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Agriculture to Industry: the End of Intergenerational Coresidence*

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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 of the structural change out of agriculture, in which the coresidence choice is endogenous. We calibrate the model on US data and simulate it. The model can match well the decline in US intergenerational coresidence between 1870 and 1940.

Keywords: living arrangements, family economics, structural change, economic development, unified growth theory

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

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1 Introduction

In this paper, we provide a macroeconomic model in which the structural change out of agriculture determines a shift from intergenerational coresidence to the nuclear family, and we quantify the importance of this mechanism by means of numerical simulations for the United States between the 19th and 20th century.

The family structure in the United States has changed significantly since the nineteenth century. One of the major changes has been the shift from intergenerational coresidence to independent living arrangements for the elderly: according to data, the percentage of elderly persons residing with their adult children plummeted from almost 68% in 1850, to almost 17% in 1990 (see Figure 1).[1]

Figure 1 also shows that a companion fact to the change in intergenerational coresidence was the structural change out of agriculture. If we compare the intergenerational coresidence rate with the employment rate in agriculture between 1850 and 2010, we observe that the two time series show similar behaviour, suggesting the existence of a link between the two phenomena. In Section 2, we delve more deeply into this empirical evidence, and show that there actually exists a robust correlation between employment in agriculture and intergenerational coresidence.[2]

To rationalise the evidence, we propose a formal model based on technical change and the relative income of the different generations. Higher technical change in the industrial sector with respect to the agricultural sector causes a progressive reallocation of labour from agriculture to industry and affects the relative income of the different generations. This in turn changes the bargaining power of the different generations, and therefore the incentive to coreside.

More specifically, we build a two-sector overlapping generation model with agriculture and industry à la Hansen and Prescott (2002). We assume that the old own all the land, and receive a rent from it, while the young provide the labour force. The young can work in both the agricultural and

[1] 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. See United Nations (2005).

[2] The existence of a possible link between intergenerational coresidence and the shift from agriculture to industry is accepted by many sociologists and demographers. For instance, Ruggles (2007) argues that the shift from agriculture to industry allowed the younger generations to earn their way out of the 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.

