

$$\hat{\tau} = \max\{0, \underbrace{\frac{\beta\pi(1+r)[I_m + (1+r)a] - I_o}{\frac{2}{\pi} + \beta\pi(1+r)}}_{B}\}.$$

Note that if $\frac{2}{\pi} > 1 + r$, $A > B$, and $\tau^* > \hat{\tau}$. If $\frac{2}{\pi} = 1 + r$, $A = B$, and $\tau^* = \hat{\tau}$. And, if $\frac{2}{\pi} < 1 + r$, then $A < B$ and then the only way for $\tau^* \geq \hat{\tau}$ is if $B < 0$. This is true when $\beta\pi(1+r)[I_m + (1+r)a] < I_o$, and implies that $\tau^* = \hat{\tau} = 0$.

Case 2: Consider now the other case. Suppose the optimal tax level of the median voter is strictly less than his reservation tax, $\tau^* < \hat{\tau}$ and as a result his asset choice, and its derivative are given by $a' = \frac{\beta\pi(1+r)[I_m+(1+r)a-\tau]-(I_o+\frac{2\tau}{\pi})}{(1+r)(1+\beta\pi)}$ and $\frac{\partial a'}{\partial \tau} = \frac{-(\beta\pi(1+r)+\frac{2}{\pi})}{(1+r)(1+\beta\pi)}$, respectively.

Then the first order condition in Equation (37) can be written as:

$$\frac{-[(1+r) - \frac{2}{\pi}]}{(1+r)[I_m + (1+r)a - \tau] + [I_o + \frac{2\tau}{\pi}]} + \frac{-\beta\pi(1+r)[(1+r) - \frac{2}{\pi}]}{(1+r)^2[I_m + (1+r)a - \tau] + [I_o + \frac{2\tau}{\pi}]} \leq 0.$$

Note that if $\frac{2}{\pi} > 1 + r$, the left hand side of the first order condition is always positive which is a contradiction. If $\frac{2}{\pi} = 1 + r$, then the first order condition is zero for all tax levels below the reservation tax level. In other words, we have $\tau^* \in [0, \hat{\tau})$ and $a' = \frac{\beta\pi(1+r)[I_m+(1+r)a-\tau^*]-(I_o+\frac{2\tau^*}{\pi})}{(1+r)(1+\beta\pi)}$. And, if $\frac{2}{\pi} < 1 + r$, then the left hand side of the first order condition is negative for all tax levels below the reservation level, so $\tau^* = 0$, and $a' = \frac{\beta\pi(1+r)[I_m+(1+r)a]-I_o}{(1+r)(1+\beta\pi)}$.

We summarize these results in Table A1.

TABLE A1

Returns	Decisions
$\frac{2}{\pi} < 1+r$	$\tau^* = 0$
	$a' = \max\{0, \frac{\beta\pi(1+r)[I_m+(1+r)a]-I_o}{(1+r)(1+\beta\pi)}\}$
$\frac{2}{\pi} > 1+r$	$\tau^* = \max\{0, \frac{2\beta[I_m+(1+r)a]-I_o}{\frac{2}{\pi}+2\beta}\}$
	$a' = 0$
$\frac{2}{\pi} = 1+r$	$\tau^* \in [0, \max\{0, \frac{\beta\pi(1+r)[I_m+(1+r)a]-I_o}{\frac{2}{\pi}+\beta\pi(1+r)}\}]$
	$a' = \max\{0, \frac{\beta\pi(1+r)[I_m+(1+r)a-\tau^*]-(I_o+\frac{2\tau^*}{\pi})}{(1+r)(1+\beta\pi)}\}$

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Figure 1 --- Population in Rural and Urban Areas

