



# More hands, more power? Estimating the impact of immigration on output and technology choices using early 20th century US agriculture



Jeanne Lafortune<sup>a,b</sup>, José Tessada<sup>c,\*</sup>, Carolina González-Velosa<sup>d</sup>

<sup>a</sup> Instituto de Economía and EH Clio Lab, Pontificia Universidad Católica de Chile, Avda. Vicuña Mackenna 4860, Macul, Santiago, Chile

<sup>b</sup> Institute for the Study of Labor, IZA, Germany

<sup>c</sup> Escuela de Administración and EH Clio Lab, Pontificia Universidad Católica de Chile, Avda. Vicuña Mackenna 4860, Macul, Santiago, Chile

<sup>d</sup> Inter-American Development Bank, 1300 New York Ave, NW, Washington, DC 20577, United States

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## ABSTRACT

We study the impact of immigration-induced changes in labor supply within agriculture in the US during early 20th century, a sector where shifting output mix may be easier than in previously studied industries (manufacturing), on output and production choices. We find evidence of output mix adjustments at the county-level in response to immigration as predicted by trade models. Moreover, that response is only visible in diversified counties. Counties with higher initial specialization, likely with higher degree of factor (land) specificity, responded instead through input mixes and organizational changes. Suggestive evidence indicates that crop mix adjustments alone, without organizational changes, absorbed an important part of changes in labor endowments in diversified counties.

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## 1. Introduction

How does an economy adjust to an inflow of new workers? This question has been one of the basic motivations of the literature (and the policy debate) regarding the impact of immigration in the United States and other countries in the world. As part of the discussion about the precise estimates of the effects of immigration on the labor market outcomes of natives, the literature has improved our understanding of how natives and immigrants interact in the labor market. Some authors have suggested that native workers, even those with skill levels similar to those of migrants, are not perfect substitutes for immigrant labor (see for example, Cortés 2008, Ottaviano and Peri 2012, Peri 2009). Other authors have argued that adjustments in technology can occur in response to immigration, and these endogenous adjustments may attenuate the wage and employment effects of the inflow of workers.<sup>1</sup> Moreover, as predicted by trade theory, economies may also adjust to immigration by shifts in output mix. For example, in response to an inflow of low-skill labor, firms may increase the production of goods that are more labor intensive, generating a shift in the labor demand that allows the local economy

to absorb the inflow of workers without a change in wages. However, this is only possible in a context in which the cost of altering the output mix is not too costly and can be done relatively rapidly.<sup>2</sup>

Several studies have examined the relative importance of these adjustment mechanisms in response to immigration flows. According to this evidence, most of the absorption of additional workers seems to be occurring via changes in technology, with shifts in the output mix playing a lesser role: see for example, Card and Lewis (2005), Lewis (2004), Dustmann and Glitz (2011), and Gonzalez and Ortega (2011). One exception to this literature is Hanson and Slaughter (2002) who find evidence that output shifts might have contributed to the absorption of the immigrant inflows to the US, albeit using a different empirical strategy. Overall, one possible explanation for the limited evidence of output mix changes found in these studies may be factor specificity or high adoption costs that limit these types of adjustments.

In this paper we focus on the agriculture sector in the US between 1910 and 1940, a sector in which output (crop) adjustments may have been relatively less costly. The relative malleability of agricultural machinery across different crops may have facilitated output adjustments with respect to, say, the manufacturing sector, where capital equipment tends to be more specific. Moreover, another advantage of focusing on agriculture is that output production (in this case, crop production) is

\* Corresponding author. Tel.: +56 2 23544349.

E-mail addresses: [jlafortune@uc.cl](mailto:jlafortune@uc.cl) (J. Lafortune), [jtessada@gmail.com](mailto:jtessada@gmail.com) (J. Tessada), [cagonzalez@iadb.org](mailto:cagonzalez@iadb.org) (C. González-Velosa).

<sup>1</sup> Technology may adjust to the change in skill mix brought up by immigration, as predicted by models of capital-skill complementarity such as Krusell et al. (2000). Also, new labor intensive technologies could be endogenously generated or adopted in response to a labor inflow as in the theory of directed technological change of Acemoglu (2002).

<sup>2</sup> This mechanism corresponds to the Rybczynski theorem, the standard adjustment mechanism to changes in relative endowments in Heckscher–Ohlin trade models. One of the most common frictions that restrict this mechanism is the existence of specific factors.

easily observed and measured. Most previous studies have used shifts in the industry mix to proxy for product mix adjustments, and therefore cannot observe any product shifts within an industry. This may have generated an “aggregation” bias against the importance of product-mix adjustments.<sup>3</sup> Thus, our setup has two interesting features: direct measures of production of goods with less potential for aggregation bias, and an economic activity where capital may have a lesser degree of specificity.

This paper examines how firms, or farms in this specific case, adapted to changes in labor supply that were generated by a plausibly exogenous shock to labor endowment in rural US counties stemming from changes in inflows of immigrants during 1910 to 1940. The paper focuses on contrasting potential mechanisms through which responses to immigration may have occurred: changes in output mix versus factor adjustments.<sup>4</sup> We further explore this question by noting, in certain regions, factor-specificity will make changes to output mix more difficult, forcing farms to adjust by changing techniques and factor use ratios. Moreover, evidence from previous studies provided at the aggregate level may mask much of the heterogeneity in the adjustment mechanisms. This argument has not been previously made nor empirically demonstrated in this literature.

Besides the possibility to observe changes in output mix, several other reasons make the agriculture sector in the early twentieth century an interesting setting to conduct this analysis. First, the large immigration flows at the beginning of this period (e.g., in the early decades of the twentieth century the fraction of the population that was foreign born was larger than during the most recent decades in the United States) came to a precipitous decline in the 1920s and had important variation across time and geographical areas (both destination and origin). Second, the agriculture sector at the time was important for the US economy and received a large number of immigrants: 17% of all migrants arriving were agricultural workers in their country of origin, and more than 10% of the immigrants in the United States reported to be involved in such occupations.<sup>5</sup> Third, observing how these inflows may have fostered changes in factor use, techniques or crop choice, is facilitated by the availability of relevant data in the United States Agricultural Census and by a large number of contemporaneous studies that describe in detail the production processes and input requirements of various crops. There is, for example, data on the important technological transformations that became available to farmers in this period, with the arrival of tractors as a new source of draft power. Contrastingly, in today's economy, most immigrants work in the services sector in which techniques and capital are difficult to measure. Finally, the period from 1910 to 1940 is particularly appealing because the “frontier” was almost completely established, limiting the incorporation of new land as a mechanism to absorb the inflow of immigrant workers.

Our approach to this question follows a simple motivating framework which emphasizes the role of factor-specificity/specialization. We start by thinking of local labor markets as small open economies with access to a similar set of production technologies that use land, capital and labor. These can be combined to produce three different outputs (crops) with three different levels of labor intensity. Local economies, however, differ in the specificity of their land, which limit reallocations different crops. If local economies can change their production mix, as it is the case in the standard small open economy model in classical trade theory, we would expect capital to reallocate across crops in response to the labor inflow. As long as the economy is

in the “cone of diversification” this adjustment implies that the inflow of workers would bring no changes to the relative factor prices. However, if, due the specificity of its land, the local economy cannot make shifts in crop production or is not in the diversification cone, it will need to resort to changes in the capital intensity within each type of crop in order to absorb the change in labor endowment. These two alternatives will have consequences not only for observed crop shifts but also for a number of other variables that we will explore.

We then examine empirically whether, between 1910 and 1940, immigration-induced shocks to the (relative) supply of low-skilled labor (measured as number of agricultural or low skill workers per acre of farmland) caused farms in the United States to modify their crop choice, input mix and organization of production. We focus on changes in crop choice as a measure of shifts in output mix and also explore other margins of adjustment (input mix, scale of production, tenancy organization and draft power choice). Such variables are obtained from the Census of Agriculture, many of which were digitalized for the purpose of this study. Data on the number of immigrants, agricultural and low-skilled workers in each county were built using the Population Census of the United States.

We exploit the panel dimension of the dataset to control for national trends and other confounding factors using county and state-by-year fixed effects. To obtain causal estimates of the responses to changes to the labor supply, we use *immigration inflows* as shocks to the *total* labor supply. In order to deal with the endogenous location of immigrants across local labor markets, we follow Card (2001) and construct instrumental variables using the location of past immigrants. Furthermore, to avoid potential problems arising because of persistent shocks to the agricultural markets we construct this instrument using the location of *all* past immigrants, regardless of whether they worked in agriculture or not. Our instrument appears to be fairly strong and robust over this period when used to predict the location of immigrant agricultural workers, as well as the location of all (migrants and native) agricultural workers and low-skilled workers, at the county level.

Our results suggest that the increases in the relative endowment of labor due to immigration had a strong effect on output choices. We first present evidence showing that the share of land allocated to specific crops and the share of output value was altered by the increase in the relative endowment of agricultural workers. By comparing counties within a given state in a given year, we find that an increase in the amount of labor per acre reduced the share of land allocated to wheat and raised the share of land allocated to hay and corn as well as the share of land in which no crops were produced. Given that wheat is less labor intensive than corn and hay, we interpret the observed shifts in crop mix as adjustments in production caused by immigration-induced changes in factor availability and provide evidence against alternative causal channels. We consider the possibility that the changes in output mix could be driven by immigration-induced changes in the relative demand of crops, but the absence of changes in local crop prices is evidence against this option. We also explore whether the changes in crop choice are driven by a transmission of agricultural knowledge generated by immigration but find no evidence supporting this.

We do find some limited evidence for changes to the organization of production, particularly on average farm size. However this change is at the aggregate level, so it could reflect adjustments away from more land-intensive crops. We also explore county level changes in other margins of the organization of production, such as tenancy and use of mechanized draft power, and find no evidence of effects. Thus, overall our results using all counties find robust evidence for crop mix changes but not much support for other modes of adjustment.

We then explore some testable implications derived from the conceptual framework in which local economies absorb a change in the relative supply of labor by changing the output mix. In line with the predictions, we find that the aggregate capital–labor ratio fell almost by one percent in response to a one percent increase in the number of workers per acre. Moreover, we find no evidence that crop productivity

<sup>3</sup> Dustmann and Glitz (2011) try to surmount this with measures of skill mix at the firm level. While this strategy may ameliorate the bias, changes in product-mix within firms will still go unobserved. See Lewis (2013) for a discussion of this issue.

<sup>4</sup> See Lewis (2013) for a review of work on the relation between immigration and production technology, also including the channels we study in this paper.

<sup>5</sup> According to the authors' calculations using Census micro samples for 1910 to 1940, and the Reports of the Commissioner for Immigration between 1900 and 1930. During this period an even larger number of immigrants worked in manufacturing.

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