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ABSTRACT

Immigration and Work Schedules: Theory and Evidence*

We develop a theoretical framework to analyze the effects of immigration on native job amenities, focusing on work schedules. Immigrants have a comparative advantage in production at, and lower disamenity cost for nighttime work, which leads them to disproportionately choose nighttime employment. Because day and night tasks are imperfect substitutes, the relative price of day tasks increases as their supply becomes relatively more scarce. We provide empirical support for our theory. Native workers in local labor markets that experienced higher rates of immigration are more likely to work day shifts and receive a lower compensating differential for nighttime work.

JEL Classification: F22, J61, J31, R13
Keywords: immigration, working conditions, night shifts

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1 Introduction

A popular argument in favor of immigration is that immigrants work in "bad" jobs that natives do not want. Indeed, several recent papers have found that immigrants are more likely to hold jobs involving worse work conditions (Orrenius and Zavodny, 2012, 2009; Giuntella et al., 2018). This of course does not mean that immigrants have no impact on native labor market outcomes. To the extent that "bad" and "good" jobs interact in the market, an increase in the supply of those willing to take "bad" jobs can have important consequences on the market for "good." The impact of immigration on native job amenities has received surprisingly little attention in the literature.

This paper attempts to fill this void, specifically focusing on work schedules. We build a model similar in spirit to Peri and Sparber (2009) where night tasks and day tasks are separate inputs in production. Immigrants have a comparative advantage in producing night tasks, and a lower disamenity cost for working nights, which causes them to specialize in non-traditional schedules. Because night tasks and day tasks are complements, this nighttime labor supply shock raises the relative daytime wages for native workers, and induces more native workers to work during the day.

We confirm our predictions empirically using the Decennial Censuses, American Community Survey, and the American Time Use Survey. Using temporal and spatial variation in the concentration of immigrants, we find that a 10 percentage point increase in the fraction of foreign workers in a local labor market leads to a .51-.77 percentage point decrease in the probability of natives working at night, and a .73 percentage point relative increase in native daytime wages. These changes are driven by a movement of native workers into occupations which specialize in daytime employment, moving away from agriculture, mining, construction and manufacturing into wholesale and retail trade, finance, and services. We find strongest effects among low-skill workers, consistent with the prior that low-skilled natives would be the closest substitutes to immigrant workers.

Neglecting these effects would lead economists to overstate welfare losses and understate welfare improvements from immigration. Measuring just the medical gains from reduced sleep deprivation associated with night work, we estimate natives would receive $337 million in non-

pecuniary benefits from a 10 percentage point increase in percent of the population that is foreign born. Based on our estimate of the compensating differential, these previously undocumented gains may be orders of magnitude larger.

Economists have long been interested in understanding the effects of immigration on labor markets and human capital (e.g., Card, 1990; Hunt, 1992; Dustmann et al., 2005; Borjas et al., 2012, 2008; Glitz, 2012; Hunt, 2017). While most studies found little evidence of negative effects of immigration on overall native wages and employment, the debate becomes more controversial when looking at subgroups who are likely to be complements or substitutes with these immigrants. For example, Ottaviano and Peri (2012) find immigration has a small positive long run effect on native wages, but large negative effect for previous immigrants. Peri and Sparber (2009), using a model similar to the one we employ, find that immigration raises the provision of jobs with manual tasks, and thus the wages of complementary jobs that require a high-degree of communication skill.

There has been much less discussion of how immigration affects non-wage job characteristics. Giuntella et al. (2018) and Giuntella and Mazzonna (2015) find evidence that immigration reduced occupational risk and physical intensity among high-skilled natives, while Giuntella (2012) finds immigration is associated with less non-standard schedules for natives in Italy. None of these papers provide a theoretical framework for understanding how immigrants impact native job amenities, and we provide the first comprehensive empirical study of these effects in the United States.

Work scheduling is a particularly important job dimension for studying immigration. Nearly 5.5 million foreign-born workers work in jobs with non-standard hours, accounting for more than 18% of non-regular hours in the United States (Dramski, 2017). In sectors such as manufacturing, where stopping or idling machines is a large cost, non-standard shift workers are crucial, yet several reports have shown that firms have often trouble staffing overnight shifts.[1] Non-standard hours are also a particularly costly job disamenity. There is growing evidence that night shifts can severely impact individual health (Schernhammer et al., 2001; Costa, 1996; Knutsson, 2003). Indeed, the disruption of circadian rhythms can have negative effects on obesity, diabetes, cardiovascular diseases and certain types of cancer (Kecklund and Axelsson, 2016; Giuntella and

[1] https://www.cpbj.com/incentives-opportunities-attract-workers-to-off-hour-shifts/

Mazzonna, 2019; Rajaratnam et al., 2013). Furthermore, working night shift may pose challenges for work-family balance (Liu et al., 2011; Strazdins et al., 2006).

Our model offers a novel take on the determination and magnitude of compensating differentials. The canonical approach focuses on the tradeoff between the firm's cost of providing job amenities and the wage decreases workers are willing to take in exchange for those amenities (e.g., Thaler and Rosen, 1976).[2] In equilibrium, workers with lower valuation of these amenities sort into low amenity jobs. This approach remains in our core, we embed it in a general equilibrium model where high and low amenity jobs (day and night employment) are complements in production, and thus labor supply determines the equilibrium provision of amenities and compensating differential. While most of the literature focuses on occupational safety, it would be easy to adopt our approach to this setting, or any other job amenity.

This paper is organized as follows. In Section 2 we build our general equilibrium model of work schedules. Section 3 describes the data. Section 4 lays out our empirical strategy and discusses threats to identifaction. In section 5 we estimate the causal effect of immigration on native work schedules and compensating differentials, and provide a host of robustness exercises. We discuss welfare implications and some concluding remarks in Section 6.

2 A Model of Equilibrium Work Schedules with Immigration

2.1 Primitives

We consider an open economy similar to Peri and Sparber (2009). Firms combine two inputs, day tasks (D) and night tasks (N), through a CES production function to produce a final good Y

$$Y = \left[\beta D^{\frac{\theta-1}{\theta}} + (1-\beta)N^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{1}$$

where $\theta \in (0, \infty)$ measures the elasticity of substitution between inputs and β captures their relative productivities. Note that while we focus on work schedules, we could equivalently view the inputs as risky and safe tasks, or tasteful and distasteful work. We treat Y as the numeraire

[2]This theory obviously implies that jobs with worse amenities should have higher pay, a prediction which has remarkably little support. Guardado and Ziebarth (2019) develop a model where workers, rather than firms, take action to provide job safety, which produces a negative correlation between job accidents and wages in equilibrium.

good so that all prices are in terms of Y.

