The Wage Impact of Undocumented Workers

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Abstract

Using administrative, individual-level, longitudinal data from the state of Georgia, this paper finds that documented workers employed by a firm that hires undocumented workers earn a wage premium of about 0.7 percent. However, in most sectors, that premium erodes and eventually turns negative as the firm's employment share of undocumented workers increases. The differential impact across workers of varying wage levels allows us to isolate the likely source for the overall expected positive wage impact.

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I. Introduction and Background

The United States has a long history of immigration debate. Through the last century and into this one, immigration policy has been subjected to changing economic needs, fears, and political whims. Positive contributions of immigration have been identified by Neal and Uselding (1972) who estimate that the flow of immigrants into the United States between 1790 and 1912 resulted in a 13 to 42 percent higher level of capital stock than would have prevailed in the absence of immigration during these years (also see Barro and Sala-i-Martin 1995 and Chiswick et al. 1992). Immigration has also been more recently explored in various countries as a mechanism for replacing retiring baby-boom workers (e.g., Hamada and Kato 2007, Hotchkiss 2005, Denton and Spencer 1997).

Concerns surrounding immigration are rooted in an expectation that the arrival of new workers into a labor market would displace native workers and/or put downward pressure on wages. The purpose of this paper is to investigate the impact on wages of the presence of a specific class of immigrants -- undocumented workers. The literature presents a wide range of estimates of the effects of immigration on wages and employment of native workers, but little is known about the impact of undocumented workers. The conventional wisdom has been that a 10 percent increase in the population share of immigrants results in a one to four percent decrease in native wages (for example, see Friedberg and Hunt 1995, Borjas et al. 2006, and Orrenius and Zavodny 2007). The measured impact of immigration on the displacement of workers is less clear. Card (1990), Wright et al. (1997), Butcher and Card (1991), and Card and DiNardo (2000) find no evidence of immigrant inflows affecting native migration patterns or employment outcomes. Whereas, Frey (1996) and Borjas (2005) identify a significant relationship between

immigrant inflows and either native outflows or lower net native in-migration, and Card (2001) finds lower rates of employment within cities with high immigrant arrivals.

More recent evidence from Peri (2009) and Peri and Sparber (2009) suggests that immigrants do not crowd-out employment of native born workers; there is no significant effect on hours worked of native born workers in the short run, but hours significantly increase in the long-run; and that there is no short-run impact on native worker income. However, over time, a net increase of immigrants equal to one percent of employment significantly *increases* income per worker from 0.6 to 0.9 percent. This positive impact on worker income derives from increased efficiency and productivity through task specialization, especially among low-skilled natives. In the short-run, capital intensity is decreased as additions to the workforce are from lower skilled workers, but over time businesses expand their capital as they increase production. These conclusions are consistent with those made in earlier work by Barro and Sala-i-Martin (1995) and Chiswick et al. (1992), linking higher levels of immigration to capital deepening and higher per capita consumption.

While estimates of the impact of immigration as a whole on the labor market outcomes of native workers abound, much less is known about the impact of undocumented workers. The reason is the dearth of information about the labor market presence or characteristics of undocumented workers. To a certain extent, the impact of undocumented workers can be expected to be similar to that of immigrants as a whole; however there are some important differences between the two groups of workers. First of all, the number of undocumented workers in any labor market is only a fraction of the total number of immigrants, suggesting the impact, in either direction, would be much weaker. Second, undocumented workers are likely to be even more limited in their opportunities and therefore have lower elasticities of labor supply

(see Hotchkiss and Quispe-Agnoli 2009). This would tend to make them an even less expensive factor substitute for native labor of similar skill. This lower elasticity of labor supply will also have implications for wage differentials between documented and undocumented workers. The more concentrated undocumented workers are in an industry the greater is the opportunity for firms to exercise monopsony power and keep wages of undocumented workers low. And, thirdly, certain skills, such as communication, are likely to be more lacking in undocumented workers (than in immigrants in general) so that, according to Peri and Sparber's (2009) model, there would be greater opportunities for even low-skilled native workers (or their employers) to shift the native skill contribution to production toward those that are more highly rewarded (specializing in tasks requiring greater communication skills).