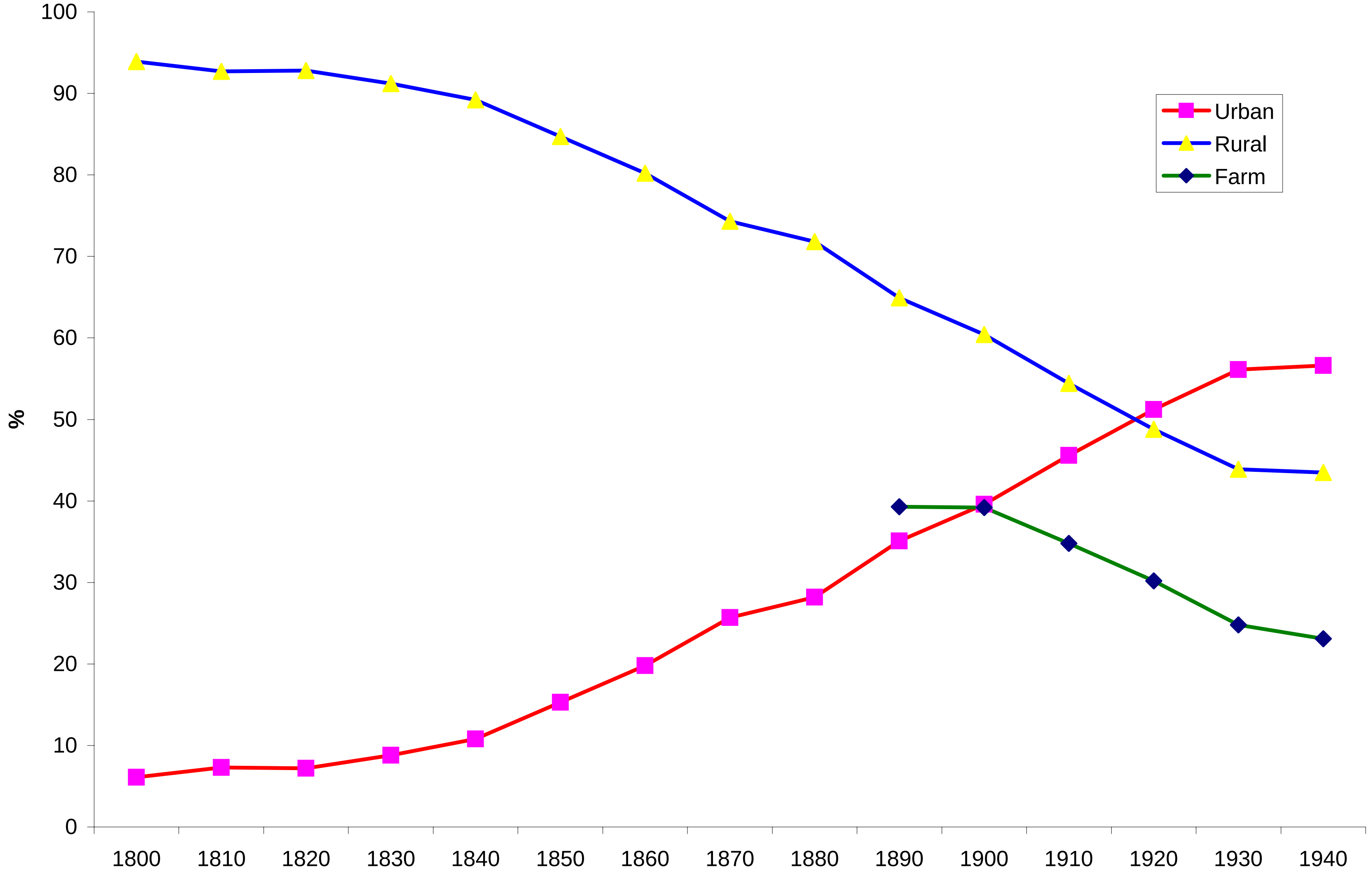


Figure 2: Urbanization and Elderly (65+) Population Across U.S. States -- 1930
States in Circles Introduce State Pension Plans before 1935

