Agriculture to Industry: the End of the Patriarchal Family*

Luca Pensieroso† Alessandro Sommacal‡

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Abstract

We show that the structural change of the economy from agriculture to industry was a major determinant of the observed shift in intergenerational coresidence. We build a two-sector overlapping generation model with collective bargaining among family members in case of coresidence. We calibrate the model on US data and simulate it. Depending on the specifications, the model is able to reproduce between 54 and 91 percent of the overall drop of the US coresidence rate between 1870 and 1970.

Keywords: Unified Growth Theory, Intergenerational Living Arrangements, Bargaining Power, Family Economics, Structural Change

JEL Classification: O40, O11, O33, J10, E13

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†IRES, Université catholique de Louvain. E-mail: luca.pensieroso@uclouvain.be

‡Department of Economics, University of Verona; Econpubblica, Bocconi University. E-mail: alessandro.sommacal@univr.it

1 Introduction

The family structure in Western societies has changed significantly since the nineteenth century. Broadly speaking, there has been a shift from intergenerational coresidence (patriarchal family) to independent living arrangements for the elderly (nuclear family). In the United States, according to the data provided by Pensieroso and Sommacal (2010), the percentage of elderly persons residing with their adult children plummeted from almost 66% in 1850, to 15% in 1990. A recent survey by the United Nations confirms that there is a global trend, across countries and over time towards more independent living arrangements among the elderly.[1]

Different theories have been advanced in the literature to explain the phenomenon. A group of authors maintain that the introduction of Social Security is the engine behind the observed shift in the coresidence pattern.[2] According to this perspective, also known as the "affluence hypothesis", intergenerational coresidence was imposed on its elderly members by the lack of alternatives. Others take the opposite view, also known as the "economic development hypothesis", and attribute the shift to the increased income of the young.[3] Bethencourt and Rios-Rull (2009) provide a theory compatible with both perspectives. Dealing with living arrangements of elderly widows in the United States, they show that when income is the driving factor, 2/3 of the shift is due to increased income of the young, 1/3 to increased income of the elderly, typically in the form of social security.

The mechanisms behind the effects of income on the coresidence patterns have been scrutinized only recently in formal economic models. Salcedo, Schoellman, and Tertilt (2012) model families as a collection of roommates: coresidence is chosen because individuals find it profitable to share a public good, typically housing services. Because of non-homothetic preferences, as income increases, the share of income allocated to the public good decreases, leading to the eventual demise of coresidence. In Pensieroso and Sommacal (2010), the growth rate of the economy and the family structure are co-determined by technical change and variations in the cultural factors affecting the taste for coresidence. They model the choice of coresidence as the outcome of a cooperative bargaining, à la Chiappori (1988, 1992a,b). In their model, coresidence is the chosen living arrangement when it is Pareto-superior to the outside option, that is living alone. They conclude that when technical progress is fast enough, the

[1] United Nations (2005).

[2] See for instance Costa (1997), McGarry and Schoeni (2000), among others.

[3] Aquilino (1990), Ruggles (2007), Ward, Logan, and Spitze (1992), Whittington and Peters (1996), to mention but a few.

economy experiences a transition from stagnation to growth, there is a shift from coresidence to non-coresidence, and the social status of the elderly tends to deteriorate.

Our article fits the "economic development hypothesis", and complements in particular the work by Pensieroso and Sommacal (2010). We shall show that an important determinant of the observed change in the family structure was the structural change of the economy from agriculture to industry that characterized the industrial revolution.

The structural change out of agriculture, whose explanation is still debated,[4] is a defining feature of the industrial revolution. Its role in determining economic development is hardly controversial. Most recently, Hansen and Prescott (2002) have argued that the structural change from agriculture to industry was the main driving force behind the shift from Malthusian stagnation to economic growth.

That the structural change out of agriculture might have influenced the family structure is also widely accepted. According to Ruggles (2007), the shift from agriculture to industry allowed the younger generations to earn their way out of family life: as a matter of facts, the emergence of wage labour during the process of industrialization made them independent, as they were not forced to work on the property of the family anymore, typically land or handicraft shops.