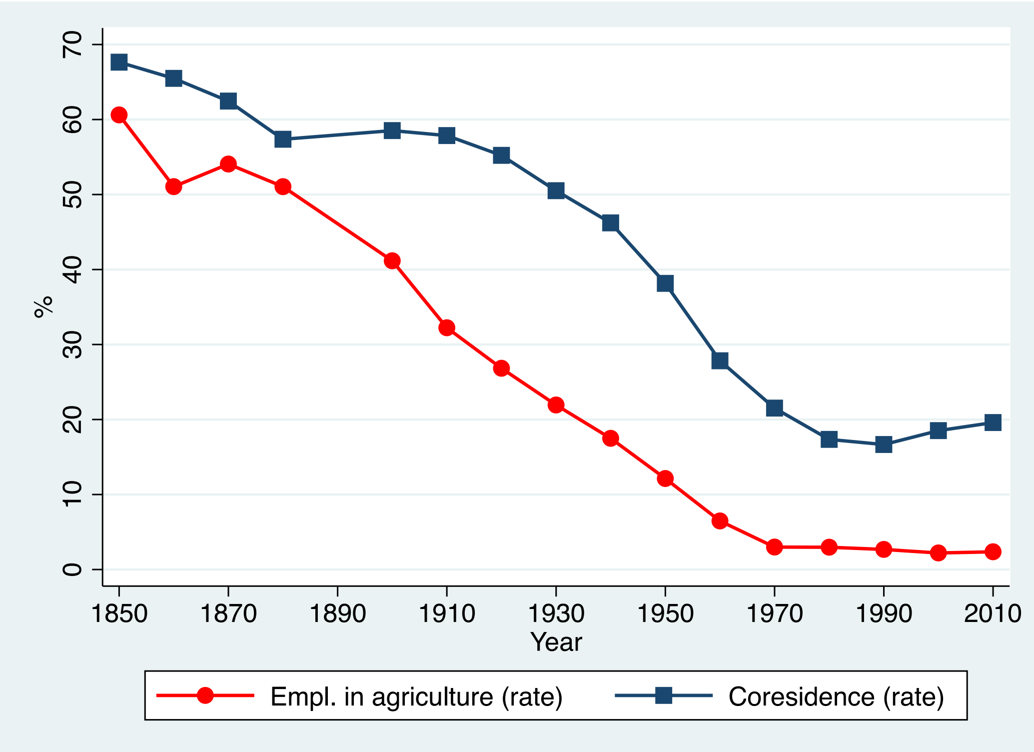

Figure 1: Intergenerational coresidence rate and employment rate in agriculture in the United States, 1850-2010. Intergenerational coresidence rate: percentage of persons aged more than 65 living with at least one child aged more than 18. Source: our elaboration on Ruggles et al. (2015). Married couples are counted as single observations. Persons living in group quarters such as rooming houses and military barracks are excluded from the sample. Employment rate in agriculture: percentage of individuals employed in agriculture over the total labour force. Source: our elaboration on Ruggles et al. (2015). We use the reconstructed IPUMS data on occupation available as the variable *IND1950*. For both series, census data in 1890 are missing. Alaska, District of Columbia and Hawaii are excluded from the sample.

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 shifts from agriculture to industry. The functional distribution of income changes: the wage earned by the young increases, while the rent earned by the old decreases. We assume collective bargaining among family members in case of coresidence, as in Pensieroso and Sommacal (2014). Accordingly, coresidence is deeply influenced by the relative income of the young with respect to the old, which coincides here with the functional distribution of income. In particular, coresidence decreases when the relative income of the young increases. Therefore, the industrial take off implies a lower coresidence rate.

We calibrate the model on US data and run different simulations to quantify the relevance of the proposed mechanism. Overall, our model can reproduce the qualitative behaviour of the intergenerational coresidence rate for the whole period. Furthermore, the model matches the decline in intergenerational coresidence between 1870 and 1940 remarkably well from a quantitative point of view.

This article is linked to two strands of the literature, the literature on the structural change out of agriculture and that on intergenerational coresidence.

The structural change out of agriculture, whose explanation is still debated, is a defining feature of the industrial revolution. Its role in determining economic development is hardly controversial, as witnessed by a long standing literature in economic development.[3]

For what concerns the decline in intergenerational coresidence, different theories have been advanced in the literature to explain it. A group of authors maintain that the introduction of Social Security is the engine behind the observed shift in the coresidence pattern.[4] 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.[5]

[3]See for instance Alvarez-Cuadrado and Poschke (2011) Doepke (2004), Gollin et al. (2002), Harris and Todaro (1970), Hansen and Prescott (2002), Harris and Todaro (1970), Kuznets (1966), Lewis (1954), Nurkse (1953), Rostow (1960).

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

[5]Aquilino (1990), Pensieroso and Sommacal (2014), Ruggles (2007), Ward et al. (1992), Whittington and Peters (1996), to mention but a few. Bethencourt and Rios-Rull (2009) provide a theory compatible with both the affluence and the economic development hypotheses. Dealing with living arrangements of elderly widows in the United States,

As explained in Pensieroso and Sommacal (2014), the two perspectives can be viewed as complementary rather than alternative, and the pre-eminence of one over the other mainly depends on the period under exam. In particular, the economic development hypothesis seems more relevant for the period before WWII, while the affluence hypothesis for the period after the 1950s. As we do not model Social Security in the United States, the economic development hypothesis looks more compelling for our analysis. Accordingly, we use the model by Pensieroso and Sommacal (2014), who propose a general equilibrium theory of the economic development hypothesis in a secular perspective.

The rest of the paper is organised as follows. Section 2 discusses the empirical link between employment in agriculture and intergenerational coresidence. Section 3 presents the model. In Section 4 we calibrate the model on US data and simulate it. Section 5 concludes.

2 Empirical evidence

In this article, we maintain that the structural change out of agriculture has been a major determinant of the end of intergenerational coresidence. The data presented in Figure 1 are suggestive and go in this direction. In this section we delve deeper into this empirical correlation.

We build intergenerational coresidence rates and employment rates in agriculture for each State of the United States between 1850 and 2010 (excluding Alaska, Hawaii and Washington DC).[6] So we have a panel with 48 observations for 16 decades (census data for 1890 are missing).