Workers have one indivisible unit of labor which they must allocate to either a daytime job or a nighttime job. Their output (quantity of day/night tasks) in each job depends on their skill endowment, with d being their stock of day skills and n being their stock of night skills. This endowment in turn is determined by their type, which is either foreign (f) or native (n). A foreign worker allocated to a nighttime job produces an output of n_f night tasks, and similarly for daytime jobs and native workers. Foreign workers have a comparative advantage in night production so that $\frac{n_f}{d_f} \geq \frac{n_n}{d_n}$. This could be, for instance, because foreign workers possess a comparative advantage in manual skills, as shown by Peri and Sparber (2009), and manual tasks are more prevalent at night. Define $\frac{n_n}{d_n} \equiv \eta$ and $\frac{n_f}{d_f} \equiv \nu\eta$ where $\nu \geq 1$ represents the degree to which foreign workers possess a comparative advantage at night tasks. The set of workers in the economy is of measure 1, with f being the fraction foreign.

Working a nighttime job creates a private disamenity cost that is in part determined by the worker's nativity. Native worker i incurs cost c_i, while a similar foreign worker incurs cost λc_i, with $\lambda \leq 1$. The parameter c is distributed continuously over $(0, \infty)$ with twice differentiable cdf $G(c)$. In other words, the distribution of native disamenity costs stochastically dominates that for foreign workers, or foreign workers are on average more willing to work nighttime jobs.

Workers have concave utility with respect to wages. Specifically a worker who earns income x receives utility $U = \ln(x)$. This functional form allows for a tractable characterization of the equilibrium, but is otherwise inconsequential.

2.2 Labor Demand

Perfectly competitive firms maximize profits by choosing the amount of day tasks and night tasks to purchase from workers given market task prices w_D and w_N,

$$\pi = \left[\beta D^{\frac{\theta-1}{\theta}} + (1-\beta) N^{\frac{1-\theta}{\theta}}\right]^{\frac{\theta}{1-\theta}} - w_D D - w_N N. \tag{2}$$

From the two first order conditions, we obtain the relative demand function,

$$\frac{D^D}{N^D} = \left(\frac{1-\beta}{\beta}\right)^{-\theta} \left(\frac{w_N}{w_D}\right)^{\theta}. \tag{3}$$

2.3 Labor Supply

Workers take task prices as given and choose whether to work a daytime or nighttime job. Turning first to natives, the utility for such a worker in a daytime job is

$$U_i = \ln\left(d_n w_D\right), \tag{4}$$

while for a nighttime job,

$$U_i = \ln\left(n_n w_N\right) - c_i. \tag{5}$$

By equating (4) and (5), a native worker will choose a nighttime job so long as

$$e^{c_i} \leq \omega_N \eta, \tag{6}$$

where $\omega_N \equiv \frac{w_N}{w_D}$ is the relative price of night tasks. Then, denoting $h(c) \equiv \exp g(c)$, the total output of night tasks from native workers is

$$N_n = (1-f)H(\omega_N \eta) n_n. \tag{7}$$

The first two terms represent the fraction of the population which is native multiplied by the fraction of natives who prefer nighttime jobs to daytime jobs at market prices. The final term is simply the per native output of night tasks. Likewise for daytime jobs,

$$D_n = (1-f)\left[1 - H\left(\omega_N \eta\right)\right] d_n. \tag{8}$$

Foreign workers' daytime employment utility differs from natives only due their different skill endowment,

$$U_i = \ln(d_f w_D). \tag{9}$$

For nighttime jobs, their utility also differs by their lower (average) disamenity cost,

$$U_i = \ln(d_n w_N) - \lambda c_i. \tag{10}$$

They will thus choose a nighttime job provided

$$e^{c_i} \leq (\omega_N \nu \eta)^{\frac{1}{\lambda}}. \tag{11}$$

Integrating over the distribution of c, we can find the total output of night tasks from foreign workers,

$$N_f = fH\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right) n_f. \tag{12}$$

The first two terms again represent the fraction of the population which is foreign multiplied by the fraction of foreigners who prefer nighttime jobs. The final term is the per foreign worker output of night tasks. The same applies for the total output of day tasks,

$$D_f = f\left[1 - H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)\right] d_f. \tag{13}$$

Combining the expressions for the task supply of foreign and domestic workers, we can arrive at the total relative task supply in the economy,

$$\begin{aligned} \frac{D^S}{N^S} &= \frac{D_n + D_f}{N_n + N_f} \\ \frac{D^S}{N^S} &= \frac{(1-f)\left[1 - H\left(\omega_N\eta\right)\right] d_n + f\left[1 - H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)\right] d_f}{(1-f)H(\omega_N\eta)n_n + fH\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right) n_f}. \end{aligned} \tag{14}$$

2.4 Equilibrium

At equilibrium, the relative task supply is equal to the relative demand. Equating (3) to (14),

$$\omega_N = \left[\frac{(1-f)[1 - H(\omega_N\eta)]d_n + f\left[1 - H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)\right] d_f}{(1-f)H(\omega_N\eta)n_n + fH\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right) n_f}\right]^{\frac{1}{\theta}} \frac{1-\beta}{\beta}. \tag{15}$$

Equation (15) implicitly defines the equilibrium relative task prices in the economy. The equilibrium relative task output is then determined through equation (3). Note that we can close the model for general equilibrium by assuming that workers spend all of their income on Y.

2.5 Comparative Statics: The Effect of Immigration on Native Working Conditions

We now prove a series of results regarding the impact of immigration on the labor market. For ease of exposition, we will assume that at least one of the inequalities $\lambda \leq 1$ and $\nu \geq 1$ is strict. If both $\lambda = 1$ and $\nu = 1$ then foreign and native workers are identical, and there is no impact of immigration.

We first show that immigrants sort into nighttime jobs.

Lemma 1. *The proportion of foreign workers in nighttime jobs is strictly higher than the proportion of native workers in nighttime jobs.*[3]

The proof is straightforward. Foreign workers have a comparative advantage in night task production and a relatively lower disamenity cost for nighttime jobs. Both these factors push foreign workers to work nighttime jobs at higher rates. Proposition 1 then immediately follows.

Proposition 1. *An increase in the proportion of foreign workers leads to a decrease in the relative provision of day tasks and a decrease in the relative price of night tasks.*

Since foreign workers take nighttime jobs at higher rates than natives at any given market price, and foreign workers have a comparative advantage in night task production, an increase in the fraction of the population that is foreign necessarily increases the relative output of night tasks. This leads to an increase in relative price for the now more scarce day tasks.

Since foreign workers always work more night tasks than native workers, increasing the relative proportion of foreign workers leads to a decrease in the relative provision of night tasks. In equilibrium then, since day and night tasks are imperfect substitutes, the relative price of day tasks increases as their supply becomes relatively more scarce.

Note that our result speaks to the equilibrium provision of *tasks* and not the overall rate of *employment*. The latter depends on the relative skill endowments of native and foreign workers.

[3]For proof of this and all other results, see Appendix A.

For example, suppose that foreign workers have an absolute advantage in night task production. It is possible then that night task provision could increase (and thus night task prices decrease), but that there would be less overall workers employed in nighttime jobs. However, as the next proposition shows, the effects on employment and wages within demographic group are unambiguous.