In this paper, we shall provide a framework in which higher technical change in the industrial vis à vis the agricultural sector causes a progressive reallocation of labour from agriculture to industry. This affects the functional distribution of income, changing in turn the bargaining power of the different generations, and therefore the incentive to coreside.

We will build a two-sector overlapping generation model with agriculture and industry. We shall assume collective bargaining among family members in case of coresidence, as in Pensieroso and Sommacal (2010). In our model, the old own all the land, and receive a rent from it. The young instead provide the labour force. They can work in both the agricultural and the industrial sector, their choice being driven by a no-arbitrage condition on wages in the two sectors. As productivity in the industrial sector relative to productivity in the agricultural sector takes off, employment shift from agriculture to industry, as in Hansen and Prescott (2002). The wage earned by the young increases, while the rent on land decreases. As coresidence is deeply influenced by the functional distribution of income, the industrial take off implies lower coresidence rates.

A peculiarity of the model discussed here with respect to Pensieroso

[4]See Alvarez-Cuadrado and Poschke (2011).

and Sommacal (2010) is that differently from them, we will assume that when coresidence is Pareto-efficient the probability that coresidence be the chosen living arrangement is positive but in general different from one. This makes coresidence a continuous variable, thereby introducing the coresidence rate in the model. Such a modification makes the model quantitative, and therefore suitable to be taken to the data. Accordingly, we will calibrate the model on US data and simulate it to verify whether it is able to predict the observed pattern of the US coresidence rate.

2 The model

There are two sectors in the economy, agriculture (a) and industry (i), producing a final good Y with two different processes. The production function in the agricultural sector is

$$Y_{a,t} = A_{a,t} H_{a,t}^{\beta} L^{1-\beta}, \tag{1}$$

where L stands for land and $H_{a,t}$ for the hours worked in sector a, in period t. We assume that land is in fixed supply. The variable $A_{a,t}$ denotes total factor productivity (TFP) in agriculture.

The production function in the industrial sector is

$$Y_{i,t} = A_{i,t} H_{i,t}, \tag{2}$$

where $A_{i,t}$ denotes TFP in industry.

The aggregate production function for this economy is

$$Y_t = Y_{a,t} + Y_{i,t}. \tag{3}$$

The final good Y_t is the numeraire.

The production functions (1) and (2) are such that if the ratio $A_{a,t}/A_{i,t}$ is big enough, only the agricultural sector is operative. If instead the ratio $A_{a,t}/A_{i,t}$ is arbitrarily low, then both sectors will be operative. This asymmetry between the two sectors is explained by the fact that land is in fixed supply, implying that the marginal productivity of labour in agriculture goes to infinity when employment in the agricultural sector tends to zero.

Calling $w_{a,t}$ the wage in agriculture, $w_{i,t}$ the wage in industry and R_t the rent from land, profit maximizations in the two sectors implies

$$w_{a,t} = \beta A_{a,t} H_{a,t}^{\beta-1} L^{1-\beta}, \tag{4}$$

$$R_t = (1-\beta)A_{a,t}H_{a,t}^{\beta}L^{-\beta}, \tag{5}$$

$$w_{i,t} = A_{i,t}. \tag{6}$$

If both sectors are operative, labour mobility across sector ensures that $w_{a,t} = w_{i,t} = w_t$. If only the agriculture sector is operative, then the wage paid in the economy is $w_t = w_{a,t}$.

Without loss of generality, we shall assume $L = 1$.

The economy is populated by two overlapping generations of individuals living for two periods, the young, (y), and the old, (o). The size of each generation is N, and it is constant over time.

In the first period, the agent is young and supplies inelastically one unit of labour. He can work in both sectors.[5] He inherits the land from the old at the end of the period. In the second period, the agent is old and does not work. He earns the return on land and leaves the land to the young as bequest.

In each period, the young and the old can either live apart or coreside.

The coresidence decision is modeled as in Pensieroso and Sommacal (2010) to whom the interested reader may refer for further details.