The analysis in this paper makes use of longitudinal, administrative, individual-level data from the state of Georgia to investigate how the presence of undocumented workers affects the wages of documented workers. Controlling for individual and firm level fixed effects, the results indicate that workers employed by single-establishment firms who hire undocumented workers can expect to earn wages about 0.5 percent higher than they would at a firm that does not employ undocumented workers, but the effect does vary across sectors. Potential explanations for this overall positive impact on wages are explored.

A. Immigration Policy

Immigration legislation dates from the founding of the nation.[1] The two most recent Federal efforts to address concerns of undocumented immigration are the Immigration and Control Act (IRCA) of 1986, and the Illegal Immigration Reform and Immigrant Responsibility Act (IIRIRA) of 1996. Both of these laws were passed in response to the growing population of unauthorized immigrants identified at the time, however they were quite different in their

[1] For historical details, see CBO (2006) and FAIR (2007).

approaches to addressing the concerns spawned by that growth. Whereas the IRCA is best known for creating two amnesty programs for unauthorized immigrants, the focus of the IIRIRA was one of border enforcement (see Fix and Passel 1994 and Nuñez-Neto and Viña 2006 for more details).

Since the terrorist attacks of 2001, and in response to continued dramatic growth in unauthorized immigrants, there have been renewed calls for additional comprehensive immigration policy reform. The absence of forthcoming Federal legislation has been the likely motivation of many states to pass state-level laws targeted at unauthorized immigrants. The number of laws enacted has grown from 39 in 2005 to 208 in 2010.[2] The first major immigration legislation in Georgia became law in July 2007. The analysis in this paper makes use of data through 2005, so this recent change in the legal environment in Georgia will not be reflected in the analysis.

B. Identifying Unauthorized Immigrants

Identifying unauthorized immigrants is the greatest challenge in investigating their impact. The most common method used to estimate the number of unauthorized immigrants is the residual approach, or merely calculating the difference between the total measured foreign-born population and the legal immigrant population (see Hanson 2006). According to the latest figures, there are 11.2 million unauthorized immigrants living in the U.S. as of March 2010 (Passel and Cohn 2011). It is also estimated that about four percent of the total are located in Georgia. Between 2000 and 2010, Georgia experienced one of the largest percentage increases of unauthorized immigrants in the U.S. -- 70 percent (Passel and Cohn 2011).

A second data source that has been used to look at unauthorized immigration is

[2] See the National Conference of State Legislatures website, "Issues and Research: Immigration," <http://www.ncsl.org/Default.aspx?TabID=756&tabs=951,119,851#951>.

information on border apprehensions from the U.S. Border Patrol. Estimating the level of unauthorized immigration using apprehension data is problematic, primarily because it is not only a function of the number of attempts to cross the border (which have been shown to vary with expected relative U.S./Mexico economic conditions), but also a function of the enforcement efforts of border patrol and a function of the number of attempts (see Hanson and Spilimbergo 1999, and GAO 2006).

According to DHS estimates for January 2009, 62 percent of unauthorized immigrants come from Mexico, as compared to 55 percent in January 2000. Therefore it is not surprising that surveys from Mexico constitute a third source of data on unauthorized immigrants. The Mexican Migration Project (MMP) is a household survey conducted during the winter months when seasonal migrants return to Mexico. The Legalized Persons Survey (LPS) is a survey of unauthorized immigrants who were granted permanent legal residence in the U.S. under the amnesty provision of the Immigration and Control Act of 1986. In general, the MMP and LPS have been found to be more useful in characterizing undocumented immigrants than actually counting them. Orrenius and Zavodny (forthcoming), using the MMP, report that over the period between 1980 and 2004, approximately 62 percent of migrants from Mexico were unauthorized.

Among the newest sources of data of information about immigrants is the New Immigrant Survey (NIS). The sample includes new legal permanent residents in the U.S., admitted in 1996, and over-samples employment based immigrants. The immigrants are administered three surveys over a 12 month period and are asked a host of questions about their original entry into the U.S. and about their experiences since arriving. Based on this survey, combined with administrative micro-data from the Department of Homeland Security, Jasso et

al. (2008) estimate that 32 percent of new adult immigrants granted legal permanent residence in the U.S. in 1996 had originally arrived in the U.S. illegally, overstayed visa expirations, or were employed illegally.