Table 1 shows results from our regression analysis. In column (1) we regress the intergenerational coresidence rate on the employment rate in agriculture. It turns out that the correlation is positive and significant at the 1% level. An increase in the employment rate in agriculture by 1 percentage point increases the intergenerational coresidence rate by almost 0.6 percentage points. In column (2), we control for state-fixed effects. The coefficient on the employment rate in agriculture is still positive and significant at the 1%. Moreover, its quantitative importance increases: once time-invariant differences across States are taken into account, an increase in the employment rate in agriculture by 1 percentage point increases the intergenerational coresidence rate by 0.7 percentage points.

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.

[6]For definitions and computation methods see the caption of Figure 1.

Independent variable: Coresidence rate			
	(1)	(2)	(3)
Employment in agriculture	0.595***	0.710***	0.758***
	(0.0204)	(0.0189)	(0.0351)
Constant	24.54***	16.01***	
	(0.713)	(2.516)	
State fixed effects	no	yes	yes
IV	no	no	2^{nd} stage
Observations	732	732	693
R-squared	0.551	0.710	0.691
Number of states		48	48
*** p<0.01, ** p<0.05, * p<0.1			

Table 1: Regression results. Independent variable: intergenerational coresidence rate. Robust standard errors in parentheses (clustered at the state level when using fixed effects). Instrumental variable in the IV regression: 1-period-lagged employment in agriculture.

Independent variable: Employment in agriculture (t)	
	(1)
Employment in agriculture (t-1)	(0.917***)
	(-0.0088)
Observations	693
Number of clusters	48
F(1,47)	10640.5
*** p<0.01, ** p<0.05, * p<0.1	

Table 2: First stage IV regression. Independent variable: employment rate in agriculture at time (t). Robust standard errors clustered at the state level in parentheses.

Although we are mostly interested in correlations here, the panel dimension of our data allows us to go one step further towards investigating a causal link. One *caveat* in interpreting the above correlations in terms of causality is that there might be a reverse-causality problem: intergenerational coresidence might have determined the employment rate in agriculture and not the other way round. The idea is that it is more likely that the young was working on the family estate (land), in case of intergenerational coresidence.

To deal with this problem, we instrument the employment rate in agriculture on its one-period lagged value, and run an IV regression. The exclusion restriction is that the lagged employment rate in agriculture has no direct effect on the current coresidence rate other than the effect it holds on the current employment rate in agriculture. Results from the first stage of the IV regression are shown in Table 2 and suggest that the lagged employment rate in agriculture is a good instrument. Results for the second stage of the IV regression are shown in Table 1, column (3). The coefficient on the employment rate in agriculture is still positive and significant at the 1% level. Quantitatively, an increase in the employment rate in agriculture by 1 percentage point increases the intergenerational coresidence rate by 0.76 percentage points.

This evidence suggests that the employment rate in agriculture might have affected the intergenerational coresidence rate. In the rest of this article, we provide a theoretical mechanism that rationalises this evidence, and quantify its the relevance via numerical simulations.

3 The model

3.1 Production

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, while $\beta \in (0, 1)$ denotes the labour-share 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 $L = 1$.

3.2 Households

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.[7] 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.[8]

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

[8] In our model there is no market for land. Given that the price of agricultural land has been decreasing over the past two centuries in the United States (see Hansen and Prescott (2002)), results would qualitatively be the same, if we included a market for land. In fact, under the assumption that the old are the owner of land, the additional income on top of rents that the old would derive from selling land would be decreasing over time.

In each period, the young and the old can either live apart or coreside.[9] 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.[10] The variable κ^j measures the taste for living together (for instance, the taste for privacy). The parameter δ is a 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 $\hat{V}_t^j$.

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

[9] The coresidence decision is modeled as in Pensieroso and Sommacal (2014).

[10] 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, $Z = \frac{1}{p}$.

living alone or with the young. Imposing $\hat{V}_t^j = \tilde{V}^j(\theta_t, \kappa^j)$ for$j = (y, o)$, the formulas for $\theta_{min,t}$ and $\theta_{max,t}$ read:[11]

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

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

It is possible to show that if $\theta_{min,t} < \theta_{max,t}$, coresidence is always Pareto improving.[12] However, the model is silent about the ultimate determinants of the actual bargaining power θ, which accordingly might also fall outside the interval $[\theta_{min,t}, \theta_{max,t}]$. In the following, we assume that whenever $\theta_{min,t} < \theta_{max,t}$, 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, we set the probability of coresiding, π_t, to zero.

We assume that the size 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 $\Delta_\theta \equiv (\theta_{max,t} - \theta_{min,t})$ we find:

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

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 Δ_θ is decreasing in d_t if

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

We assume that this condition always hold.

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[11] 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 $\kappa^j \geq 1$.

[12] See Pensieroso and Sommacal (2014).

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 $A_{a,t}/A_{i,t}$.

3.3 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 that

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

The economy is then along a balanced growth path with a growth rate given by γ_a.

As $\gamma_a < \gamma_i$, the ratio $A_{a,t}/A_{i,t}$ decreases over time and eventually passes the threshold level $1/\beta$. From then onwards, the industrial sector becomes profitable and therefore operative. The growth rate is equal to

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

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.

3.4 The end of intergenerational coresidence

We assume that at time 0, $A_{a,0}/A_{i,0}$ is such that $\Delta_\theta > 1$, implying that the coresidence rate π is positive. The idea is that in such a scenario, the functional distribution of income favours the old: rents are high because the marginal productivity of land is relatively high. As time goes by, the ratio $A_{a,t}/A_{i,t}$ decreases, which implies that the functional distribution of income d_t increases (see Equation (16)). Given that the difference Δ_θ is a decreasing function of d_t, the assumed patterns for sectoral TFP implies that the difference Δ_θ decreases as the economy undergo a structural transformation from agriculture to industry. 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. We shall limit to the period between 1870, so as to exclude the American civil war (1861-1865).

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:

$$\begin{cases} \pi_t = \frac{\phi\Delta_\theta}{1+\phi\Delta_\theta} & \text{if} \quad \Delta_\theta > 0, \\ \pi_t = 0 & \text{if} \quad \Delta_\theta \leq 0, \end{cases} \tag{21}$$

where $\phi > 0$. This simple parametric formulation ensures that π is between 0 and 1 and it is increasing in $\Delta_\theta \equiv \theta_{max} - \theta_{min}$.

Table 3 illustrates the chosen values for the structural parameters of the model. The 'Target' column reports the reference variable used for the calibration of each parameter. We interpret one model period to be 20 years.

The preference for private consumption, α, is calibrated so that the ratio between public goods and private goods in personal consumption expenditure in 1929 (the first year for which we have data) is 1.8, as reported by Salcedo et al. (2012). Because of our assumptions on preferences, this

Parameter	*Value*	*Target*
α	0.37	Share of private expenditures in 1929
β	0.5	Share-cropping contracts
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	2.58	Coresidence rate in 1870

Table 3: Calibration of the parameters

translate in the condition $(1-\alpha)/\alpha = 1.8$, which gives a calibrated value of 0.37 for α.

The value of the labor share in the agricultural sector, β, is in accordance with the typical share-cropping contract, which, according to Doepke (2004), allocates 50 percent of output to the land owner.

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 the share of employment in agriculture in 1870.

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).

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.[13]

The parameter ϕ in Equation (21) is calibrated to match the US coresidence rate in 1870, which was equal to 62.45%.

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 Simulations

The unit period is 20 years. By construction, the model matches the coresidence and the employment rate in agriculture in 1870. Starting from 1870,

[13]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.

we plug the values of γ_i and γ_a and run a numerical simulation. The objective is to study the evolution of the coresidence rate as the model economy witnesses a take-off from agriculture to industry.

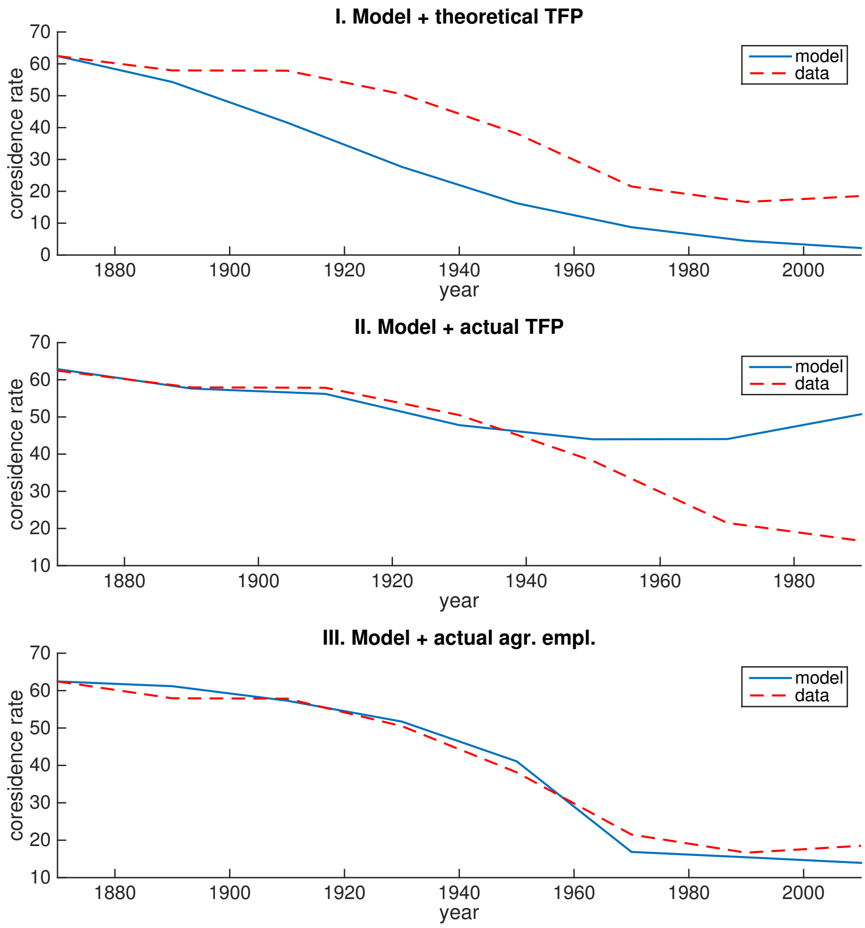

Figure 2: Simulations: intergenerational coresidence rate

Figure 2 (Panel I) shows the pattern of the coresidence rate in the model (blue line), and compare it with the data (red-dashed line). The model has the right qualitative behaviour, but it overestimates the drop in the coresidence rate.

Given that our model provides a joint explanation of the shift from agriculture to industry and the change in the coresidence rate, the specific way in which we have modelled the structural change out of agriculture (i.e. à la Hansen and Prescott (2002)) turns out to affect our results on coresidence. If we relax this or that aspect of the Hansen and Prescott structure, our model of the coresidence choice gets significantly nearer to the data.

We start by relaxing the assumption of a constant growth rate of TFP in both sectors, and uses TFP data from Alvarez-Cuadrado and Poschke (2011) in its stead as exogenous impulse mechanism for the model. Using these data, Alvarez-Cuadrado and Poschke (2011) argue that in the United States the structural change out of agriculture was mostly labour pull - i.e. driven by productivity increases in the industrial sector - till WWI and mostly labour push - i.e. driven by productivity increases in agriculture - after WWII. In our model à la Hansen and Prescott (2002), on the other hand, the structural change out of agriculture is entirely labour-pull. So, by construction the model cannot reproduce the structural change after WWII, once we feed in the actual values of TFP.[14] Results from our simulations with TFP data are shown in Figure 2 (Panel II), and confirms this intuition.[15] The predicted value of the coresidence rate matches the data almost perfectly up to 1940, that is for the entire period in which, in the data as in our model, the structural change out of agriculture is labour-pull. After 1940, the relative TFP in agriculture increases, while the employment rate in agriculture still decreases in the data: the structural change becomes labour push. In this context, our model predicts a change of the functional distribution of income in favour of rents, and accordingly an increase in coresidence, which is at odds with the data.

As an additional exercise, we run a simulation in which employment in agriculture in each period is taken directly from the Census data. In this case, we are agnostic about the causes of the shift from agriculture to industry (i.e. we do not take a stance in the labour-pull/labour-push controversy), and just study its consequences in terms of income distribution and therefore intergenerational coresidence in our model. Results are shown in Figure 2 (Panel III). The model now tracks the data almost perfectly for the overall period.

These results lead to the conclusion that the core mechanism of our model going from the structural change out of agriculture to the change in coresidence holds good qualitatively and is quantitatively relevant until the 1940s.

[14]While this modelling choice has this obvious drawback, it has the advantage of allowing for a tractable integration between a multi-sectoral model of production and a general equilibrium model of intergenerational coresidence.

[15]The productivity data by Alvarez-Cuadrado and Poschke (2011) stop at 1990.

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 19th century.