We assume that the utility function of an agent of type $j = y, o$ is:

$$U(c_t^j, x_t^j; \delta) = \alpha \log c_t^j + (1-\alpha)\log x_t^j + \delta \log \kappa^j, \tag{7}$$

where c_t^j and x_t^j stands for consumption and housing services, respectively. We assume that housing services are a private good, if agents live alone, and a pure public good, if they live together. The price of x is denoted by p.[6]

The variable κ^j measures the taste for living together (for instance, the taste for privacy). The parameter δ is dummy variable. It takes the values $\delta = 0$, if agent j lives alone, and $\delta = 1$ if the agents coreside.

If the young and the old live apart, they maximize $\hat{U}(c_t^j, x_t^j) \equiv U(c_t^j, x_t^j; 0)$ subject to their respective budget constraints

$$p_t x_t^y + c_t^y = w_t, \tag{8}$$

$$p_t x_t^o + c_t^o = R_t. \tag{9}$$

From the solution to this maximization problem we get the indirect utility functions $\hat{V}_t^j$.

[5] This implies $H_{a,t} + H_{i,t} = 1$.

[6] We assume that x is produced using a linear technology $x = ZY^x$, where Y^x are the units of the final good Y used in the production of x. In equilibrium, $Z = \frac{1}{p}$.

If the young and the old live together, they will bargain over the distribution of the resources within the family. We model such bargaining using a collective model (Chiappori (1988, 1992a,b)). Hence, the household maximizes the sum of the utility functions of the young and the old, weighted by their respective bargaining power:

$$\max \theta_t \tilde{U}(c_t^y, x_t) + (1 - \theta_t)\tilde{U}(c_t^o, x_t),$$

subject to

$$p_t x_t + c_t^y + c_t^o = w_t + R_t, \tag{10}$$

where $\tilde{U}(c_t^j, x_t) \equiv U(c_t^j, x_t; 1)$.

From the solution to the maximization problems we get the indirect utility functions $\tilde{V}^j(\theta_t, \kappa^j)$.

In this model, coresidence can only occur when there exists at least one value of θ_t such that coresidence is Pareto improving, with respect to the outside option 'non coresidence'. We define $\theta_{min,t}$ as the value of the bargaining power of the young such that they are indifferent between living alone or with the old. By the same token, we define $\theta_{max,t}$ as the value of the bargaining power of the young such that the old are indifferent between living alone or with the young. The formulas for $\theta_{min,t}$ and $\theta_{max,t}$ read:[7]

$$\theta_{min,t} = \left(\frac{w_t}{w_t + R_t}\frac{1}{\kappa^y}\right)^{\frac{1}{\alpha}}, \tag{11}$$

$$\theta_{max,t} = 1 - \left(\frac{R_t}{w_t + R_t}\frac{1}{\kappa^o}\right)^{\frac{1}{\alpha}}. \tag{12}$$

It is possible to show that if $\theta_{min,t} < \theta_{max,t}$, coresidence is always Pareto improving.[8] However, the model is silent about the ultimate determinants of the actual bargaining power θ. In fact, although in this case coresidence may be optimal in the Pareto sense, the actual bargaining power θ might fall outside the interval $[\theta_{min,t}, \theta_{max,t}]$. In the following, we assume that when $\theta_{min,t} < \theta_{max,t}$, coresidence is the chosen living arrangement with a positive probability $\pi_t = \pi(\theta_{max,t} - \theta_{min,t})$, decreasing in the difference $(\theta_{max,t} - \theta_{min,t})$. The idea is that the actual bargaining power θ is less likely to fall within the interval $[\theta_{min,t}, \theta_{max,t}]$, the smaller the interval is.

When instead $\theta_{min,t} \geq \theta_{max,t}$, coresidence is never Pareto improving. In this case, the probability of coresiding, π_t, is zero. We assume that the size

[7] Notice that $0 \leq \theta_{min,t} \leq 1$ holds if and only if $\frac{w_t}{w_t+R_t} \leq \kappa^y$. Similarly, $0 \leq \theta_{max,t} \leq 1$ holds if and only if $\frac{R_t}{w_t+R_t} \leq \kappa^o$. These conditions always holds for any $\kappa^j \geq 1$.

[8] See Pensieroso and Sommacal (2010).

of each generation is large enough to ensure that the law of large numbers holds. Accordingly, we can interpret π_t as a coresidence rate.