This paper differs in the way in which unauthorized individuals are identified. In addition, it is not the goal of this paper to obtain an accurate count of unauthorized immigrants, but to identify a reasonable sample with which to perform statistical analyses of labor market outcomes. State administrative data are used to identify invalid social security numbers used by employers in reporting worker earnings. It is a common misconception that all undocumented workers are working "off the books." There is considerable evidence that many employers report, either knowingly or unknowingly, and pay taxes on the wages paid to undocumented workers.[3] Unlike most other studies, the measure used here does not capture the supply of undocumented workers, but, rather, the demand, as the workers are identified through employment records. The advantage of this data source is that it is not subject to sample selection issues plaguing survey results. The disadvantage is that it does not capture undocumented workers not reported on employers' payrolls. However, the result is a sample of undocumented workers that represents about 20 percent of all undocumented workers in the state of Georgia.

II. Data

The primary data used for the analyses in this paper are the Employer File and the Individual Wage File, compiled by the Georgia Department of Labor for the purposes of administering the state's Unemployment Insurance (UI) program. These data are highly

[3] The Social Security Administration keeps track of wages reported by employers but cannot be matched to a valid name or SSN. This repository of unmatched wages is referred to as the Earnings Suspense File (ESF). It is widely agreed that the exponential growth in the ESF is attributable to the growth in unauthorized immigrants. For tax years 2001 and 2002 alone, 1.8 billion dollars were placed into the ESF.

confidential and strictly limited in their distribution. The data are available from the first quarter of 1990 through the fourth quarter of 2006. The Employer File provides an almost complete census of firms in the U.S., covering approximately 99.7 percent of all wage and salary workers (Committee on Ways and Means 2004).[4] The establishment-level information includes the number of employees, the total wage bill, and the NAICS classification of each establishment. The Individual Wage File, which links individual workers to their employer, is used to construct workforce characteristics at the firm level. We take advantage of the longitudinal nature of the data to calculate the firm's age, employment variability, turnover rates, and worker tenure. The data also contain a 6-digit NAICS industry code and the county of location, allowing us to construct or merge in various industry- and county-level indicators.

We restrict the analysis to single establishment firms for two reasons. First, workers are only linked to the firm in which they are employed. If a firm has multiple establishments, we do not know at which establishment the workers is employed, nor do we know exactly the physical location of the firm, as the address in the file could correspond to the firm headquarters, physical location, mailing address, etc. These problems of measurement error don't arise when we limit the analysis to single establishment firms. The second reason we restrict the analysis is because it is a clear way to reduce the number of observations without employing some sampling scheme. The full data sample has over 178 million observations, restricting to single establishment firms reduces the sample by about half. Conclusions are only generalizable to single establishment firms.

Regrettably, the data set contains no information about workers' demographics or, more importantly, immigration status. However, again making use of the longitudinal nature of the

[4] Certain jobs in agriculture, domestic services, non-profit organizations are excluded from UI coverage; excluded workers are not represented in the data.

data, we estimate an individual fixed effects model, allowing us to control for individual characteristics that do not vary over time (e.g., innate human capital, immigration status).

A. Using SSNs to Identify Undocumented Workers

Details of how the SSN is used to identify undocumented workers are contained in Appendix A. The abbreviated version is that there are some easily identifiable ways in which a SSN is determined to be invalid. We conclude that some of those reasons are either errors or the result of incomplete record keeping by the firm. We restrict our identification of undocumented workers to invalid SSN that are more likely to have been generated by the workers -- numbers that look valid, but are not. Workers with invalid SSNs for any other reason are considered neither undocumented or documented and, thus, are excluded from the analysis; this will clearly undercount the actual number of undocumented workers. However, all workers, regardless of SSN classification, are included in counts of aggregate firm employment.