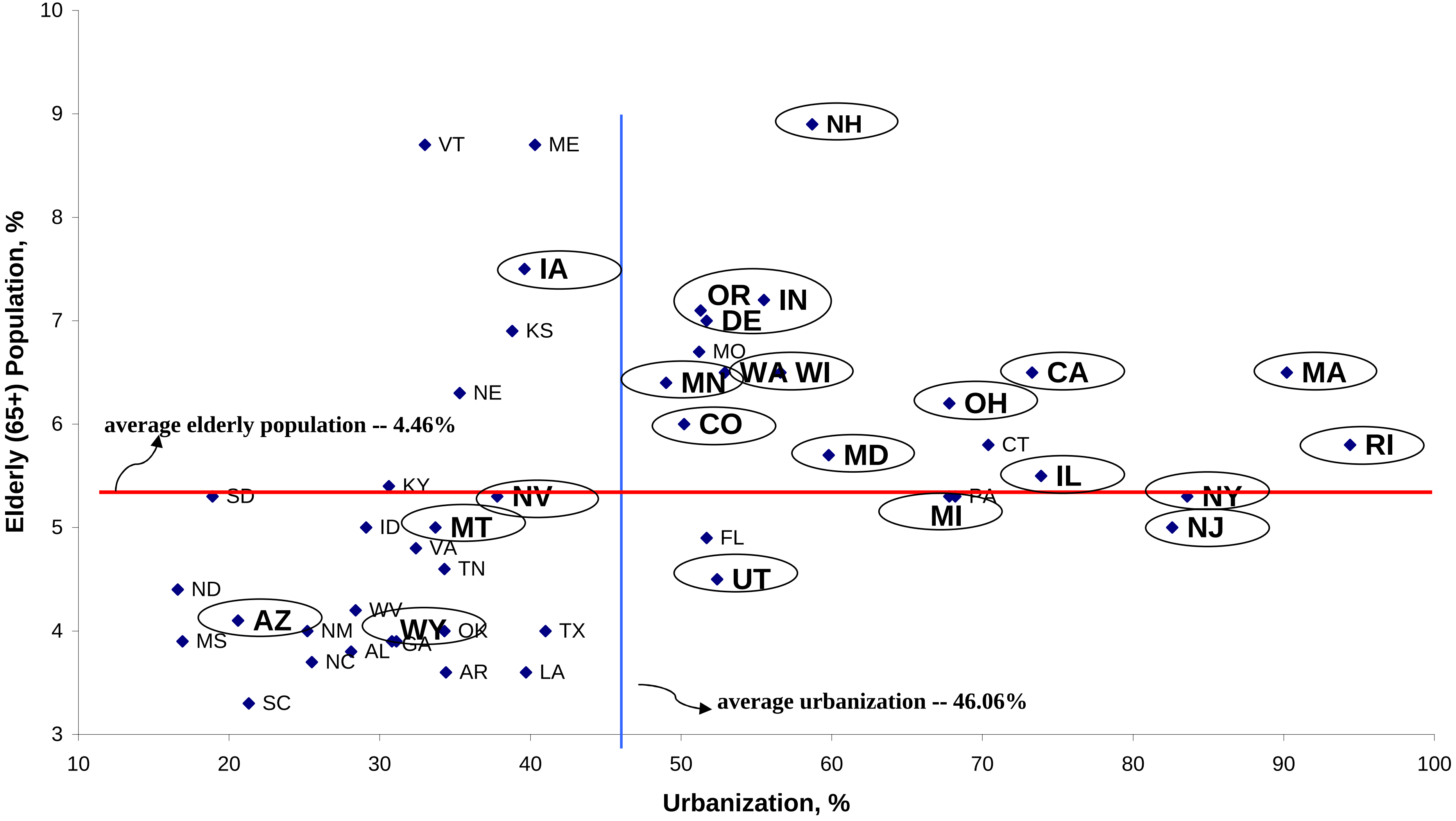


Figure 3: Fraction of Labor Force in Agriculture in 1890 and The Adoption of Social Security