Computing the difference $(\theta_{max,t} - \theta_{min,t})$ we find:

$$\theta_{max} - \theta_{min} = 1 - \left(\frac{1}{(1+d_t)\kappa^o}\right)^{\frac{1}{\alpha}} - \left(\frac{d_t}{(1+d_t)\kappa^y}\right)^{\frac{1}{\alpha}} \tag{13}$$

where $d_t \equiv \frac{w_t}{R_t}$.

As a consequence, living arrangements will in general depend on the taste for coresidence κ^j, on the weight of the public good in the utility function $(1-\alpha)$, and on the functional income distribution d_t. In particular, it is possible to show that $(\theta_{max,t} - \theta_{min,t})$ is decreasing in d_t if and only if

$$\frac{\kappa^y}{\kappa^o} < d^{(1-\alpha)}. \tag{14}$$

We assume that this condition always hold.

Using Equations (4) and (5), the functional income distribution d_t can be written as

$$d_t \equiv \frac{w_t}{R_t} = \frac{\beta}{(1-\beta)H_{a,t}}. \tag{15}$$

When only the agricultural sector is operative, $H_{a,t} = 1$ and d_t is a constant. When instead both sectors are operative, wage equality across sectors ensures that

$$H_{a,t} = \left(\frac{\beta A_{a,t}}{A_{i,t}}\right)^{\frac{1}{1-\beta}}. \tag{16}$$

Therefore, d_t is a decreasing function of $A_{a,t}/A_{i,t}$.

3 The industrial revolution

We assume that the TFP in the two sectors evolves according to the following law of motions:

$$A_{a,t+1} = (1+\gamma_a)A_{a,t}, \tag{17}$$

$$A_{i,t+1} = (1+\gamma_i)A_{i,t}, \tag{18}$$

where $\gamma_a < \gamma_i$ are the constant growth rate of TFP in agriculture and industry, respectively.

Following Hansen and Prescott (2002), we assume that at time $t = 0$ both technologies are available, but the productivity ratio $A_{a,0}/A_{i,0}$ is such that wages in the agricultural sector are strictly higher than wages in the industrial sector, and therefore only the agricultural sector is operative. For this condition to hold, it must be

$$\frac{A_{a,t}}{A_{i,t}} > \frac{1}{\beta} \tag{19}$$

In such as scenario, the marginal productivity of land is high, as the rent paid to landowner - the old, is. The economy is along a balanced growth path with a growth rate given by γ_a.

Asymptotically, the weight of the agricultural sector goes to zero and the economy is along a balanced growth path where the growth rate tends to γ_i. During the transitional dynamics, both sectors are operative and the growth rate is equal to

$$\gamma_t = \frac{(1+\gamma_i)A_{i,t} + (1-\alpha)(1+\gamma_a)A_{a,t}\left[\alpha\frac{(1+\gamma_a)A_{a,t}}{(1+\gamma_i)A_{i,t}}\right]^{\frac{\alpha}{1-\alpha}}}{A_{i,t} + (1-\alpha)A_{a,t}\left[\alpha\frac{A_{a,t}}{A_{i,t}}\right]^{\frac{\alpha}{1-\alpha}}} - 1, \tag{20}$$

which is not constant.

As $\gamma_a < \gamma_i$, the ratio $A_{a,t}/A_{i,t}$ decreases over time. If the initial condition $A_{a,0}/A_{i,0}$ is such that $(\theta_{max,0} - \theta_{min,0}) > 1$, the coresidence rate will be $\pi_0 > 0$. When the ratio $A_{a,t}/A_{i,t}$ passes the threshold level $1/\beta$, the industrial sector becomes profitable and then operative. As explained above, d_t is a decreasing function of the ratio $A_{a,t}/A_{i,t}$ (see Equation (16)), and, when Condition (14) holds, the difference $(\theta_{max,t} - \theta_{min,t})$ is a decreasing function of d_t . Therefore, the assumed patterns for sectoral TFP implies that the difference $(\theta_{max,t} - \theta_{min,t})$ decreases over time. Consequently, the coresidence rate π_t shrinks, and eventually becomes zero. Coresidence fades away as the industrial revolution kicks in.