Proposition 2. *An increase in the proportion of foreign workers leads to an increase in the proportion of native workers working in daytime jobs and an increase in the relative daytime wages of native workers.*

This result follows directly from Proposition 1. A decrease in relative night task prices raises relative daytime job wages, which in turn pushes natives to work in more daytime jobs.

3 Work Schedules, Immigration, and Earnings Data

Our primary sources of data are the 1990 and 2000 US Census, and the 2005-2015 waves of American Community Survey (ACS, Ruggles et al., 2017). These data include a variety of economic and demographic variables, including country of birth, as well as the time of departure from home and work. For our instrument we draw on the 1970 Census. All data is obtained from the Integrated Public Use Microdata Series (IPUMS) housed at the University of Minnesota's Minnesota Population Center. We will focus on employed prime-age workers (25-54), but our results are substantively unchanged when including the full working age population (16-64).[4]

We define a local labor market as a commuting zone (CZ), following the definitions created by Tolbert and Sizer (1996). We assign individuals to a CZ based on their county group (1970) or Public Use Micro Area (PUMA; 1990, 2000, and ACS) using the crosswalks constructed in Autor and Dorn (2013) and Autor et al. (2019). We classify immigrants based on their country of birth into 16 distinct groups or regions (see Smith, 2012) and calculate the share of immigrants by region of origin living in each CZ.

Our main dependent variable is the likelihood of working a night shift. We construct an indicator for night shifts which takes values equal to one for all workers who left home to work between 6pm and 6am. Approximately 16.5% of native workers in our sample report

[4] In 1980-2000 Census and ACS, the employment status is asked only of individuals age 16 or above.

working night shifts (as defined above), while among non-natives the percentage is 18.2%. Table 1 provides basic OLS estimates between immigrant status and work schedules. After inclusion of CZ and year fixed effects, immigrants are 2.2 percentage points (or 13% relative to the mean native) more likely than natives to work a night shift (column 1). These differences appear to be in part due to differences in language skills. Individuals who report speaking no English at home are 7.2 percentage points more likely to work night shifts (column 2), while those reporting bad or no English are 5.9 percentage points more likely (column 3). This suggests that differences in work schedules may be due to the comparative disadvantage of immigrants in communication-intensive tasks documented by Peri and Sparber (2009).

The final two columns of Table 1 provide further evidence of these descriptive differences using the 2003-2015 waves of the American Time Use Survey (ATUS). These data include precise information on the hours worked from personal time diaries, but substantially smaller samples and coarser geographic information. We restrict the sample to full-time employed individuals ages 15-64 reporting to have worked on the day of the diary. Using the same definition adopted for the ACS, we classify approximately 19% of native workers as working night shifts, compared to 25% of immigrants. After accounting for CZ and year fixed effects, this amounts to an 8 percentage point difference (column 4). With the richer ATUS data we can also construct measures based on actual work times. Roughly 8% of natives report working more than half of their daily hours between 6pm and 7am, compared to 11% of natives. We find a 3.6 percentage point difference after including CZ and year fixed effects (column 5). Unfortunately the American Time Use Survey does not include information on language spoken at home.

4 Estimation Strategy and Identification Threats

To identify the effect of immigration on natives' likelihood of working night shifts, we exploit variation across time in the share of immigrants living in a given CZ. Formally, for individual i living in CZ c in time t we estimate the following equation:

$$N_{ict} = \alpha + \beta S_{ct} + X'_{ict}\gamma + Z'_{ct}\lambda + \delta_c + \tau_t + \epsilon_{ict}, \tag{16}$$

where N_{ict} is an indicator for whether the individual worked at night; S_{ct} is the share foreign-born in the CZ working-age population; X_{ict} is a vector of individual-level characteristics (age, sex, education, and experience); Z_{ct} is a vector of time-varying CZ-level controls (such as share of males and share of the population with a high school degree); δ_c is a vector of CZ fixed effects; τ_t is a vector of year fixed effects, and ϵ_{ict} captures the residual variation in the likelihood of working a night shift.[5]

We slightly modify this approach to test our prediction on wages:

$$W_{ihct} = \alpha_h + \beta_h S_{ct} + X'_{ict}\gamma + Z'_{ct}\lambda + \delta_c + \tau_t + \epsilon_{ihct}, \tag{17}$$

where W is the worker's wage, and $h \in \{D, N\}$ indicates whether the individual worked a day shift or a night shift. $\beta_D > \beta_N$ (i.e. a positive coefficient on the interaction between day shift and immigrant share) indicates an increase in relative daytime wages in response to immigration as predicted by our model.

While the spatial correlation approach has been widely used in the immigration literature, it is subject to two main criticisms (e.g., Borjas et al., 1996; Borjas, 2003). First, immigration may induce out-migration of natives, which would bias wage and employment effects upwards. We note that while the literature on the effects of *immigration* on native migration is mixed (e.g., Card, 2001; Borjas, 2006), a large body of research has found little to no migratory response due to *economic* shocks to the local labor market, particularly for low-skill workers who would face the most direct competition from immigrants (e.g., Bound and Holzer, 2000; Glaeser and Gyourko, 2005; Autor et al., 2013; Batistich and Bond, 2019). Nonetheless, our model views immigration as a relative supply shock to nighttime labor. If night working natives move out of the CZ in response, it would bias us towards finding effects on employment, but away from finding effects on wages.

The second concern is that immigration is a non-random process and immigrants will cluster in areas with better economic opportunities. Previous work has shown that during expansionary periods (particularly in the short-run) employers prefer to increase production by extending work hours, and therefore the relative composition of night tasks, rather than hiring (Nunziata, 2003).

[5]To abstract from any impact immigration can have on population growth, we use 1970 CZ population as the denominator in our foreign-born share variable.

We would therefore expect that OLS results would be biased away from finding the effects on natives predicted by our model.

To address these concerns, we instrument for the local immigrant population share using a "shift-share" instrumental variable (IV) approach originally proposed by Altonji and Card (1991) and Card (2001), and used more recently at the CZ-level by Smith (2012) and Orrenius and Zavodny (2015). This strategy exploits the fact that immigrants tend to locate in CZs that have higher densities of residents from their country of origin, and thus we identify off of a "pull factor" related to social preferences rather than economic forces.[6]

Specifically, we define the predicted number of immigrants in CZ c and year t as:

$$\hat{F}_{ct} = MED\left(\frac{I_{1970}}{N_{1970}}\right) N_{c,1970} + \sum_{p=1}^{16}\left(\frac{I_{c,p,1970}}{I_{p,1970}}\right) \Delta I_{-c,p,t,1970} \tag{18}$$

where $MED\left(\frac{I_{1970}}{N_{1970}}\right)$ is the median CZ immigrant-to-native ratio in 1970, $N_{c,1970}$ is the number of natives in c in 1970, $\left(\frac{I_{c,p,1970}}{I_{p,1970}}\right)$ is the share of all immigrants from region of origin p living in c in 1970, and $\Delta I_{-c,p,t,1970}$ is the inflow of immigrants from p into the U.S. (excluding the inflow into c) between 1970 and t. In other words, the first part of (18) provides an exogenous measure of predicted immigrant population in c in 1970, whereas the second part redistributes the subsequent national inflows of immigrants based on the origin-specific 1970 distributions.

Using (18), we then impute the total share of immigrants in each CZ as:

$$\hat{S}_{ct} = \frac{\hat{F}_{ct}}{P_{c,1970}} \tag{19}$$

where $P_{c,1970}$ is the total CZ population in 1970. We then estimate equation (16) by two-stage least squares (2SLS), using $\hat{S}_{ct}$ as an instrument for S_{ct}, and similarly for (17). In words, our instrument is the CZ-level immigrant population share that would have been predicted based on the historical geographic distribution of immigrants in the United States. Cross-time variation in $\hat{S}_{ct}$ is driven only by changes in the national population of immigrants; the denominator is held fixed at its 1970 value.[7]

[6] Note, however, that social networks can have important benefits for immigrant labor markets (Åslund et al., 2014; Dustmann et al., 2015). What matters for our identification, however, is that these economic benefits are orthogonal to positive aggregate shocks to the local labor market.

[7] Our results are robust to alternative definitions of $\hat{F}_{ct}$. See Appendix B.

A typical criticism of this instrument is that the local economic shocks that drove the initial distribution of immigrants can persist. These concerns should be mitigated by our use of CZ fixed effects which capture any time invariant economic conditions, and region-year fixed effects which capture time-varying shocks at a larger geographic level. We thus isolate variation due only to the differential impact on CZs in close geographic proximity of changes in the national composition of immigrants. Furthermore, our 1970 base year predates the large recent structural changes in labor demand (e.g. skill-biased technical change and increases in trade from low-income countries), as well as most of the shift away from Europe as the primary source of immigration (e.g., Borjas, 1994; Katz and Autor, 1999; Autor et al., 2008, 2013). As a robustness exercise, we present alternative estimates using 1960 as a base year, which predates the passage of the Immigration and Nationality Act of 1965 (and its full implementation in 1968), further disentangling our instrument from the economic shocks attracting recent immigrant cohorts.[8] Finally, we directly test for this long-term persistence by estimating a placebo regression of the the 1990-2000 CZ-level trend in nighttime work on the 2000-2015 trend in the instrument. We find no significant correlation, providing support for the validity of the instrument.

An additional recent criticism raised by Jaeger et al. (2018) is that the exclusion restriction of our instrument may be violated in the presence of strong serial correlation of immigrant flows. For example, if Mexico were persistently the primary source of immigrants in the United States, the share of the Mexican population in a CZ in 1970 will predict both immigrant flows in the 1980s and the 1990s. We may thus conflate the impact of recent immigrants on native schedules with the long run adjusment effects to previous waves. In general, we would expect this to bias us away from finding any results. A short run increase in the relative supply of night workers would attract capital investment complementary to such work in the long run, ameliorating some of the initial wage effects. Nonetheless, we follow the suggestion of Jaeger et al. (2018), and address this concern by controlling for lagged immigrant flows and including a lagged instrument in our first stage (see section 5.1).

[8]Prior to the Immigration and Nationality Act of 1965, U.S. immigrant flows were regulated by a system of quotas based on the primarily-European ethnic composition of early 20th century immigrant populations, which thus constrained immigration from Latin America and Asia.

5 The Effect of Immigration on Work Schedules

We begin by using the ACS in Table 2 to estimate the relationship between immigration and the probability of natives working a night shift. In column (1) we control simply for gender, education (11 categories), work experience, and a quadratic in age. Consistent with our model, we find a 10 percentage point increase in the share of immigrants in the local labor market (roughly one-half of a standard deviation) is associated with a .24 percentage point decrease in the probability of natives working at night, or 1.4% relative to the average native. Column (2) presents our preferred specification which includes time-varying CZ-level controls for the share of high school dropouts, high school degree holders, college degree holders, males, whites, blacks, the log of population, as well as CZ and year fixed effects. These controls reduce our point estimate by about 40%, but it remains statistically significant. The latter four columns re-estimate columns (1) and (2) for men and women separately, and we see little evidence of a heterogeneous effect by gender.

Table 3 applies the instrumental variable strategy outlined in Section 4. Our 2SLS estimate for the full population (column 1) is more than 2.5 times larger (in absolute value) than that from OLS, consistent with our prior that the correlation between economic growth and immigration should bias OLS estimates downwards.[9] The magnitude of the coefficient increases further when including time-varying controls (column 2). We also find more pronounced gender differences, at least when measured in percentage points. A 10 percentage point increase in immigrant share decreases the probability of males working a night shift by .74 percentage points (column 3, 35% of native mean), and .44 percentage points for women (column 5, 39% of native mean). Note however that the relative impact with respect to the sample means is similar across genders. Time-varying CZ-level controls again increase the magnitudes when estimating separately by gender, but decrease the precision (columns 4 and 6).

We turn to the ATUS in Table 4. Using the more precise measure of night work, having 50% or more of one's working hours occurring between 6pm and 7am, we find similar effects. A 10% increase in the share of immigrants decreases natives' likelihood of working night shifts by .5 percentage points (column 2). We again observe IV estimates (column 2) larger than the OLS

[9] OLS estimates may be also attenuated because of measurement error (Aydemir and Borjas, 2011).

ones (column 1). Columns 3-6 report the results separately by gender. If anything, they suggest a larger effect among women, although the difference is not precisely estimated.

In Table 5, we test our predictions on wages. We estimate (17) via 2SLS on our sample of prime age native workers from the Census and ACS. Looking at annual wage income in column 1, we find evidence of a substantial 7.9 percentage point compensating differential for night work. Consistent with our theory, we find that this differential is decreased by higher rates of immigration (the Share foreign-born $\times$ Day shift interaction). Specifically, we estimate a 10 percentage point increase in immigrant share causes a .7 percentage point increase (lowering) of relative daytime income (nighttime premium). Including time-varying CZ characteristics has little impact on these estimates in column 2. Columns 3 and 4 report the effects on (imputed) hourly and weekly wage. We find a smaller magnitude of immigration on the relative hourly wage, suggesting that one margin on which native day workers gain is through a relative increase in hours worked. This is consistent with previous studies that have shown increases in absenteeism for workers assigned to night shifts (Hafner et al., 2017). Our weekly wage estimates look very similar to our annual wage estimates.