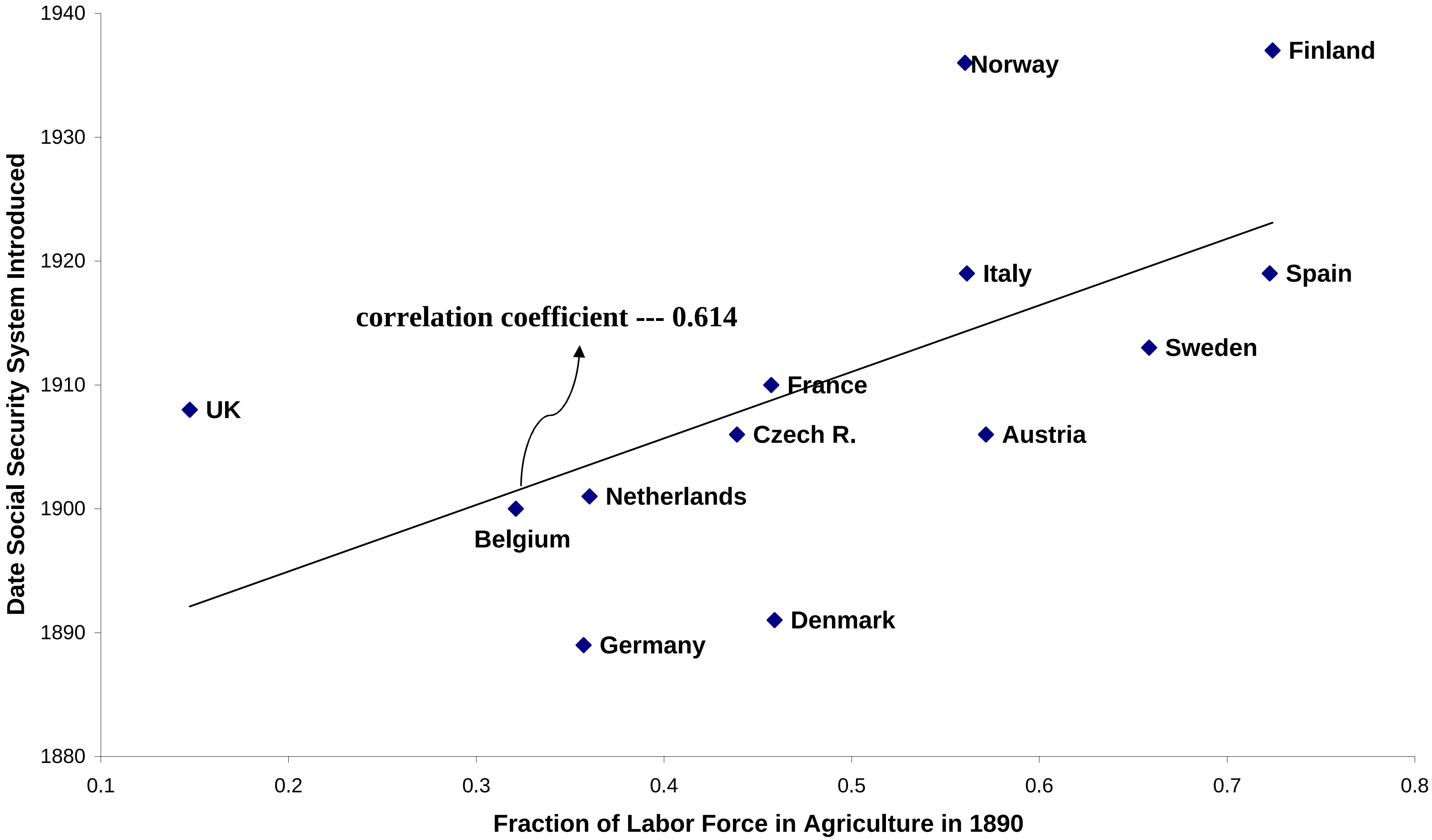


Figure 4 --- TFP in Agriculture and Non Agriculture