4 The quantitative exercise

In this section, we run a quantitative exercise to verify if the model outlined above is able to match the observed shift in the US coresidence patterns documented in Figure 1. The objective is to quantify the strength of the mechanism outlined in the previous section.

4.1 Calibration

In order to simulate the model, we need to specify the functional form of the probability to coreside π, and to calibrate the structural parameters.

Concerning the probability to coreside, we shall assume:

$$\begin{cases} \pi_t = (\theta_{max,t} - \theta_{min,t})^{\phi} & \text{if} \quad \theta_{max,t} - \theta_{min,t} > 0, \\ \pi_t = 0 & \text{if} \quad \theta_{max,t} - \theta_{min,t} \leq 0, \end{cases} \tag{21}$$

where $\phi > 0$. This simple parametric formulation ensures that π is always between 0 and 1, and increasing in $(\theta_{max} - \theta_{min})$. The parameter ϕ affects both the level of the coresidence rate and its sensitivity to variations in $(\theta_{max} - \theta_{min})$.

Table 1 illustrates the chosen values for the structural parameters. The 'Target' column reports the reference variable used for the calibration of each parameter. We interpret one model period to be 20 years.

Parameter	*Value*	*Target*
α	0.80	Median expenditure on housing in the USA in 2009
β	0.6	Share-cropping contracts/English National Accounts 1688
γ_i	0.485	Trend growth of U.S. GDP in the XX century
γ_a	0.029	Trend growth of GDP in Western Europe, 1700-1820
κ^y	1	No role for cultural factors
κ^o	1	No role for cultural factors
ϕ	0.24	Coresidence rate in 1870

Table 1: Calibration of the parameters

The parameter ϕ in Equation (21) is calibrated to match the US coresidence rate in 1870, which was equal to 60%.

The value of the land share, β, is taken from Doepke (2004). It is the average between the typical share-cropping contract, allocating 50 percent of output to the land owner, and the English National Accounts from Deane and Cole (1969), indicating that rents amounted to 27 percent of national income in 1688.

We set the initial conditions for the TFPs in the two sectors so that A_i is 1, and the ratio A_a/A_i is such that the model matches the data about employment in agriculture in 1870.[9]

The growth rate of TFP in the industrial sector, γ_i, is computed as the 20-years equivalent to an annual growth rate of 2%. This is the value of the growth of US GDP in the XX century, according to Kehoe and Prescott (2002).

[9]Data on emplyment in agriculture are from U.S. Bureau of the Census (1975).

The growth rate of TFP in the agricultural sector, γ_a, is computed as the 20-years average growth rate of GDP per capita of a bundle of Western European countries between 1700 and 1820.[10]

The preference for private consumption, α, is calibrated to match the value of the median expenditure on housing (by owner) in the United States in 2009. Data and definitions are from U.S. Bureau of the Census (2011).

We leave aside the role of cultural factors in the determination of the coresidence rate, by assigning to κ^y and κ^o a value of 1.

4.2 Simulation

Figure 2 shows the pattern of coresidence in the model (blue line), and compare it with the data (red-dotted line). Overall, the model account for about 91% of the change in the coresidence rate, meaning that the structural change out of agriculture was a major determinant of the change in the family structure.

Our model provides a joint explanation of the shift from agriculture to industry and the change in the coresidence rate. One might wonder whether our results on coresidence are directly driven by the way in which we modelled the structural change out of agriculture. To verify whether this is actually the case, we run a simulation in which employment in agriculture in each period is taken from the data. Results are shown in Figure 3 (green line). The overall explanatory power of the model diminishes, with the structural change out of agriculture now accounting for about 54% of the change in the coresidence rate. However, the pattern of the data is better reproduced. These results lead to two conclusions. First, the benchmark model must overestimate the shift of employment out of agriculture. Figure 4 confirms this intuition. There, we report the evolution of employment in agriculture in the benchmark model (blue line), in the data (red-dotted line) and in the model in which employment in agriculture in each period is taken from the data (green line). The benchmark model clearly overestimates the fall in employment in agriculture. Second, the core mechanism of our model going from the structural change out of agriculture to the change in coresidence is quantitatively relevant, even

[10] The countries are the Western Europe 12 group in Maddison (2011): Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland and United Kingdom. We use those countries as representative of what GDP per capita was among colonists in the United States. For comparison, the value of γ_a in Hansen and Prescott (2002) is 0.03.

once the overestimation of the fall of employment in agriculture is taken away.

