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Abstract

Why do some regions grow faster than others? More precisely, why do rates of convergence differ? Recent research points to labour market frictions as a possible answer. This paper expands along this line by investigating how these labour market frictions interact with regional migration. Motivating this are two important observations: (1) farm-to-nonfarm labour reallocation costs have fallen, disproportionately benefiting poorer agricultural regions; and (2) migration flows vary dramatically by region, lowering (raising) marginal productivities in destination (source) regions. Using a general equilibrium model of structural transformation calibrated with US regional data over time, I find regional migration barriers magnify the income convergence effect of labour market improvements. For instance, recent research points to improved nonagricultural skills acquisition as a driver of Southern US convergence with the North. I find the strong link between labour markets and Southern convergence follows from the South's historically extensive migration restrictions. Finally, the model captures the low convergence rates experienced by other regions, such as the US Midwest.

1 Introduction

Vast and persistent cross-country income differences have puzzled economists since the days of Adam Smith and today motivate an extensive research literature. While instances of convergence between poor and rich exist, particularly within Europe and East Asia, there is no consistent evidence that low-income countries experience faster rates of economic growth than high-income ones. The key question is then: Why do rates of convergence differ across countries? Recent work points to productivity differences as a necessary and important component of any possible answer (Caselli, 2005). In addition, it is now widely recognized that dual-economy considerations - barriers and frictions between agricultural and nonagricultural sectors - are a key source of these productivity differences (Duarte and Restuccia, 2010; Vollrath, 2009; Restuccia et al., 2008). While fruitful, these cross-country contexts lack extensive time-series wage and price data to measure the extent of labour or product market frictions.

Despite cross-country data limitations, the nature of dual-economy frictions can be investigated equally well at the subnational level. In fact, longer time series data on wages, prices, and other relevant variables, exists for US states than between countries around the world. In this context, the general pattern is rapid convergence between Southern and Northeastern states and less convergence between the initially richer Midwest and the Northeast. The key question can now be expressed: Why do rates of convergence differ across regions? Recent research by Caselli and Coleman (2001) find declining costs for farm workers to switch to nonagricultural pursuits is an important driver of this convergence, in addition to being a source for overall structural change. Building on their work, and an observation that labour market barriers to worker switches are larger in the South and Midwest than within the Northeast, this paper reveals how regional migration frictions enhance the convergence impact of regional labour market improvements.

Between region migration in the United States have been an important phenomenon with qualitatively, and potentially large quantitative, implications for convergence. Briefly put, there was a massive post-war increase in the size of Southern and, to a lesser extent, Midwestern labour forces relative to the Northeast. Such flows are normally thought of as a convergent force, as labour responds positively to wage (marginal product) differences. If labour responds to other factors, however, it may opt to migrate towards lower wage areas, which would *increase* average income dispersion. I

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will show that improvements in the ability of workers to switch from agricultural to nonagricultural occupations in one region will attract migrants from the other. If the region experiencing the labour market improvement has lower wages, such as in the US South, then in-migration results in increased regional income inequality. The impact of labour market improvements on regional convergence is thus enhanced by migration restrictions, which is the key result of this paper.

Three key observations for the United States motivate this research: first, barriers to labour reallocation from agriculture to nonagriculture have shrunk; second, the geographic distribution of employment and population has changed dramatically over time; and third, rates of income convergence vary by region. To examine these observations, I use a general equilibrium model of structural transformation calibrated to match historical data for various US regions. I find an important interaction between internal migration and the impact of labour market distortions on regional convergence. Specifically, barriers to regional migration magnify the convergence effect of labour market improvements (specifically, in labour's ability to switch from agricultural to nonagricultural employment). Intuitively, labour reallocation shrinks farm labour supply and increases relative farm wages, disproportionately improving overall average income in the agriculturally-specialized region, such as the Midwest[1] or South[2]. Improvements in a region's labour market, however, make it a more attractive region in which to live. The resulting labour inflow offsets some of the income gains, due to diminishing labour productivity. Thus, it is in the presence of regional migration barriers that one would expect the largest convergence impact from labour market improvements. This mechanism may provide additional insight into how the Southern and Midwestern states experienced dramatically different rates of income convergence with the industrial Northeast[3], despite both being agriculturally specialized with equally distorted labour markets.

This paper contributes to the structural transformation and growth literature and, in particular, joins research dealing with frictions within a two-sector, multi-region framework. As a whole, this literature examines the strong negative relationship between the share of output and employment commanded by the agricultural sector and the overall level of economic activity - a phenomenon known

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[1]Midwestern States (MW): IA, IL, IN, MI, MN, MO, ND, NE, OH, SD, WI

[2]Southern States (S): AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA, WV

[3]Northeastern States (NE): CT, MA, MD, ME, NH, NJ, NY, PA, RI, VT

as the "Kuznets fact" of growth. Recently, various researchers have developed simple models to explain this, from increasing consumer goods variety (Greenwood and Uysal, 2005; Foellmi and Zweilmueller, 2006) or preference non-homotheticities (Kongsamut et al., 2001) to differential sectoral productivity growth (Ngai and Pissarides, 2007) or capital deepening (Acemoglu and Guerrieri, 2006).[4] While capturing the output and employment facts quite well, these models cannot match a number of other observations relating to regional incomes, sectoral wages, or internal migration patterns.

Recent attempts to capture regional convergence, a rising agricultural wage, and internal labour flows show that it is important to move beyond frictionless market structures. In particular, Caselli and Coleman (2001) incorporate labour market frictions between agriculture and non-agriculture to show that improved ability of workers to acquire manufacturing skills can capture the rise in relative agricultural wages observed in the data - a feature previous models could not. This channel, which will be expanded on later, also leads to convergence in income levels between regions. Another recent paper by Herrendorf et al. (2009) investigates the consequences of goods market frictions between regions. The authors find that large reductions in transportation costs between regions are an important driving force behind westward settlement patterns in the mid-1800s. Finally, in a recent and related piece, I investigate to what extent both labour and goods market frictions might interact to capture a broader set of regional convergence experiences (Tombe, 2008). The results point to an important mitigating influence of transportation cost reductions on regional convergence. Each of these papers establish important roles for market frictions in matching historical data. This paper is distinct from existing work by addressing how internal migration flows influence interactions between labour and goods market frictions and regional convergence patterns.