Figure 1 plots the prevalence of undocumented workers in the seven broadly defined sectors with the highest incidences. The concentration of workers in these sectors was also identified nationally by Fortuny et al. (2007).[5] The pattern of growth is also consistent with Fortuny et al. who estimate that 72 percent of unauthorized immigrants in Georgia arrived in the last 10 years.

[Figure 1 here]

Fortuny et al. (2007) estimate that 4.5 percent of the workforce in Georgia was undocumented in 2004. In our sample 1.0 percent of workers are classified as undocumented in 2004, implying that the sample used for the analysis in this paper is capturing about 22 percent of all undocumented workers in the state of Georgia. This is a respectable representation, given

[5] Fortuny et al. (2007) estimate that nationally in 2004 the percent of workers in leisure and hospitality and construction that was undocumented was 10 percent each, nine percent of workers in agriculture, and six percent each in manufacturing, professional and business services, and other services. Also see Pena (2009).

that to be included in the sample all workers have been included on the firm's wage report in the first place, and we are being very conservative in the identification of workers as undocumented. Note that the identification process we use in this paper does not make any assumptions about whether the employer knows a worker is documented or undocumented. In addition, the goal of the conservative identification process was to end up with a sample in which we can have a high degree of confidence that the sample is representative of the undocumented workforce, not to actually count the number of undocumented workers in Georgia.

B. Are Undocumented Workers Correctly Identified?

There are several reasons we are confident that the sample of undocumented workers is representative. First of all, the rate of growth seen in both the number and percent of undocumented workers identified in Georgia matches closely the rate of growth in the Social Security Administration's (SSA) earnings suspense file (ESF). The ESF is a repository of social security taxes paid by employers that cannot be matched to a valid name or SSN. It is widely believed that this growth in the ESF reflects growing incidence of unauthorized work in the U.S. (Bovbjerg 2006).

Figure 2 plots the number of workers (panel a) and the percent of workers (panel b) identified as undocumented along with the size of the ESF. This figure shows a remarkable consistency between the growth seen in workers identified as undocumented and the ESF.

[Figure 2 here]

Data from Census and Homeland Security suggest that between 40 and 60 percent of Mexicans in the U.S. are undocumented, and that 61 percent of unauthorized immigrants come from Mexico.[6] Clearly not all Hispanics are undocumented, or vice versa, however using

[6] The 2008 ACS estimates that 11.4 million people in the U.S. were born in Mexico (http://www.census.gov/population/www/socdemo/hispanic/cps2008.html). The DHS estimates that 7.03 million

weighted data from the Current Population Survey (CPS), we calculate the average annual growth in total workers and total number of foreign born, Hispanic workers in the U.S. and in Georgia in order to compare growth rates to those in our sample. These results are reported in Table 1. The workforce in GA grew faster over the period than the U.S. workforce (2.9 percent vs. 1.5 percent, respectively). In addition, the number of foreign born, Hispanic workers in the U.S. grew faster (eight percent per year) than the overall workforce; this phenomenon has been documented by others (Passel and Cohn 2009). But most importantly for our purposes is that the growth rate of foreign born, Hispanic workers in GA (roughly 27 percent per year), which is much larger than in the U.S. overall (also see Passel and Cohn 2009), is similar to the growth in the number of workers in GA classified here as undocumented. We also observe a similarly large growth rate in the number of foreign born, Hispanic workers with less than a high school degree (21%), among which we might expect a larger share of undocumented workers than among foreign born, Hispanics in general.

[Table 1 here]

The close match in growth rates in the number of workers classified as undocumented with that of the SSA ESF and with the number of foreign born, Hispanic workers in Georgia as measured by the CPS, suggests that the mechanism employed in this paper to identify undocumented workers is accurate; it's clear that not all undocumented workers are being captured in the data, but likely those identified as undocumented are undocumented. Any remaining mis-classifications will show up in the error term and limit the estimation in its ability to identify any systematic relationships between wages and the presence of undocumented workers.

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undocumented workers from Mexico were in the U.S. in 2008 (http://www.dhs.gov/xlibrary/assets/statistics/publications/ois_ill_pe_2008.pdf).

D. