Notes: The figure depicts overall changes in the occupational structure over the period 1910–1940 as displayed in Figure 3 and contrasts them with the structural changes due to electrification as implied by our IV estimates (Tables C.22 and C.30) scaled by the average increase in transmission lines within a county (Figure 4). Panel A focuses on occupations while panel B reports results for industries. Bars are sorted from top to bottom by employment share in 1910 and the underlying population are working age men (16-65) with a reported occupation. We only report implied IV estimates for statistically significant coefficients (at least 10% significance level). The underlying data on the occupational and industrial structure are the full count U.S. Censuses. The impact of electrification is estimated using historical maps of the U.S. electricity grid and hydroelectric potential as an instrument. Details are provided in Sections 3 and 4.

Fig. 1. Approximate contribution of electrification to structural transformation, 1910–1940

Bank argues that “infrastructure has a central role in the development agenda and is a major contributor to growth” (World Bank, 2005) and it has helped 45 million people to gain access to electricity from 2014 to 2018 and spent over $5 billion on energy programs.\(^2\) Ethiopia is a leading example of a developing nation recently investing heavily in electricity, as its production has increased seven-fold in the 16 years since 2000 (Fried and Lagakos, 2017, 1). Despite these massive investments in electrification, there is still considerable debate on what exactly these economies should expect in response.

We contribute to this debate by exploring the causal effect of electrification on U.S. structural change from 1910 to 1940. Looking at this historical episode allows us to analyze the long run impacts of electrification over three decades, which is generally not possible in the modern development literature but is important given the lengthy time general-purpose technologies need to unfold their full potential through complementary innovations.\(^3\)

The primary challenge in estimating the impact of electrification is that adoption was endogenous to existing levels of development, skill and industrial composition. We address this concern by appealing to two related observations: first, while coal-powered electricity was widely available in urban areas by 1910, hydroelectric power was limited. The primary benefit of hydroelectric power generation is its low variable cost, while the main downsides are sizable fixed costs (e.g., building a dam in a remote location) and the remoteness of the most suitable sites for power generation. We argue that the latter was the main reason for the dominance of coal before 1920.\(^4\)

Second, the high-voltage power grid was nonexistent in 1910, and greatly expanded after 1920 (see Figs. 2 and 4), due to technological innovations in power transmission.\(^5\) Since coal could be transported to any given location, this new technology was not particularly useful for coal generated power. In stark contrast, this technology allowed hydroelectric power to be transported to end users from remote locations, making massive construction projects such as the Hoover Dam viable. The low variable cost of hydroelectric power combined with high-voltage transmission lines imply that the expansion of the grid led to a significant reduction in the price of electricity in serviced locations and increased adoption in such areas.

Our strategy to estimate the causal impact of electrification exploits the geographic variation in this price shock. While the eventual path of the distribution lines that connected individual places to the grid was almost certainly driven primarily by electricity demand, we argue that places close to highly suitable locations for hydroelectric power generation were effectively exogenously “treated” with high-voltage power lines. To implement this idea, we use geographic variation in “hydroelectric potential”—a measure governed by fixed, exogenous topographic characteristics of a place, inversely related to the cost of building and operating a hydroelectric power station in any given location—to instrument for the observed geographic expansion of the high-voltage

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\(^3\) See, for example, Rud (2012) and Burlig and Preonas (2016), which look at most over a two decade interval to analyze the effects of electrification in India, and Fried and Lagakos (2017), who look at the period since 2012 because Ethiopia’s electrification is so recent. As an example of the long lags and importance of complementary investments to general-purpose technologies, consider (Eden and Gaggli, 2018), who illustrate that the full effects of information and communication technology (ICT) significantly lagged its first invention and were substantially amplified by complementary non-ICT investments.

\(^4\) Hughes (1993) outlined the constraints of coal and hydro generation and emphasized that a regional grid started to be formed only from about 1920, facilitated by improved transmission lines.

\(^5\) Feasible transmission voltages increased from under 50 kilovolts in 1900 to over 150 kilovolts around 1920 (Lewis and Severini, 2020).