2 Empirical Patterns, by Region

Data for three major regional groups in the United States display unique growth experiences that point to the importance of migration, labour market frictions, and income convergence. Specifically, I investigate two regional pairs: (1) the Northeastern versus Southern states; and (2) the Northeastern versus Midwestern states. Figure 1 illustrates the geographic location of each region.

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[4]A concise review of the issues involved may be found in Matsuyama (2005).

There are three important observations that guide the analysis. First, barriers to labour reallocations out of agriculture have dramatically fallen in all regions. Figure 5 shows how both regions begin 1880 with a majority of their workforce employed on the farm, which declines to insignificance by 2000[5]. In addition, Figure 3 displays the agricultural wages relative to nonagricultural wages for both regions - their experiences largely coincide. In 1880, agricultural workers earned approximately five times less than their nonagricultural counterparts, while they earned only slightly more than 20% less by 2000. From this wage data, I infer that labour markets were equally distorted in the sense of worker occupational switching costs. One need not take a position on what these frictions might be, from poor access to nonagricultural skills training to explicit restrictions on nonfarm labour recruitment policies, all such distortions are captured by the model in a reduced-form manner.

The second feature in the data presents the main puzzle this paper seeks to address: differential rates of regional convergence. Figure 4 starkly illustrates a far higher degree of income convergence between the South and Northeast than for the Midwest. The South's relative overall earnings nearly doubled between 1880 and 2000 while the Midwestern's rose by barely 10% from its already high level. It is worth emphasizing that despite equally distorted local labour markets and very agriculturally specialized workforces, the Southern states' overall average income is almost half the Midwest's. Two forces might account for this: first, higher transportation costs lead to compensating nominal wage levels in the Midwest (the topic of Tombe (2008)); and second, higher cost of regional migration facing Southern residents suppresses labour productivity and wages in that region (a feature of this paper).

The third and final fact is illustrate by Figure 5: the geographic distribution of employment has changed dramatically through time. Between 1880 and 2000 the Southern states' total employment relative to the Northeast's increased by nearly 80% and the Midwestern states' increase by 20%[6]. It is these large internal labour flows that I argue can offset much of the convergence impact of improved labour markets. Simply put, the relative incomes of the Southern and Midwestern states would have been higher but for the in-migration that took place since 1880. It also appears that only the last half-century saw notable flows towards the South, which might suggests a large initial cost of migration[7].

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[5]It is certainly true that the Southern states experienced a greater degree of structural change but later analysis will find this difference alone is incapable of explaining the unique regional experiences.

[6]These patterns are not due to differential rates of child birth or mortality.

[7]For instance, explicit restrictions to recruiting farm labour in many Southern states by agents outside the state by

3 The Model

At its core, this is a two-region, two-sector model. Both goods are available for consumption but one - called the agricultural good - faces a subsistence requirement, and therefore an income-elasticity below unity. The two regions may engage in trade of either good by incurring an iceberg transportation cost. Workers may also select either sector to work in, but must receive manufacturing skills in order to become employed in that sector. I outline the details below.

3.1 Firms

3.1.1 Goods Producing

An agricultural sector and a manufacturing sector exist in each of two regions, populated by perfectly competitive firms. I assume that the competitive advantage of the one region - the "core" - is in manufacturing and will completely specialise in its production. By extension, both agricultural and manufacturing activities may be conducted in the other region - the "periphery". Each produces output using input factors of land, labour, and capital within constant returns to scale production technologies. Thus, for each region $i \in \{p, c\}$ and sector $s \in \{f, m\}$

$$Y_s^i \quad = \quad A_s^i N_s^{i\,\alpha_s} L_s^{i\,1-\alpha_s} \tag{1}$$

where Y, N, and L respectively denote output, land, and labour. By assumption, $A_f^p > A_f^c = 0$ for all $t = [0, .., \infty)$. To simplify notation, the periphery agriculture is selected as the numeraire ($P_f^p = 1$). Regional land endowments are exogenously set, with the fraction for the periphery denoted by ω. The inclusion of land within the production functions ensures a nondegenerate distribution of manufacturing production between the regions by creating diminishing returns to scale in the regionally mobile factor (labour).

Each firm exists in a competitive environment and, therefore, takes output prices, P_s^i, as given. In addition, factor markets are competitive and land rents and wages - respectively, r and w - are

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the various enticement laws, emigrant-agent laws, and contract-enforcement laws passed in the 1890s and early 1900s. See Roback (1984) for more details.

also exogenous to each firm. They each use the production technology from Equation (1) to maximize profits,

$$\Pi_s^i \;=\; P_s^i Y_s^i - w_s^i L_s^i - r_s^i N_s^i \quad \forall \, i = p, c \text{ and } s \in \{f, m\}.$$

This implies firm input demands must satisfy standard first-order necessary conditions,

$$\frac{\partial Y_f^p}{\partial N_f^p} = P_m^p \frac{\partial Y_m^p}{\partial N_m^p} \;=\; r_t^p \tag{2}$$

$$P_m^c \frac{\partial Y_m^c}{\partial N_m^c} \;=\; r_t^c \tag{3}$$

$$\frac{\partial Y_f^p}{\partial L_f^p} \;=\; w_f^p \tag{4}$$

$$\frac{\partial Y_m^i}{\partial L_m^i} \;=\; \frac{w_m^i}{P_m^i} \quad \forall \, i = p, c \tag{5}$$

3.1.2 Transportation

Goods produced in one region may be transported to consumers in another region by incurring an iceberg-cost, leaving fraction Δ successfully delivered. This feature of the economy is modelled by assuming there exists a perfectly competitive transportation sector, where firms maximize profits earned through goods sold in one region that were purchased in another. This technology is similar to that utilised by Herrendorf et al. (2009), who further allow distinct food and non-food transportation costs. Formally, for D_s^i and B_s^i representing the quantity of good s delivered to (bought from) region i, we have the objective for all $i, j = p, c$, $i \neq j$, and $s \in \{f, m\}$

$$\max_{D_s^i, B_s^i} \pi_t \;=\; P_f^i D_f^i + P_m^i D_m^i - p_f^j B_f^j - p_m^j B_m^j.$$