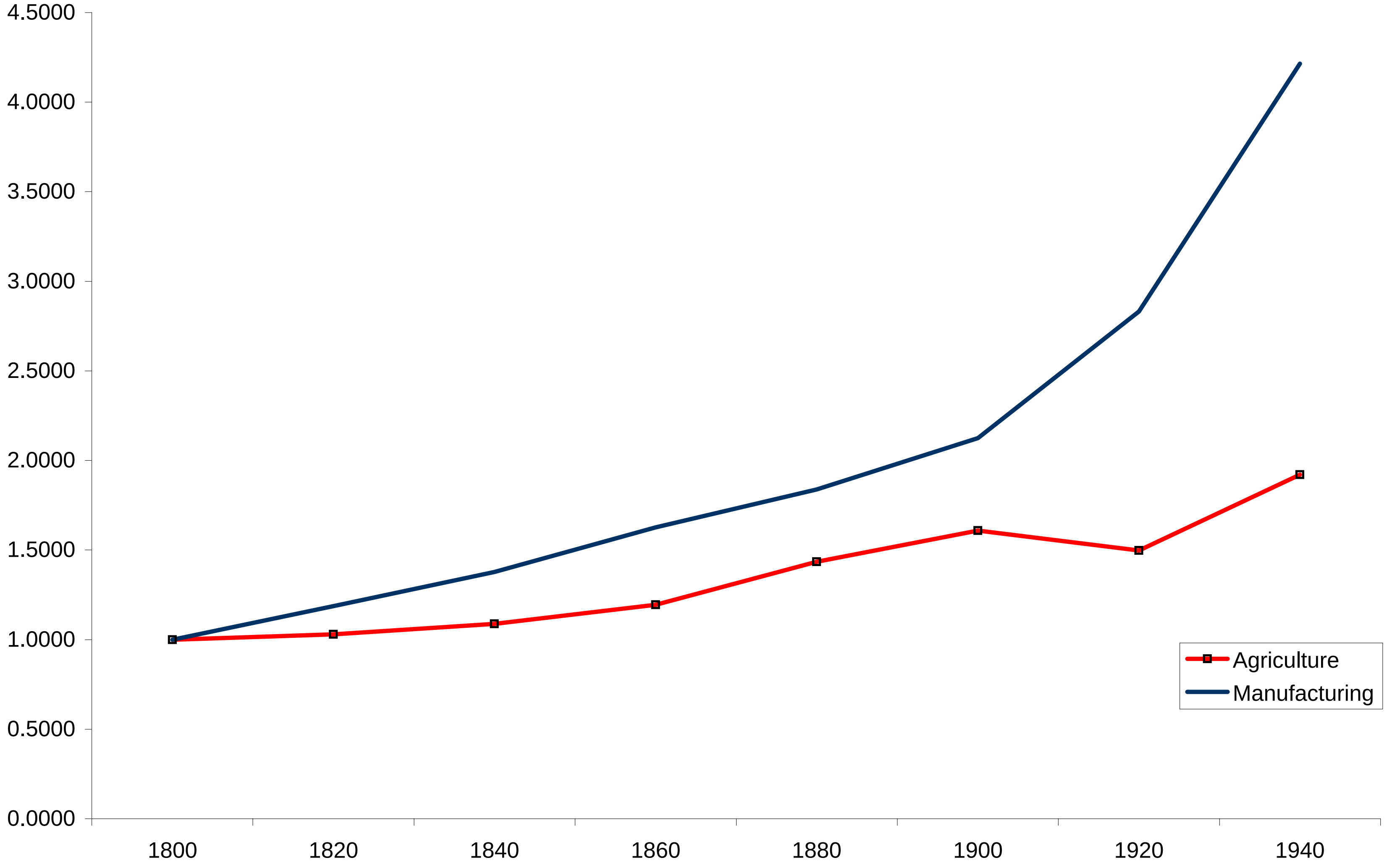
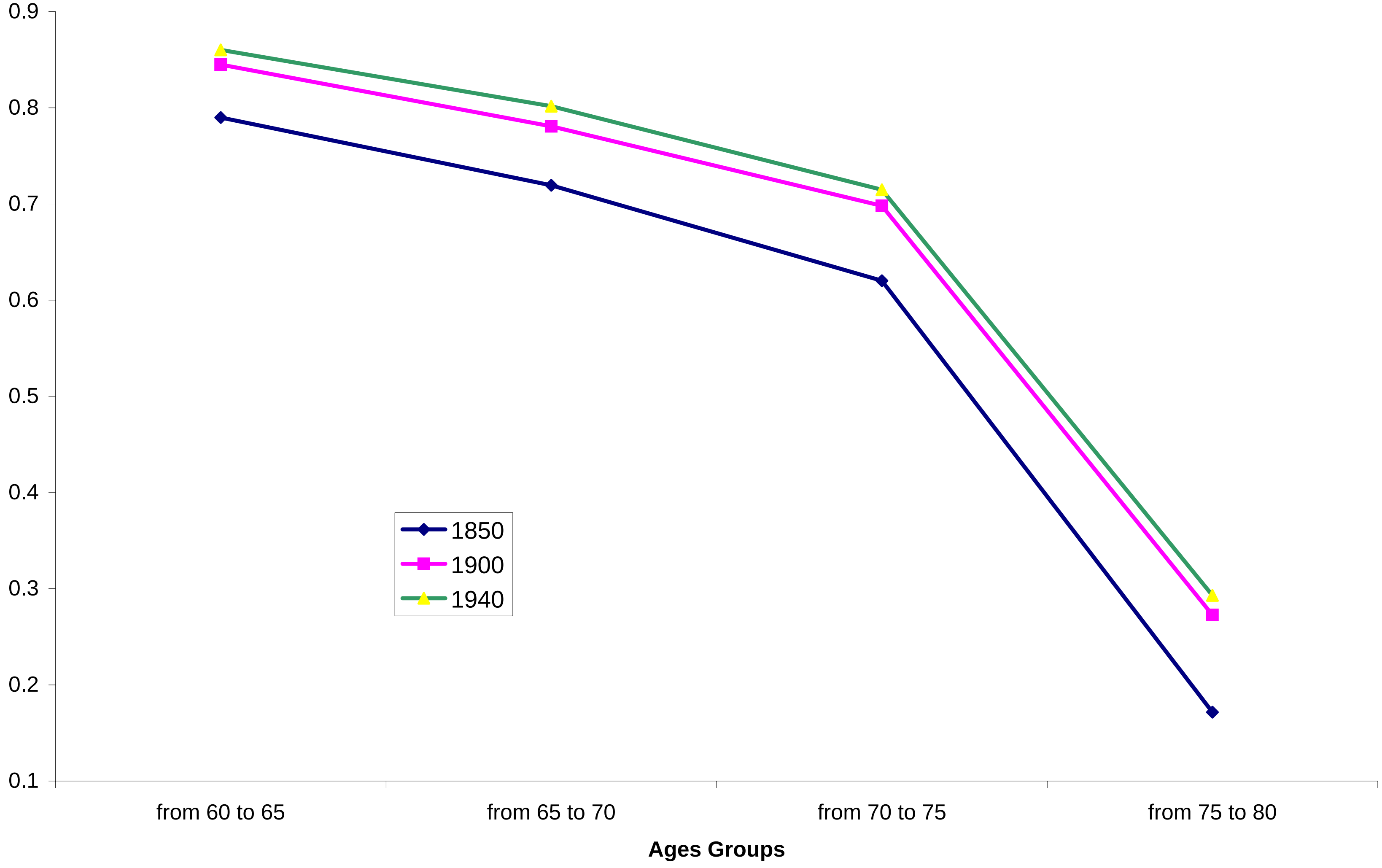


Figure 5 --- Conditional Survival Probabilities



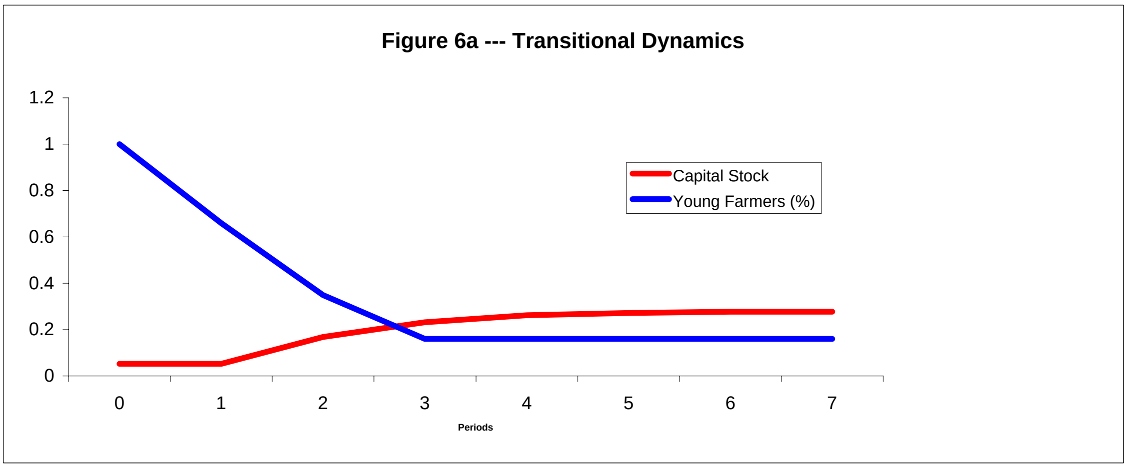


Figure 6a --- Transitional Dynamics
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
Periods
Capital Stock
Young Farmers (%)

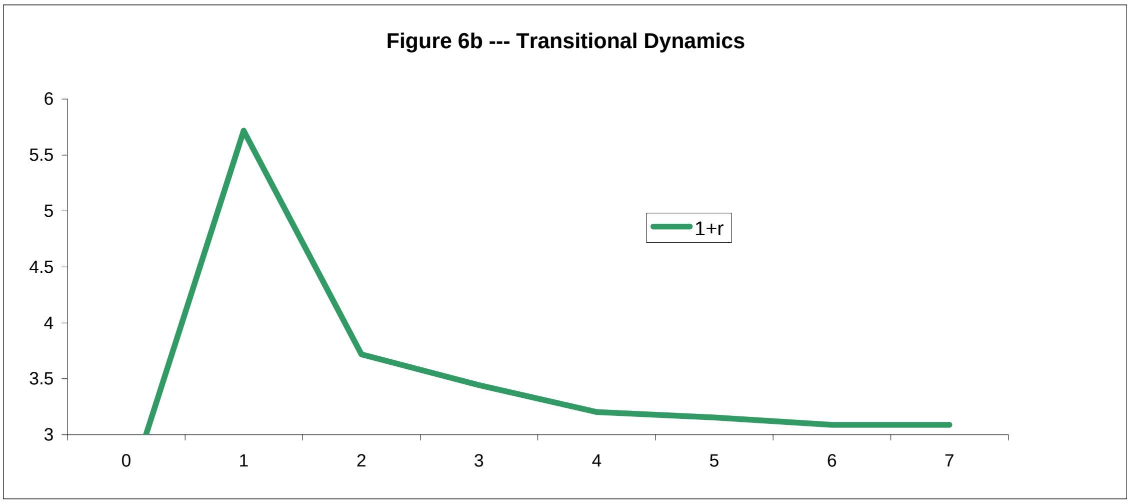


Figure 6b --- Transitional Dynamics
6
5.5
5
4.5
4
3.5
3
0
1
2
3
4
5
6
7
1+r

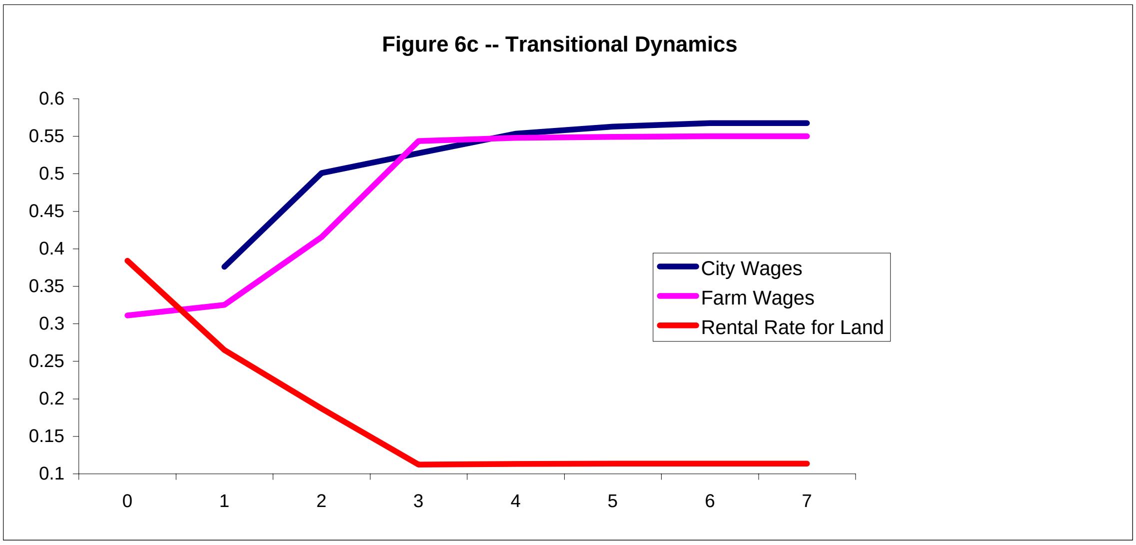


Figure 6c -- Transitional Dynamics
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0
1
2
3
4
5
6
7
City Wages
Farm Wages
Rental Rate for Land