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

We have calibrated the model on US data. Results from the simulations show that first, the model has the right qualitative behaviour and, second, quantitatively the structural change out of agriculture can account for most of the observed change in the coresidence pattern until WWII.

This paper is the first to explore the secular change in intergenerational coresidence from a quantitative macroeconomic perspective. It focuses on a particular mechanism, the change in the relative income of the young induced by the shift away from agriculture to industry. Other explanations are possible, including the introduction of Social Security, or the demographic transition. We leave the quantitative macroeconomic analysis of those hypotheses to future research.

References

Alvarez-Cuadrado, F. and M. Poschke, "Structural Change Out of Agriculture: Labor Push versus Labor Pull," *Americal Economic Journal: Macroeconomics*, 2011, *3*, 127–158.

Aquilino, W. S., "The Likelihood of Parent-Adult Child Coresidence: Effects of Family Structure and Parental Characteristics," *Journal of Marriage and the Family*, 1990, *52*, 405–419.

Bethencourt, C. and J. V. Rios-Rull, "On the Living Arrangements of Elderly Widows," *International Economic Review*, 2009, *50*, 773–801.

Chiappori, P.A., "Rational Household Labor Supply," *Econometrica*, 1988, *56*, 63–90.

_ , "Collective Labor Supply and Welfare," *Journal of Political Economy*, 1992, *100*, 437–467.

_ , "Collective Models of Household Behavior: An Introduction," *European Economic Review*, 1992, *36*, 355–364.

Costa, D. L., "Displacing the Family: Union Army Pension and Elderly Living Arrangements," *Journal of Political Economy*, 1997, *105*, 1269–1292.

Doepke, M., "Accounting for Fertility Decline During the Transition to Growth," *Journal of Economic Growth*, 2004, *9*, 347–383.

Gollin, D., S. Parente, and R. Rogerson, "The role of agriculture in development," *American Economic Review*, 2002, pp. 160–164.

Hansen, G. D. and E. C. Prescott, "Malthus to Solow," *The American Economic Review*, 2002, *92* (4), 1205–1217.

Harris, J. R. and M. P. Todaro, "Migration, Unemployment and Development: A Two-Sector Analysis," *The American Economic Review*, 1970, *60* (1), 126–142.

Kehoe, T. J. and E. C. Prescott, "Great Depressions of the 20th Century," *Review of Economic Dynamics*, 2002, *5*, 1–18.

Kuznets, S., *Modern Economic Growth: Rate, Structure and Spread*, Yale University Press, 1966.

Lewis, W. A., "Economic Development with Unlimited Supplies of Labour," *The Manchester School*, 1954, *22* (2), 139–191.

Maddison, A., *Historical Statistics of the World Economy: 1-2008 AD*, `http://www.ggdc.net/MADDISON/oriindex.htm`, 2011.

McGarry, K. and R. F. Schoeni, "Social Security, Economic Growth and the Rise in Independence of Elderly Widows," *Demography*, 2000, *37*, 221–236.

Nurkse, R., "The Problem of capital Formation in less-developed Countries," *Oxford University Press*, 1953, *33*, 1–337.

Pensieroso, L. and A. Sommacal, "Economic Development and the Family Structure: from *Pater Familias* to the Nuclear Family," *European Economic Review*, 2014, *71*, 80–100.

Rostow, W. W., *The stages of growth: A non-communist manifesto*, Cambridge University Press, 1960.

Ruggles, S., "The Decline of Intergenerational Coresidence in the United States, 1850 to 2000," *American Sociological Review*, 2007, *72*, 964–989.

— **, K. Genadek, R. Goeken, J. Grover, and M. Sobek**, "Integrated Public Use Microdata Series: Version 6.0," [dataset], University of Minnesota 2015.

Salcedo, A., T. Schoellman, and M. Tertilt, "Families as Roommates: Changes in U.S. Household Size from 1850 to 2000," *Quantitative Economics*, 2012, *3*, 133–175.

United Nations, *Living Arrangements of Older Persons Around the World*, New York: United Nations, 2005.

Ward, R., J. Logan, and G. Spitze, "The Influence of Parent and Child Needs on Coresidence in Middle and Later Life," *Journal of Marriage and the Family*, 1992, *54* (1), 209–221.

Whittington, L. and H. E. Peters, "Economic Incentives for Financial and Residential Independence," *Demography*, 1996, *33* (1), 82–97.