The comparative advantage of the core region in manufacturing goods and the periphery in agriculture ensures $D_f^p = D_m^c = B_m^p = B_f^c = 0$. Furthermore, given the nature of the transportation costs, it must be the case that

$$D_s^i \;=\; \Delta B_s^j \quad \forall i, j = p, c, i \neq j$$

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which, together with zero profit condition, implies

$$\Delta_t P_m^p \;=\; P_m^c, \tag{6}$$

$$P_f^c \;=\; 1/\Delta_t. \tag{7}$$

3.2   Households

There is a population normalized to unity in this economy. As is standard in models of structural change, each agent is endowed with preferences that treat consumer goods asymmetrically, with agricultural goods contributing to utility only above a subsistence level. This results in an income inelastic demand for agricultural goods that leads labour to shift to the manufacturing sector over time and for agriculture's share of consumption to decline. Each agent selects a region of residence and, to simplify matters, defers its subsequent decisions to a regional household. That is, individual agents are only sovereign over their location of residency. Household consumption is evenly divided amongst its members. Finally, non-labour income from land rent is region-specific.

Formally, the household of region $i \in \{p, c\}$ employed in sector $s \in \{f, m\}$, with agricultural subsistence level $\bar{a}$, faces the following problem

$$\max_{\{c_f^i, c_m^i, L_f^i, L_m^i\}} \left\{ \tau \log(c_f^i - \bar{a}) + (1 - \tau) \log(c_m^i) \right\} \tag{8}$$

subject to

$$P_f^i c_f^i + P_m^i c_m^i \;\leq\; L_f^i w_f^i + L_m^i w_m^i + N^i r^i. \tag{9}$$

This leads to two simple equilibrium requirements. First, optimal allocation between consumption goods is such that the marginal rate of substitution equal the output price ratio,

$$\frac{U_m(c_f^i, c_m^i)}{U_a(c_f^i, c_m^i)} = \frac{1 - \tau}{\tau} \frac{c_f^i - \bar{a}}{c_m^i} \;=\; \frac{P_m^i}{P_f^i} \quad \forall\, i \in \{p, c\}. \tag{10}$$

Second, their region of residence is selected to maximize utility, subject to a migration cost proportional

to utility (for convenience). In equilibrium, migratory incentives will not exist, which implies,

$$(c_f^p - \bar{a})^\tau c_m^{p\,1-\tau} \quad = \quad \mu(c_f^c - \bar{a})^\tau c_m^{c\,1-\tau} \tag{11}$$

If we assume that all agents in the process of switching sectors do so in the periphery, then the share of the population living in the core is simply its labour force share, L_m^c.

3.2.1 Occupational Choice

Given that the extent of labour market frictions is a key piece of this model, a detailed look at its assumed features is important. Essentially, the frictions are assumed to exist between sectors in the peripheral region. That is, labour is not freely mobile between agricultural and nonagricultural pursuits. This is captured in a reduced form fashion, in that no *particular* source for the friction is explicitly modelled. Instead, a cost proportional to wages is imposed on peripheral-region nonagricultural workers. One might consider this cost as uncompensated training, where a certain fraction of a period is required to maintain one's nonagricultural skills. Alternatively, it could be a payroll tax that is later rebated in a lump-sum fashion to the Southern household. Such a tax would impact relative sectoral wages but not total household income. Simply put, any policy that increases the costs of hiring nonagricultural labour in the peripheral region would suffice.

Given the existence of this cost on nonagricultural employment in the periphery, the household there will make the occupational allocation choice based only on its effect on total income. An agent will be selected for manufacturing skills only if the earnings in that sector are sufficient to compensate for the cost. I assume that ξ represents proportion of earnings lost due to the friction. So, the peripheral household selects an agent to engage in manufacturing production if selects sector m if and only if

$$(1 - \xi)w_m^p \quad \geq \quad w_f^p \tag{12}$$

The value assigned to ξ will be exogenously set to match the *observed* difference in wages between the two sectors under the condition that Equation (12) holds with equality.

3.3 Market Clearing Conditions

To close the model, the following standard market clearing conditions must hold.

$$L_m^p + L_f^p + L_m^c = 1 \tag{13}$$

$$N_m^p + N_f^p = \Omega \tag{14}$$

$$N_m^c = 1 - \Omega \tag{15}$$

These equations merely require: (1) labour in all regions and sectors sum to one, the normalized total and (2) peripheral-land sum to the amount exogenously allocated to that region, Ω.

In addition, agricultural and manufacturing goods markets must clear. Each region produces, consumes, exports, and imports goods. To simplify the following equations, I will impose at this point that the periphery imports manufactured goods and exports agricultural goods, while the core does the opposite. This follows given the nature of the comparative advantages assumed. Finally, with the total population normalized to unity and all people in the education sector living in the periphery by assumption, the population in the core and the periphery, respectively, is L_m^c and $(1 - L_m^c)$. Hence,

$$L_m^c C_f^c = D_f^c$$

$$(1 - L_m^c)C_f^p + B_f^p = Y_f^p$$

$$L_m^c C_m^c + B_m^c = Y_m^c$$

$$(1 - L_m^c)C_m^p = Y_m^p + D_m^p$$

Combining these with the results implied by the transportation firm problem solved earlier, and observing that Walrus law, we find that the agricultural goods market clearing condition is sufficient, and expressed as

$$(1 - L_m^p)\Delta C_f^p + L_m^c C_f^c = \Delta A_f^p N_f^{p\alpha_f} L_f^{p\,1-\alpha} \tag{16}$$

4 Calibration

There are various parameters in the model that require calibration. Table 1 outlines the strategy and the values to which each parameter is set. To begin, two parameters are set identical across regions, remain constant through time, and take on values generally accepted in the literature. Land's (or the immobile factor's) share of output[8], α, is set to 0.4 and the preference weight for agricultural goods, τ, is set to 0.01. Two additional parameters can also be set to values directly observable in the data. The transportation costs parameter, Δ, is set to match observed price differences for identical goods across each region and the wage wedge, ξ, is set to match observed wage data. Interested readers can find details regarding the data used to calibrate these two parameters in Section 6.

Productivity in the peripheral agricultural region is normalized to 1 in 1880 and productivity in the nonagricultural sectors - both core and peripheral - are calibrated to match data on the distribution of employment[9]. The growth rates of sectoral productivities are determined, jointly with the other indirect parameters, to help match the extent of labour reallocation and regional incomes in 1990. Finally, the between-region migration cost - the most atypical aspect of the model - must be presented with care. For brevity, I relegate a detailed discussion to Section 6 and note here that migration cost values are required to fully match the regional distribution of employment and relative incomes in 1880 and 1990. The calibrated values in Table 1 suggest that migration costs from the Southern region were far higher than from the Midwest. This is entirely consistent with many qualitative historical analysis, such as Wright (1986). The productivity growth of the agricultural sector is also clearly higher than nonagricultural, consistent with findings of other researchers (Caselli and Coleman, 2001; Jorgenson and Gollop, 1992).

In summary, the fully calibrated model incorporates declining migration costs, declining trans-

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[8]Interpreting N as land might lead to a different value. For instance, the ratio of land rent to total nonagricultural capital rent is 0.14, which implies land's share when physical capital is included is 0.06. This represents 0.1 the value of the standard labour share. Hense, $\alpha_m = 0.1$ when physical capital is abstracted from. The same argument is used for the agricultural sector, but with land's share of capital rent at 0.5, which implies $\alpha_f = 0.33$. However, this model need not restrict N to land alone, as it represents any immobile factor used in the production function. While I use a common $\alpha = 0.4$ throughout, the results remain largely unchanged under the alternative values. That being said, migration flows become increasingly sensitive to other parameters, and the model more difficult to solve, as $\alpha_m \to 0$.

[9]This strategy of determining the regional productivity parameters by matching model output to targets, rather than directly calculating TFP from the data, is a necessary consequence of the lack of a long series of region-specific sectoral output and input data. The results are robust to an alternative approach discussed in Section 6.

Table 1: Calibration of Model Parameters

(a) Common Time-Invariant Parameters

Parameter	Description	Target	Value
α	Nonlabour Income Share	Literature	0.4
τ	Agricultural goods' preference weight	Literature	0.01

(b) Region-Specific and Time-Varying Model Parameters

Parameter	Description	Target	MW-NE		S-NE	
			1880	1990	1880	1990
Directly Calibrated Using Observable Data						
$\hat{\Delta}_t^i$	Between-region transportation cost	Price differentials	0.70	0.90	0.95	0.99
ξ_t^i	Sectoral switching cost	Wage differentials	0.78	0.27	0.81	0.28
Jointly Calibrated Using Model Output			1880	1990	1880	1990
$\bar{a}^i$	Subsistence level for food	Consumption shares	0.13		0.21	
Ω^i	MW/S immobile factor share	Regional incomes	0.38		0.33	
μ_t^i	Ease of between-region migration	Regional employment	0.58	0.78	0.37	0.82
			Initial	Growth	Initial	Growth
$A_{f,t}^P$	MW/S agricultural productivity	Normalization	1.00	2.91%	1.00	3.97%
$A_{m,t}^P$ }	Nonagricultural productivity	Sectoral Employment	0.98	1.97%	0.97	2.22%
$A_{m,t}^C$		& Regional Incomes	1.01	1.95%	1.03	1.93%

The model through time is treated as two separate static exercises. Parameters are calibrated to a unique value for each regional group and each year. Parameters can be classified into three groups: (1) The generally accepted parameter values that are constant through time and common across regions; (2) those with observable counter parts in the data, whose values are set directly to match data; (3) unobservable parameters calibrated jointly such that model output matches observable data. The 1990 values of the various parameters is reported directly except for the productivity parameters, as the growth rates between 1880 and 1990 is more informative. Finally, note that indirectly calibrated parameters are estimated simultaneously and the listed targets are those that are most sensitive to the corresponding parameters.

Table 2: Calibration Performance vs. Data

(a) Midwest-Northeast						(b) South-Northeast			
Observed Outcome in	1880		1990			1880		1990	
Peripheral Region	Data	Model	Data	Model		Data	Model	Data	Model
Relative Employment Size	1.05	1.05*	1.16	1.16*		1.06	1.06*	1.59	1.59*
Agricultural Employment Share	0.55	0.55*	0.03	0.04		0.73	0.73*	0.03	0.03
Relative Income	0.81	0.81*	0.86	0.86*		0.43	0.43*	0.83	0.83*

Note: Asterisks denotes targets

portation costs, rising productivity, among others, is reported in Table 1. The data targets selected to calibrate the parameters are: (1) the peripheral region's share of both region's employment; (2) the average peripheral wages relative to the core; and (3) the agricultural labour share in the peripheral region. To determine 1990 parameter values I calibrate the rate of productivity growth in each sector, as well as the migration cost parameter, to match targets (1), (2), and the aggregate agricultural labour share[10]. The calibrated model output is found in Table 2.

5 Counterfactual Experiments

5.1 Labour Market Frictions

The key contribution of this paper is demonstrating how the presence of migration restrictions enhance the contribution of labour market improvements to regional income convergence. To that end, I will isolate the impact of an improvement in the labour market by adjusting *only* that parameters from its initial 1880 value, leaving all other unchanged. This experiment will be repeated when labour flows between regions is restricted; the results are presented in Table 3.

In the standard model as originally presented, the Midwest would experience a massive employment inflow (becoming over twice as large as the Northeast region) as a result of the lower labour market friction. The overall impact on relative regional incomes is nil. This results from, on the one hand, improved labour markets increase regional average incomes while, on the other hand, an employment

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[10]The peripheral share is not targeted since moving from 4% to 3% requires an unrealistically high agricultural productivity growth rate. The model does not have agricultural production in the core region while there is in the data, so having a slightly higher peripheral agricultural share but matching aggregate shares seems reasonable. This is only important when agricultural shares are low.

Table 3: Isolating the Effect of Labour Market Improvements

		Reduce Labour Market Friction by Two-Thirds	
Observed Outcome	1880 Benchmark Model Values	Model with Migration	Model with No Migration
Midwestern Region			
Relative Employment Size	1.05	2.20	1.05
Agricultural Labour Share	0.55	0.31	0.39
Relative Income	0.81	**0.80**	**1.06**
Relative Utility	0.58	0.58	0.81
Southern Region			
Relative Employment Size	1.06	2.85	1.06
Agricultural Labour Share	0.73	0.44	0.55
Relative Income	0.43	**0.46**	**0.67**
Relative Utility	0.37	0.37	0.58

The wedge between agriculture and nonagricultural wages is reduced by two-thirds while all model parameters are kept at their 1880 values. This roughly corresponds to the improvement observed between 1880 and 1990. The impact of this change on the extent of regional income convergence is observed when migration is permitted and when it is not. The impact on convergence is completely offset by the in-migration triggered by the improved regional labour market.

inflow lowers labour's marginal product and, therefore, earnings. The second experiment is identical to the first but restricts employment to its 1880 allocation; that is, migration is restricted. In this case, there is less structural transformation (in the sense of the agricultural labour share falls by less - to 39% instead of 31% in the first experiment) and a dramatic increase in the Midwestern relative income. Thus, the convergence impact of improving labour markets is largest for those regions that also have high degrees of migratory restrictions, like the US South.

The results just highlighted continue to hold for alternative measures of convergence. For instance, the data reveals relative GDP per capita measures by region behave nearly identically to relative wages[11]. In the model, the two measures are equivalent given the identical labour shares across regions. A measure of the *real* convergence impacts are displayed with relative utility levels implied by the model. There is clear convergence along this dimension as well. One should not view these results

[11]There is a difference in levels, with both the Midwest and South displaying a lower relative GDP/Capita value than relative wages for all years. This may be due to a higher nonlabour share of income in the Northeastern states. Data utilized for this exercise is from Caselli and Coleman (2001)'s Data Appendix. My calculations available upon request.

Table 4: Isolating the Effect of Transportation Cost Reductions

| | | Reduce Transportation Costs by Two-Thirds | |
| | 1880 Benchmark | Model with | Model with |
Observed Outcome	Model Values	Migration	No Migration
Midwestern Region			
Relative Employment Size	1.05	1.02	1.05
Agricultural Labour Share	0.55	0.51	0.50
Relative Income	0.81	**0.66**	**0.65**
Relative Utility	0.58	0.58	0.57
Southern Region			
Relative Employment Size	1.06	1.07	1.06
Agricultural Labour Share	0.73	0.72	0.72
Relative Income	0.43	**0.42**	**0.42**
Relative Utility	0.37	0.37	0.37

The transporation cost across regions is reduced by two-thirds while all model parameters are kept at their 1880 values. This roughly corresponds to the improvement observed between 1880 and 1990. The impact of this change on the extent of regional income convergence is observed when migration is permitted and when it is not.

as suggesting that migration restrictions are beneficial. On the contrary, reductions in Northeastern utility and wage levels contribute to the convergence.

5.2 Goods Market Frictions

In order to demonstrate that the existence of the migration option is not important for the other major friction in the model, I conduct a similar experiment for the fraction of goods that successfully arrive at their destination, Δ. Results are displayed in identical format in Table 4. Of particular note, there is *no* substantial difference between the impact of transportation cost reductions when migration is permitted or not. In addition, there are two interesting observations made here that are entirely consistent with Tombe (2008). First, lower transportation costs lead to peripheral emigration. This is due to cheaper means of satisfying the subsistence consumption for core-residents, which means migrants can take advantage of cheaper nonagricultural products while still eating a sufficient amount. Second, there is a sizable divergence impact. Lower transportation costs lower between region price differences and, therefore, relative wages. Specifically, core-producers of the nonagricultural good earn

a higher price while the peripheral producers earn a lower one. This latter point follows directly from the nonagricultural goods prices contain a "delivery charge" to compensate for lost goods (recall Equation (6)). In any case, the migration channel appears to interact mainly with the labour market and not the goods market frictions.

6 Discussion

6.1 Effects of Transportation and Migration Costs

This section will present a few derivations to highlight the underlying channels through which transportation and migration costs influence the model's equilibrium. First, Equation (11) - may be combined with optimal consumption allocation conditions - Equations (10) and (9) - and regional pricing conditions - Equations (6) and (7) - to arrive at the following,

$$\frac{M^c - P^c_f \bar{a}}{M^p - P^p_f \bar{a}} = \mu^{-1} \Delta^{1-2\tau} \tag{17}$$

where $M^i \equiv L^i_f w^i_f + L^i_m w^i_m + N^i r^i$ is the total nominal income of region i. Note that for $\Delta = 1$ and $\mu = 1$ we have income equalization, $M^p = M^c$. For $\Delta < 1$ we have $M^p > M^c$. Thus, as transportation costs fall $((1-\Delta) \downarrow)$ peripheral earnings also fall relative to the core. A similar argument establishes that higher migration costs, μ, lower peripheral incomes.

6.2 Calibration of Transportation Cost Parameter

This parameter specifies the fraction of shipped goods that successfully arrive at the destination. In the model, price ratios between different locations depend exclusively on this parameter. Data from the 1887 Report of the Senate Committee on Transportation Routes shows that to transport a bushel of wheat between Atlantic ports to Great Lake ports by rail averaged 21 cents. This is a significant charge, given the average price of a bushel of wheat was 104 cents over in 1870s.[12]. Harley (1980) compiles additional evidence on wheat and freight prices. Depending on the route, the 1880 per bushel rate to ship wheat from Chicago to New York at that time ranged between 8 to 15 cents. Further west,

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[12]Average wheat prices available within the Statistical Abstracts of the United States

the rate was nearly double, with an additional cost to ship from Kansas City to Chicago at 11 cents. The farm price of a bushel of wheat was 118 cents in New York, 101 in Indiana, 93 in Wisconsin, 82 in Iowa, and 73 in Kansas. Thus, the further west one is relative to New York, the higher the transportation costs and the lower the wheat price. While land-route rates between Southern and Northeastern locations are not provided, the rate to ship from Odessa, TX or New York to Liverpool, UK were nearly identical (10.4 versus 8.6 cents, respectively). This suggests that the ocean shipping rate from Southern ports to Northeastern ones were *substantially* lower than land-based routes between MW and NE. Indeed, the wheat price was very similar in Odessa to New York, with the wholesale bushel price at 112.[13] Given these price data, I settle on an 1880 value for Δ of 0.7 between the Midwest and Northeast and 0.95 between the South and Northeast. In addition, the annual reduction in transportation costs will be set at 1% per year, for both regional groups, roughly consistent with findings of Glaeser and Kohlhase (2004).

6.3 Calibration of Peripheral Labour Market Frictions

As previously established, the cost of peripheral nonagricultural labour, denoted ξ, creates a wedge in nominal wages. This implied wedge will be used from data to determine the size of ξ. Using unadjusted data from Caselli and Coleman (2001), who derive results for the post-1940 period, and spliced with data from Lee et al. (1957) (also provided by Caselli and Coleman (2001)), one can find the relative agricultural prices in 1880. Specifically, I uniformly scale down the relative earning for agricultural workers in the Lee et al. (1957) data in order to match the census results for the year 1940. This procedure is identical to that employed by Caselli and Coleman (2001). The underlying cause of the difference between the two series is that Lee et al. (1957) includes the operator's self-employment income, not just the pure labour earnings.

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[13]The farm price was not available for Odessa at this time, so the wholesale price was used. The New York wholesale price, at 120 in Winter and 117 in Spring, is nearly identical to the annualised average farm price of 118, which suggests this is an acceptable approximation.

6.4 Calibration of Between-Region Migration Costs

For brevity, I focus in this section on the Midwest-Northeast data, though all qualitative results hold for the South-Northeast case as well. First, I investigate the model's ability to match 1880 data without any migration costs whatever. Second, after establishing the inability of the model to do so, I investigate migration costs that *do not* fall over time. Finally, I determine to what extent migration costs must decline to match the 1880 and 1990 data, with plausible values of the remaining parameters.

Given the peripheral region's low paying agricultural sector, costless migration requires that this region must differ in its nonagricultural productivity and land endowment sufficiently to ensure that individuals (in the model) wish to reside there. That is, in the absence of lower peripheral utility (due to migration costs) there must productivity premium to have utility levels successfully equalise. However, this higher productivity will increase the relative earnings of this region compared to the core. Table 5, Column (1), displays the set of parameters and the model outputs that are closest to the data. The relative income of the peripheral region is clearly *far* above that found in the data, with Midwestern average earnings 118% of the Northeast compared to the true data of 81%. If Northeastern productivity parameters were to be increased (from their currently low value of 0.78 to something closer to the Midwestern value) then model agents would migrate away from the Midwest, leading the model to miss along the relative employment size dimension.

Given the importance of including some sort of Utility-wedge in the model to properly match the data, I perform another experiment that sets all initial parameter values to match the 1880 values. I then maintain the migration costs at their initial level but allow other parameters to evolve according to observed data and calibrate the productivity parameters to give the model the best chance of matching 1990 data. Column (2) of Table 5 shows that without a reduction in migration costs, a large core-premium productivity premium is still insufficient to match data. Intuitively, as structural change takes place the peripheral region becomes increasingly able to achieve higher utility as labour moves to the nonagricultural sector. However, to maintain the initial 1880 Utility wedge the core region's productivity must grow substantially more than the periphery's. Specifically, the core's annual growth rate is 1.75% while the periphery's is 1.5%. This differential growth, however, leads to the model failing to match the observed degree of regional convergence, with Midwestern incomes falling behind to 64%

Table 5: Model Performance under Various Migration Cost Assumptions

(a) Data vs. Model Output

		Midwest-Northeast			
		1880		1990	
Variable	Data	No Cost (1)	Data	Constant Cost (2)	*Only* Declining Cost (3)
L^p/L^{c*}	1.05	1.08	1.16	1.16	0.19
L^p_f/L^{p*}	0.55	0.80	0.03	0.04	0.92
w^p/w^{c*}	0.81	1.18	0.86	0.64	1.05

Note: Asterisks denotes targets

(b) Calibrated for Model to Match Targets

Specification	Year	Ω	μ	A^S_f	A^S_m	A^N_m	$\bar{a}$
(1)	1880	0.58	1	1.00	1.05	0.78	0.28
(2)	1990	0.38*	0.58	26.12	5.11	6.84	0.13*
(3)	1990	0.38*	0.78	1.00*	0.98*	1.01*	0.13*

Note: Asterisks denote baseline values

of the Northeast. Clearly, a model with constant migration cost is unable to match data.

Finally, a model with *only* declining migration costs will similarly be unable to match data. Column (3) in Table 5 contains the result of holding all parameters at their 1880 values but for the migration cost parameter, which is reduced to the baseline 1990 value of 0.78 (compared to 0.58). It clearly illustrates that without other parameters changes a large number of workers must migrate *out* of the peripheral region to sufficient raise its relative utility levels. This leads to a far lower size and far higher income levels for that region that is actually observed. So, reducing the regional utility wedge (migration cost) to slightly over 50% of its original level[14] *in addition* to the other parameter changes is necessary to match data.

This large reduction in migration costs appear entirely in agreement with existing literature. Quantitative comparisons are difficult but has long been recognised that the difficulty of migration between regions or countries is decreasing in the stock of previous migrants in the destination. The initially large utility differential suggested by the model may also be consistent with previous estimates. Greenwood (1975), for example, conducts an interesting literature review and points out that black migrants out

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[14]The utility cost of migrating out of the peripheral region is 1-μ. So, (1-0.78)/(1-0.58)=0.524

Table 6: Average Annual Growth Rates of Key Variables, 1880-1990

Statistic	Agriculture	Nonagriculture	HSUS Series
Employment Growth	-1.01%	2.38%	Ba652,Ba653,Ba814,Ba817
Producer Price Growth	1.24%	2.41%	Cc66,Cc68,Cc126,Cc127
Nominal GDP Growth	2.14%	5.79%	Ca216,Ca136,Da1117
Real GDP Growth	0.91%	3.39%	Ca211,Ca136,Cc66
A	**1.51%**	**1.96%**	

Source: Historical Statistics of the United States, Millenium Online Edition. Pre-1929 Nonfarm GDP Growth is implied from employment weighted average from overall GNP and farm output growth. Pre-1929 Farm GDP Growth is assumed equal to agricultural output growth.

of the Southern region could experience a fifteen to twenty percent earning increase. Moreover, there are substantial psychic costs of migration, which suggests the utility wedge suggested by the model for the Southern region may not be too ridiculous. This is especially true given that psychic costs seem inversely related to one's level of education (Schwartz, 1973) and the Southern African-American population was particularly disadvantaged along this dimension.

6.5 Alternative Productivity Calibration

The results of the original calibration strategy will be compared to a simple Solow-residual calculation from the *Historical Statistics of the United States* that are based on national-level output. In addition, recent BEA data will also be used to make reasonable regional-specific adjustments. The decomposition of the data will proceed for each sector s. Denoting growth rates as γ, we have $\gamma_{A_s} = \gamma_{Y_s} - (1 - \alpha_s)\gamma_{L_s}$. The decomposition assumes the land input is fixed through time, both in total and in terms of its productivity, which is reasonable given that one finds a 0.03% annual growth in the index of cropland between 1910 and 1990[15]. The values used for real GDP and employment growth in each sector are taken from over a century of data (1880-1990) from the *Historical Statistics*, and assumed to be representative for the period under which the model will be simulated: 1880-1990. The values and precise sources can be found in Table 6, with 1.51% annual growth for A_f and 1.96% for A_m.

While I lack regional data sufficient to determine growth in A_m by region since 1880, I can use recent data from the Bureau of Economic Analysis to examine whether a 10-15% faster growth in

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[15]HSUS Series Da665

Southern nonagricultural productivity is reasonable. Specifically, I use data for the period 1969-1997 to estimate that A_m in the South grew at 7.75% per annum[16] while only 6.75% in the North. Moreover, the Midwest had a growth rate remarkably similar to the North, with 6.5% per annum. Thus, the original calibration results of 2.22% for Southern nonagricultural productivity growth compared to 1.93% for the Northeast appears very reasonable.

The lower rate of agricultural productivity growth found here is different, however, from the original calibration. Using this lower value for agricultural productivity growth, the model fails to fully capture the labour reallocation out of agricultural - though it still results in a single-digit share in 1990. The overall conclusion regarding the impact of migration restrictions on the relationship between labour market and income convergence is unaffected by the alternative agricultural productivity growth rate.

7 Conclusion

Using a general equilibrium model of structural transformation calibrated to match historical data for various US regions, this paper finds that barriers to regional migration magnify the impact that improvements in the ability of workers to switch from agricultural to nonagricultural employment have on regional convergence. Put another way, it finds that sectoral labour market frictions have effectively no impact on a region's relative earnings position unless they are coupled with explicit migration restrictions, as one would find historically in the US South. More generally, these results may be applicable to recent relaxations of the Chinese Hukou migration restrictions. China's economy is experiencing dramatic structural change while inter-provincial average income differences are growing. This model suggests this pattern may be due to the offsetting impact of relaxed migrations restrictions. In any case, these results highlight that future research should incorporate internal migration flows into the analysis of labour markets and regional convergence.

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[16]Note these figures are not directly comparable to earlier results, given there is no adjustment for price increases here.

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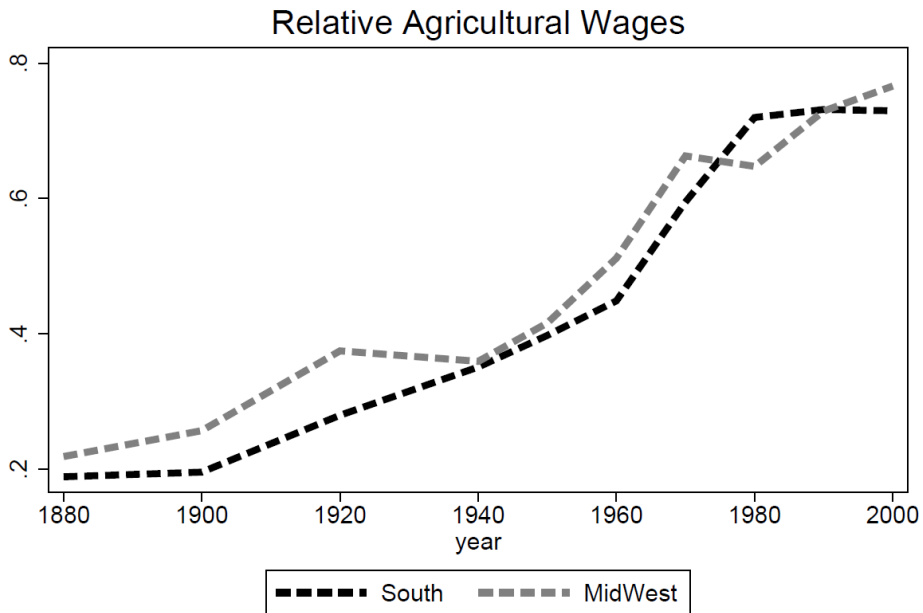Figure 1: Graphical Presentation of US Census Regions

Figure 2: Agricultural Share of Employment, by Region

Agricultural Employment Share, by Region
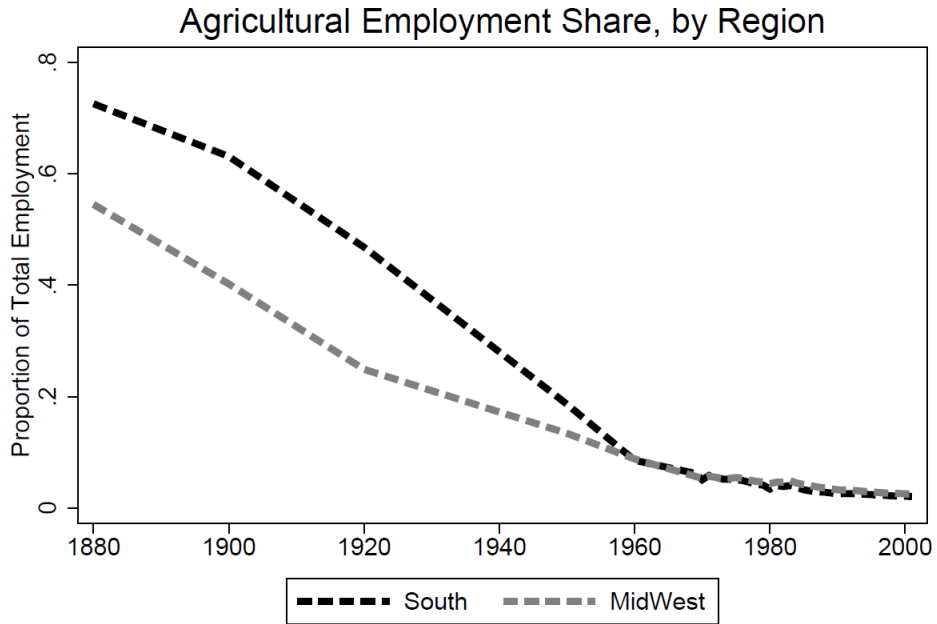
Source: Lee et al. (1957), 1880–1920; Caselli and Coleman (2001), 1940–60; BEA, 1969–2001

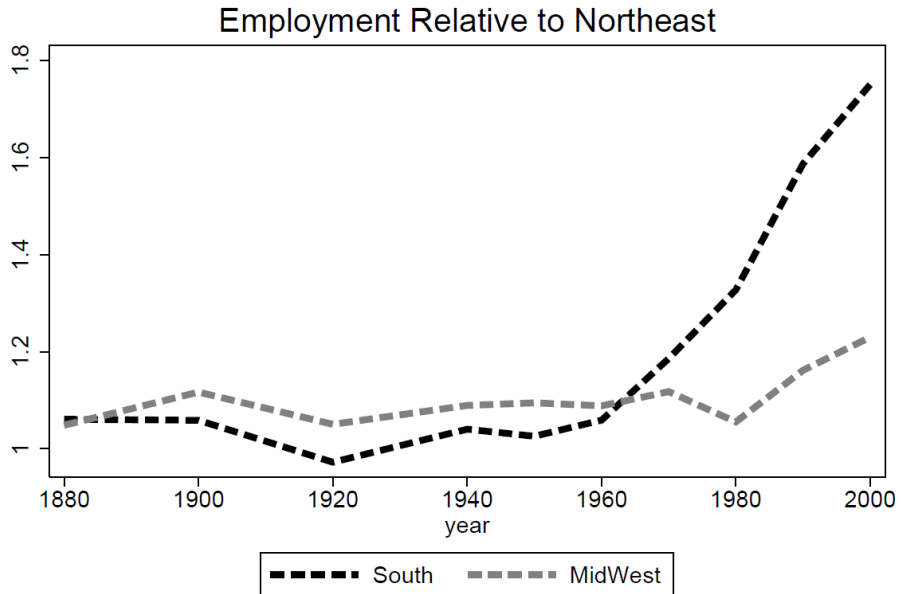Figure 3: Relative Agricultural Wages, by Region

Relative Agricultural Wages

Source: Lee et al. (1957), 1880–1920; Caselli and Coleman (2001), 1940–90; IPUMS Census, 2000

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Figure 4: Overall Average Wage Relative to Northeast, by Region

Average Income Relative to Northeast
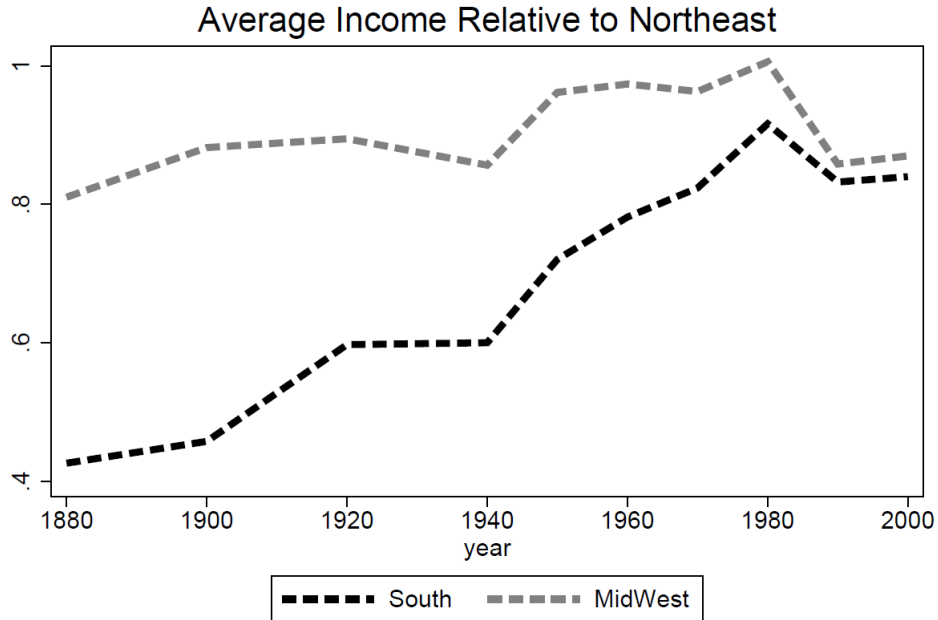
Source: Lee et al. (1957), 1880–1920; Caselli and Coleman (2001), 1940–90; IPUMS Census, 2000

Figure 5: Employment Relative to Northeast, by Region

Employment Relative to Northeast

Source: Lee et al. (1957), 1880–1920; Caselli and Coleman (2001), 1940–90; IPUMS Census, 2000