5 Conclusions

In this paper, we have shown that the structural change out of agriculture during the industrial revolution was a major determinant of the observed change in the family structure in the United States since the end of the XIX century.

We built a two-sector model of the structural change from agriculture to industry à la Hansen and Prescott (2002) with endogenous intergenerational coresidence.

We calibrate the model on US data. Results from the simulations show that the structural change out of agriculture can account for a percentage ranging from 54% to 91% of the observed change in the coresidence pattern.

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Figures

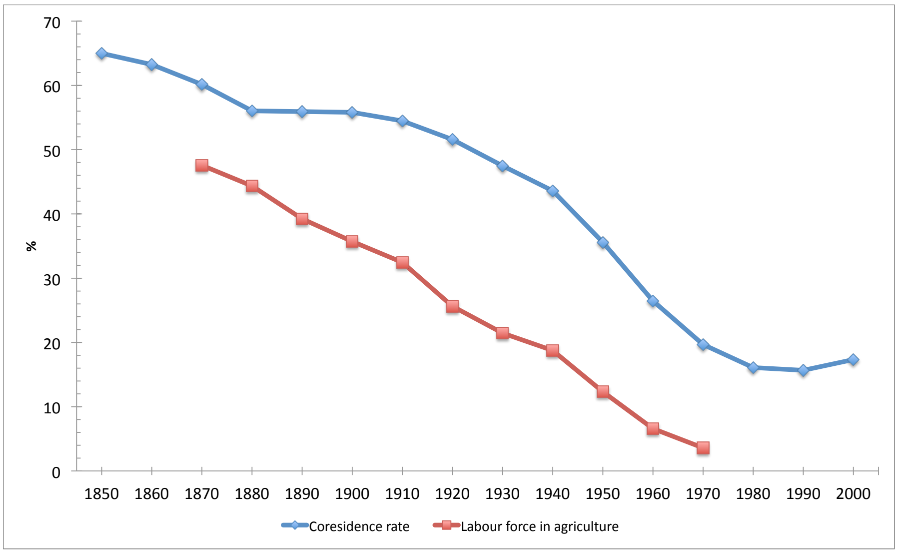

Figure 1

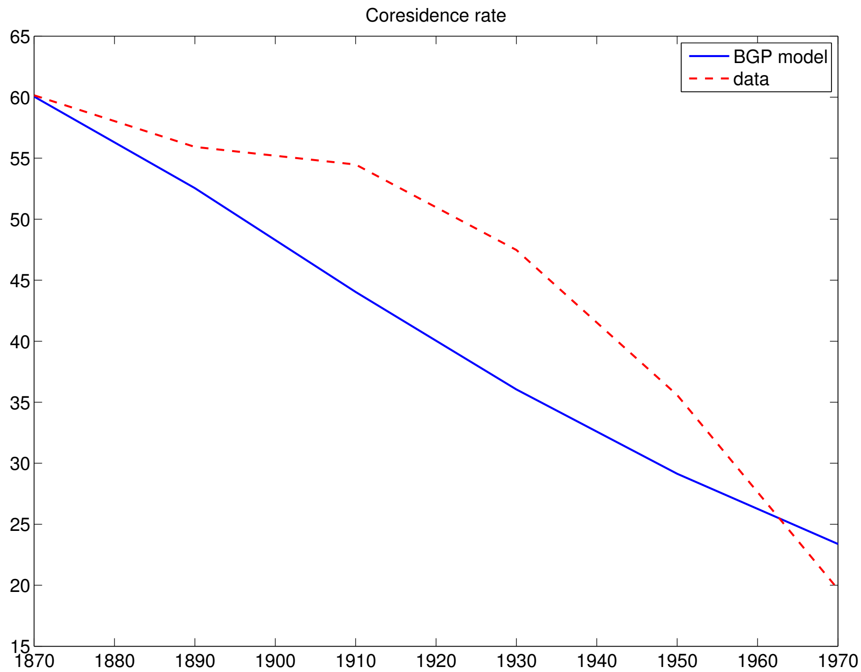
Coresidence rate
BGP model
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Figure 2

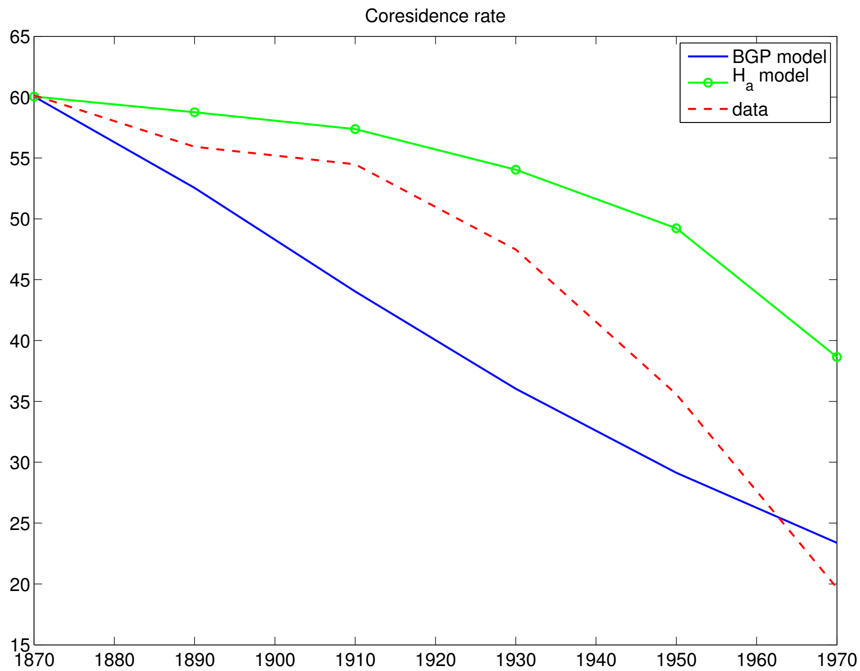
Coresidence rate
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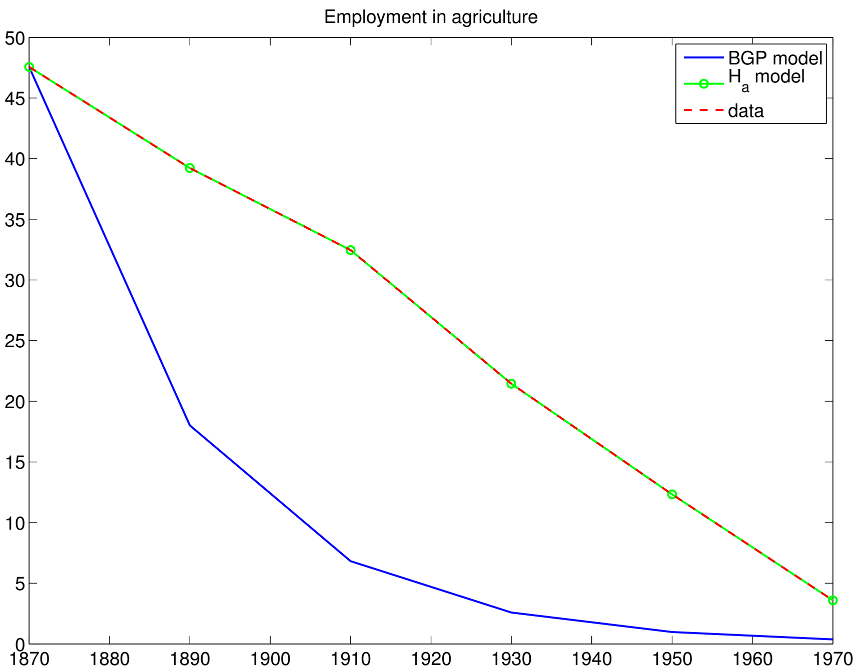
Figure 3


Employment in agriculture
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BGP model
H a model
data

Figure 4