5.1 Robustness and Validity Tests

To provide some standard robustness tests from the literature, we begin Table 6 by replicating our main results using a first difference approach. We aggregate our census and ACS data by CZ, and estimate the effect of a change in the immigrant share of the CZ population on the change in the share of employed natives who are working at night in that same period. Column 1 applies stacked differences using data from the 1990 and 2000 US Census and the 2005 and 2010 ACS. We find results very similar to that in Table 2; a 10 percentage point increase leads to a .54 decrease in relative native night employment. Column 2 implements our IV strategy and finds, if anything, a larger (in absolute value) effect of immigration on native relative night employment. Columns 3 and 4 instead use a long difference over the 1990-2015. We again find similar, if larger, estimates to those our preferred specification. Columns 5 and 6 present a standard placebo test. We estimate the relationship between our instrumental variable from 2000-2015 on changes in the fraction of natives employed in night work in the previous period (1990-2000). We find no

evidence of a relationship, providing support for our instrument.

In the first two columns of Table 7, we further address concerns about temporal correlations in economic shocks (columns 1 and 2), by using 1960 rather than 1970 as the base year of for our instrument.[10]. This base year choice predates the Immigration and Nationality Act of 1965, which removed ethnicity based immigration quotas and thus shifted the source of American immigrants away from Europe. While we lose precision due to a weaker first stage, the results are similar. A one standard deviation increase in the share of immigrants in a CZ reduces native likelihood to work night shifts by 4% (p-value:0.07).

As discussed previously, the exclusion restriction of the shift-share instrument may be easily violated in the presence of strong serial correlation of immigrant flows (Jaeger et al., 2018). This may be particularly problematic in a country like the US that has been characterized by a stable flows of immigrants from the same countries of origin (e.g. Mexico). In columns 3 and 4 of Table 7 we follow Jaeger et al. (2018) and control for the dynamic market adjustment to shocks (e.g. capital adjustment) by adding lagged immigrant flows to the regression and instrumenting for the lags using the analogous Bartik instrument.[11] Doing so, we isolate the short-run effect, from the longer-term reaction to past supply-shocks. Given the strong serial correlation in the instrument we of course lose substantial power, but the results are quantitatively similar and not statistically different from those obtained in our baseline estimation.

We provide a host of additional robustness exercises in the Appendix. First, The effects of immigration are often amplified when considering native groups who are more similar to immigrants (Peri and Yasenov, 2019). Our results support this idea. We find stronger and more precise effects when we measure the share of immigrants separately by gender (Table C.1), and when we focus only on low-skill workers (Table C.2). In addition, our estimates are substantively unchanged when using the employed immigrant share (Table C.3) or when extending the analysis to the entire working age population (Table C.4). Finally, our results are also robust to two alternative formulations of the instrumental variable (Table C.5 and Appendix B).

[10]We use the crosswalk provided in Rose (2018) from 1960 Public Use Microdata Areas (PUMAs) to 1990 Commuting Zones (CZs). We identify 728 commuting zones in the 1960 Census.

[11]We use 10 year lagged foreign-born share for 2000, and five year lags for 2005, 2010, and 2015.

5.2 Industry and Occupational Adjustments

In the previous two subsections, we established that, consistent with our theory, an increase in immigration leads to a movement of native workers from day shifts to night shifts, and a relative increase in the earnings of day shift workers. There are two possibilities for how this could occur. Native workers could move to a new shift within their same occupation, or they could switch to a new occupation which itself has different work scheduling. Understanding which of these mechanisms is dominant will inform us about the flexibility of work scheduling across the economy.

We explore this in Table 8. Column 1 repeats our main 2SLS estimation for night shifts (column 2 of Table 3) but includes occupation fixed effects. The magnitude is reduced by more than half, and our point estimate becomes statistically insignificant. Column 2 instead controls for industry fixed effects and we again see a reduction in our point estimate of nearly fifty percent, and a loss of statistical significance. Including both industry and occupation fixed effects in column 3 reduces the point estimate to nearly zero. These results strongly suggest the margin of adjustment is movement across jobs, rather than a shifting of scheduling within firms.

In the final 3 columns we turn to within industry and occupation annual income effects. Given the effects we saw on night shifts, we would expect these controls to have little impact on the marginal effect of immigration on compensating differentials. Immigration appears to effect the demand for occupations that more easily work during the day, rather than the demand for day shifts within occupation. We see just that. In each specification the day shift-immigration interaction is hardly changed relative to column 2 of table 5.

6 Welfare Implications and Conclusion

This paper develops a simple theoretical framework to analyze the effects of immigration on the allocation of work schedules. Because immigrants have lower disamenity costs for working at night, and a comparative advantage in nighttime production, immigrants specialize in non-standard shifts. Thus immigration increases the supply of night shifts, pushing natives towards daily schedules. We find strong empirical support for the model. Immigration reduces natives' likelihood of working night shifts, as well as their wage premium for working at night.

Previous attempts to measure the welfare effects of immigration have neglected the impact of changes in job amenities. To provide some context for this oversight, the CDC estimates that 44% of night shift workers sleep less than 6 hours per night compared to just 28% of day shift workers. Giuntella and Mazzonna (2019) find that a 4 percentage point gap in sleeping less than 6 hours is linked to a $82 per capita difference in health expenses.[12] Based on our results from column 2 of Table 3, a 10 percent point increase in the size of the local immigrant population would lead to a .77 percentage point decrease in the proportion of natives who work night shifts. Thus, not accounting for this single health consequence would amount to a missed welfare gain of $2.53 per native worker, or $325 million nationally.[13] But sleep deprivation is just one of the negative consequences of working night shifts. Previous research has also found adverse effects on emotional wellbeing and marital stability, the welfare effects of which are difficult to quantify (Liu et al., 2011; Strazdins et al., 2006). Our results on wages suggest that marginal natives are willing to give up 7-8% of their annual income to work in a day shift. Based off of a $52,574 average annual income for night shift working natives, this presents the possibility of $29.44 in unaccounted welfare gains per worker (or $3.8 billion nationwide). Further, we studied just the impact on a single job amenity. One could imagine immigration also affecting the physical intensity of native jobs, on the job injury and fatality risks, and job flexibility, each of which would have heretofore unmeasured welfare effects.

There is growing evidence suggesting that firms in the US have trouble staffing overnight shifts (e.g. manufacturing, growers of fresh produce). Difficulties in filling these positions may affect overall expansion and the ability of firms to add jobs at all hours.[14] In many industries, almost half of workers work non-standard shifts. As immigrants have a comparative advantage in working non-standard shifts, immigration may allow firms relying on flexible workforce to remain competitive (Dramski, 2017). At the same time, there is abundant evidence on the long-lasting detrimental effects of working night shifts on individual health. Our results show that immigration led to a reallocation of work schedules resulting in a reduction natives night work hours. The resulting positive effects on native individual health and well-being should not be

[12]They consider a battery of outcomes including the health care costs associated with increased risk of obesity, diabetes, cancer, and cardiovascular diseases.

[13]This is based on the 2018 BLS estimate of a a size of the native workforce being 128.5 million (March 2018).

[14]https://www.chicagobusiness.com/article/20170128/ISSUE01/170129840/third-shift-jobs-go-unfilled-at-chicago-manufacturers

neglected when assessing the overall impact of immigration on the labor market.

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Table 1: Work Schedules by Immigrant Status and English Proficiency: OLS Estimates

	Any night work				50% work at night
	ACS (1)	ACS (2)	ACS (3)	ATUS (4)	ATUS (5)
Foreign-born	0.022***			0.074***	0.033***
	(0.000)			(0.005)	(0.003)
No English		0.072***			
		(0.002)			
Bad or no English			0.059***		
			(0.001)		
Commuting zone FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Mean of dep. variable	0.177	0.177	0.177	0.226	0.09
St.dev. of dep. variable	0.382	0.382	0.382	0.419	0.286
Observations	23,729,458	23,729,458	23,729,458	61,214	61,214

Notes - Heteroskedasticity-robust standard errors in parentheses. Data for columns 1-3 are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey and include all currently employed individuals ages 25-54. Data for columns 4 and 5 are drawn from the 2003-2015 ATUS and include all currently employed individuals. *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *50% work at night* - binary var. equal to 1 if individual worked 50% or more of his/her work time at night (i.e. between 6pm and 7am of the following day). *Foreign-born* - binary var. equal 1 if individual born outside of U.S. (and its territories). *No English* - binary var. equal 1 if individual "Does not speak English". *Bad or no English* - binary var. equal 1 if individual either "Does not speak English" or "Yes, but not well". *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 2: Effect of Immigration on Native Likelihood of Working Night Shifts: OLS Estimates (Census/ACS, 1990-2015)

	All		Men		Women	
	(1)	(2)	(3)	(4)	(5)	(6)
Share foreign-born	-0.024***	-0.014*	-0.026**	-0.013	-0.023***	-0.014***
	(0.009)	(0.007)	(0.012)	(0.009)	(0.006)	(0.005)
Personal demographics	YES	YES	YES	YES	YES	YES
CZ-level characteristics	NO	YES	NO	YES	NO	YES
Commuting zone FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	21,447,083	21,447,083	11,403,216	11,403,216	10,043,867	10,043,867
Adjusted R-squared	0.049	0.049	0.042	0.043	0.022	0.022
Mean of dep. variable	0.166	0.166	0.212	0.212	0.113	0.113
St. dev. of dep. variable	0.372	0.372	0.409	0.409	0.317	0.317

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. The following samples were used in the estimation: all currently employed natives ages 25-54 (cols. 1, 2); all currently employed male natives ages 25-54 (cols. 3, 4); all currently employed female natives ages 25-54 (cols. 5, 6). Dependent var.: *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share foreign-born* - share of immigrants as % of total population in 1970. Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 3: Effect of Immigration on Native Likelihood of Working Night Shifts: 2SLS Estimates (Census/ACS, 1990-2015)

	All		Men		Women	
	(1)	(2)	(3)	(4)	(5)	(6)
Share foreign-born	-0.061**	-0.077*	-0.074**	-0.090	-0.043**	-0.053*
	(0.025)	(0.044)	(0.032)	(0.057)	(0.018)	(0.029)
Personal demographics	YES	YES	YES	YES	YES	YES
CZ-level characteristics	NO	YES	NO	YES	NO	YES
Commuting zone FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	21,447,083	21,447,083	11,403,216	11,403,216	10,043,867	10,043,867
Mean of dep. variable	0.166	0.166	0.212	0.212	0.113	0.113
St. dev. of dep. variable	0.372	0.372	0.409	0.409	0.317	0.317
Kleibergen-Paap rk Wald F	62.84	20.65	63.37	20.14	62.01	21.23

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. The following samples were used in the estimation: all currently employed natives ages 25-54 (cols. 1, 2); all currently employed male natives ages 25-54 (cols. 3, 4); all currently employed female natives ages 25-54 (cols. 5, 6). Dependent var.: *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share foreign-born* - share of immigrants as % of total population in 1970. Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 4: Effect of Immigration on Native Likelihood of Working Night Shifts (2003-15 ATUS)

	All		Men		Women	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Share foreign-born	-0.0273**	-0.0505**	-0.0288	-0.0356	-0.0268	-0.0630**
	(0.011)	(0.025)	(0.019)	(0.035)	(0.017)	(0.031)
Personal demographics	YES	YES	YES	YES	YES	YES
Interview characteristics	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Commuting zone FE	YES	YES	YES	YES	YES	YES
Observations	51,980	51,980	26,249	26,249	25,722	25,722
Mean of dep. variable	0.0908	0.0908	0.0983	0.0983	0.0831	0.0831
St. dev. of dep. variable	0.287	0.287	0.298	0.298	0.276	0.276
Kleibergen-Paap rk Wald F		32.48		31.11		32.90

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 2003-2015 ATUS. Estimation sample is restricted to all currently employed natives ages 15-64. Dependent var.: *50% work at night* - binary var. equal to 1 if individual worked 50% or more of his/her work time at night (i.e. between 6pm and 7am of the following day). *Share foreign-born* - share of immigrants as % of total population in 1970. Personal demographics: race, sex, age, marital status, education, # of children in household, family income. Interview characteristics: dummies for day of the week, month of the year, and whether interview during weekend/during holiday. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 5: Effect of Immigration on Native Relative Wages: 2SLS Estimates (Census/ACS, 1990-2015)

	Ln(Annual wage income)		Ln(Hourly wage)	Ln(Weekly wage)
	(1)	(2)	(3)	(4)
Share foreign-born	-0.053	-0.113	-0.054	-0.120
	(0.064)	(0.073)	(0.059)	(0.073)
Share foreign-born × Day shift	0.072***	0.073***	0.037***	0.070***
	(0.021)	(0.021)	(0.012)	(0.019)
Night shift	0.0793***	0.0801***	0.0194***	0.0715***
	(0.021)	(0.021)	(0.012)	(0.018)
Personal demographics	YES	YES	YES	YES
CZ-level characteristics	NO	YES	YES	YES
Commuting zone FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	19,874,619	19,874,619	19,874,619	19,874,619
Kleibergen-Paap rk Wald F Share foreign-born	10.85	10.85	10.85	10.85
Kleibergen-Paap rk Wald F Share foreign-born × Day shift	44.21	44.21	44.21	44.21

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. Estimation sample is restricted to currently employed native individuals ages 25-54. *Ln (Annual wage income)* - natural log of total yearly pre-tax wage and salary income. *Ln (Hourly wage)* - natural log of imputed hourly wage. *Ln (Weekly wage)* - natural log of imputed weekly wage. *Share foreign-born* - share of immigrants as % of total population in 1970. *Day shift* - binary var. equal 1 if individual departed for work at some points between 6am and 6pm. *Night shift* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 6: Effect of Immigration on Fraction of Natives working at Night: First Differences Estimates & Placebo Test

	2000-2015 Stacked differences		1990-2015 Long difference		1990-2000 Long difference	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	OLS (6)
Δ Share foreign-born	-0.054***	-0.139**				
	(0.011)	(0.068)				
Δ Share foreign-born (1990-2015)			-0.047**	-0.257*		
			(0.019)	(0.135)		
Δ Share foreign-born (2000-2015)					0.002	
					(0.010)	
Δ IV (2000-2015)						0.107
						(0.084)
Year dummies	YES	YES	NO	NO	NO	NO
CZ-level characteristics	YES	YES	YES	YES	YES	YES
Observations	2,897	2,897	674	674	674	674

Notes - Heteroskedasticity-robust standard errors in parentheses. In columns (1) & (2), standard errors are clustered at CZ level. Data are drawn from the 1990 and 2000 U.S. Census and the 2005, 2010, 2015 American Community Survey. Columns (1) & (2) use data only from years 1990, 2000, 2005, 2010, and 2015. *2000-2015 Stacked differences* - stacked first difference level changes (2000-1990;2005-2000; 2010-2005; 2015-2010) in the share of employed natives ages 25-54 working in a CZ at night (i.e. between 6pm and 6am). *1990-2015 Long difference* - a 1990-2015 level change in the share of employed natives ages 25-54 working in a CZ at night (i.e. between 6pm and 6am). *1990-2000 Long difference* - a 1990-2000 level change in the share of employed natives ages 25-54 working in a CZ at night (i.e. between 6pm and 6am). *Δ Share foreign-born* - stacked first difference level changes in the share of immigrants in a CZ (2000-2015). *Δ Share foreign-born (1990-2015)* - level change in the share of immigrants in a CZ between 1990 and 2015. *Δ Share foreign-born (2000-2015)* - a level change in the CZ-level immigrant share between 2000 and 2015. *Δ IV (2000-2015)* - a level change in the shift-share CZ-level instrument between 2000 and 2015. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. Note that in columns (1) & (2), CZ-level characteristics are included in lagged form. CZ fixed effects in columns (1) & (2) are differenced out. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 7: Effect of Immigration on Native Likelihood of Working Night Shifts, Alternative Base Years and Lagged Immigrants Shares: 2SLS Estimates

	1960 base IV		1970 base IV	
	1990-2015 (1)	1990-2015 (2)	2000;2005 2000; 2015 (3)	2000; 2005; 2010; 2015 (4)
Share foreign-born	-0.034*	-0.038	-0.040	-0.059
	(0.020)	(0.025)	(0.032)	(0.043)
Share foreign-born (lagged)			-0.020	-0.017
			(0.029)	(0.028)
Personal demographics	YES	YES	YES	YES
CZ-level characteristics	NO	YES	NO	YES
Year FE	YES	YES	YES	YES
Commuting zone FE	YES	YES	YES	YES
Observations	21,015,659	21,015,659	9,581,090	9,581,090
R-squared	0.040	0.041	0.039	0.039
Number of CZs	728	728	741	741
Kleibergen-Paap rk Wald F	4.89	5.87	22.44	33.06
Kleibergen-Paap rk Wald F (lagged)			13.92	17.87

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey and include all currently employed native individuals ages 25-54. Dependent var.: *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share of foreign-born* - share of immigrants as % of total population in 1960 (1970, respectively). Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. Columns 3 and 4 restrict the analysis to 2000, 2005, 2010, and 2015. The respective lagged shares of foreign-born are derived from 1990, 2000, 2005, and 2010. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 8: Effect of Immigration on Native Work Habits and Income within Industry and Occupation: 2SLS Estimates (Census/ACS, 1990-2015)

	Any night work			Ln(Annual wage income)		
	(1)	(2)	(3)	(4)	(5)	(6)
Share foreign-born	-0.023	-0.038*	-0.014	-0.113	-0.074	-0.110
	(0.020)	(0.022)	(0.019)	(0.074)	(0.073)	(0.078)
Share foreign-born				0.068***	0.069***	0.069***
× Day shift				(0.019)	(0.019)	(0.019)
Personal demographics	YES	YES	YES	YES	YES	YES
CZ-level characteristics	YES	YES	YES	YES	YES	YES
Occupation FE	YES	NO	YES	YES	NO	YES
Industry FE	NO	YES	YES	NO	YES	YES
Commuting zone FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	21,447,083	21,447,083	21,447,083	19,874,619	19,874,619	19,874,619
Kleibergen-Paap rk Wald F	62.66	62.68	62.58	10.81	10.80	10.80
Share foreign-born						
Kleibergen-Paap rk Wald F			44.19	44.16	44.15	
Share foreign-born × Day shift						

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. Estimation sample is restricted to all currently employed natives ages 25-54. *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Ln (Annual wage income)* - natural log of total yearly pre-tax wage and salary income. *Share foreign-born* - share of immigrants as % of total population in 1970. *Day shift* - binary var. equal 1 if individual departed for work at some points between 6am and 6pm. Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Appendix

A Proofs of Main Results

Proof of Lemma 1

Proof. The proportion of foreign workers in nighttime jobs is simply $H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)$, while that same proportion for native workers is $H(\nu\omega_N)$. As H is a strictly increasing function, inspection of the arguments proves the lemma. □

Proof of Propostion 1

Proof. Implicitly differentiating (15),

$$\frac{\partial\omega_N}{\partial f} = \frac{1}{\theta}\omega_N^{1-\theta}\left(\frac{1-\beta}{\beta}\right)^{\frac{1}{1-\theta}}\Delta_S\left(1-\frac{\partial\frac{D^S}{N^S}}{\partial\omega_N}\right)^{-1}, \tag{20}$$

where

$$\Delta_S \equiv \frac{\left[1-H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)\right]H(\omega_N\eta)n_n d_f - [1-H(\omega_N\eta)]H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)n_f d_n}{\left[(1-f)H(\omega_N\eta)n_n + fH\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)n_f\right]^2} \tag{21}$$

is the change in the relative supply function, $\frac{D^S}{N^S}$, due to a change in f holding w_N fixed. Wages and the elasticity of substitution are always positive. The relative supply of day tasks due to a decrease in the relative price of day tasks, $\frac{\partial\frac{D^S}{N^S}}{\partial\omega_N}$ is always negative, so $\left(1-\frac{\partial\frac{D^S}{N^S}}{\partial\omega_N}\right)^{-1}$ is also positive.[15] The sign of this derivative thus depends on Δ_S. From Lemma 1 we know that $1-H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right) < 1-H(\omega_N\eta)$ and $H(\omega_N\eta) < H\left([\nu\omega_N\eta]^{\frac{1}{\lambda}}\right)$. Comparing the last two terms, $n_n d_f \leq n_f d_n$ follows from the comparative advantage of foreign workers to night tasks ($\nu \geq 1$). Thus $\frac{\partial\omega_N}{\partial f} < 0$.

For relative task output, from equation (14)

$$\frac{D}{N} = \left(\frac{1-\beta}{\beta}\right)^{-\theta}\omega_N^{\theta}. \tag{22}$$

Since $\frac{d\omega_N}{df} < 0$, it follows that $\frac{\partial\frac{D}{N}}{\partial f} < 0$. □

[15] It is easy to show this derivative is strictly negative. The exact expression is long but is available upon request.

Proof of Proposition 2

Proof. The proof follows directly from Proposition 1. From equations (7) and (8), the relative employment of native workers is

$$\frac{L_{Dn}}{L_{Nn}} = \frac{1 - H(\omega_N \eta)}{H(\omega_N \eta)} \tag{23}$$

which is a strictly decreasing function of ω_N. Native relative daytime wages are simply $\omega_N \eta$, which are also strictly decreasing ω_N. □

B Alternative definitions of IV

Two alternative definitions of $\hat{F}_{ct}$ were used as a robustness check. The first has the following form:

$$\hat{F}_{ct} = \sum_{p=1}^{16} \left(\frac{I_{c,p,1970}}{I_{p,1970}} \right) I_{c,p,t} \tag{24}$$

where, as before, $\left(\frac{I_{c,p,1970}}{I_{p,1970}} \right)$ is the share of all immigrants from region of origin p living in c in 1970. However, in contrast with equation (18), in equation (24), we distribute the total national counts of immigrants based on the baseline 1970 distributions.

The second alternative version of $\hat{F}_{ct}$ has the form:

$$\hat{F}_{ct} = \sum_{p=1}^{16} \left(\frac{I_{c,p,1970}}{I_{p,1970}} \right) I_{-c,p,t} \tag{25}$$

In contrast with equation (24)), in equation (25), we exclude immigrants from c when distributing the total national counts of immigrants based on baseline distributions.

C Supplemental Figures and Tables

Table C.1: Effect of Immigration on Native Likelihood of Working Night Shifts, Gender-Specific Immigrant Shares: 2SLS Estimates (1990, 2000 Census & 2005-15 ACS)

	Women		Men	
	(1)	(2)	(3)	(4)
Share of foreign-born females	-0.0441***	-0.0524**		
	(0.0167)	(0.0264)		
Share of foreign-born males			-0.0721**	-0.111***
			(0.0318)	(0.0204)
Personal demographics	YES	YES	YES	YES
CZ-level characteristics	NO	YES	NO	YES
Commuting zone FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	10,043,867	10,043,867	11,403,216	11,403,216
Mean of dep. variable	0.113	0.113	0.212	0.212
St. dev. of dep. variable	0.317	0.317	0.409	0.409
Kleibergen-Paap rk Wald F	45.55	19.47	66.50	62.42

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. Estimation sample in col. (1) & (2) is restricted to all currently employed native females ages 25-54. Estimation sample in col. (3) & (4) is restricted to all currently employed native males ages 25-54. *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share of foreign-born females* - share of female immigrants as % of female population in 1970. *Share of foreign-born males* - share of male immigrants as % of male population in 1970. Personal demographics: education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. *Significant at the 10% level.

Table C.2: Effect of Immigration on Native Likelihood of Working Night Shifts, Low-Skilled Workers: 2SLS Estimates (1990, 2000 Census & 2005-15 ACS)

	Any night work	
	(1)	(2)
Share of foreign-born low-skilled	-0.0657**	-0.117***
	(0.0267)	(0.0264)
Personal demographics	YES	YES
CZ-level characteristics	NO	YES
Commuting zone FE	YES	YES
Year FE	YES	YES
Observations	9,577,920	9,577,920
Mean of dep. variable	0.227	0.227
St. dev. of dep. variable	0.419	0.419
Kleibergen-Paap rk Wald F	65.84	67.92

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. Estimation sample is restricted to all currently employed low-skilled (i.e. less than a HS diploma) natives ages 25-54. *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share of foreign-born low-skilled* - share of low-skilled immigrants as % of low-skilled population in 1970. Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table C.3: Effect of Immigration on Native Likelihood of Working Night Shifts: Employed Immigrant Share, 2SLS Estimates (1990, 2000 Census & 2005-15 ACS)

	Any night work	
	(1)	(2)
Share of employed foreign-born	-0.0484**	-0.0582**
	(0.0188)	(0.0296)
Personal demographics	YES	YES
CZ-level characteristics	NO	YES
Commuting zone FE	YES	YES
Year FE	YES	YES
Observations	21,447,083	21,447,083
Mean of dep. variable	0.166	0.166
St. dev. of dep. variable	0.372	0.372
Kleibergen-Paap rk Wald F	83.80	35.55

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. Estimation sample is restricted to all currently employed natives ages 25-54. *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share of employed foreign-born* - share of employed immigrants as % of employed population in 1970. Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table C.4: Effect of Immigration on Native Likelihood of Working Night Shifts : Working Age Population (16-64), 2SLS Estimates (1990, 2000 Census & 2005-15 ACS)

	Any night work	
	(1)	(2)
Share of foreign-born	-0.0470**	-0.0607
	(0.0226)	(0.0381)
Personal demographics	YES	YES
CZ-level characteristics	NO	YES
Commuting zone FE	YES	YES
Year FE	YES	YES
Observations	30,099,719	30,099,719
Mean of dep. variable	0.162	0.162
St. dev. of dep. variable	0.368	0.368
Kleibergen-Paap rk Wald F	65.26	22.23

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. Estimation sample is restricted to all currently employed natives ages 16-64. *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share of foreign-born* share of immigrants as % of total population in 1970. Personal demographics: gender, education, experience, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table C.5: Effect of Immigration on Native Likelihood of Working Night Shifts: Alternative IV Construction (Census/ACS, 1990-2015)

	Main IV		Alt IV #1		Alt IV #2	
	(1)	(2)	(3)	(4)	(5)	(6)
Share of foreign-born	-0.0614**	-0.0776*	-0.0512**	-0.0726*	-0.0554**	-0.0729*
	(0.0245)	(0.0439)	(0.0209)	(0.0416)	(0.0234)	(0.0415)
Personal demographics	YES	YES	YES	YES	YES	YES
CZ-level characteristics	NO	YES	NO	YES	NO	YES
Commuting zone FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	21,447,083	21,447,083	21,447,083	21,447,083	21,447,083	21,447,083
Mean of dep. variable	0.166	0.166	0.166	0.166	0.166	0.166
St. dev. of dep. variable	0.372	0.372	0.372	0.372	0.372	0.372
Kleibergen-Paap rk Wald F	63.67	20.60	71.35	21.26	66.64	23.89

Notes - Standard errors in parentheses, clustered at CZ level. Data are drawn from the 1990 and 2000 US Census and the 2005-2015 American Community Survey. See Appendix B for definitions of *Alt IV #1* and *Alt IV #2*. Estimation sample is restricted to all currently employed natives ages 25-54. *Any night work* - binary var. equal 1 if individual departed for work at some point between 6pm and 6am. *Share of foreign-born* - share of immigrants as % of total population in 1970. Personal demographics: gender, education, experience, sex, age, age-squared. CZ-level characteristics: % with less than HS degree, % with HS diploma (or equivalent), % with college degree, % male, % white, % black, log of total population. *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.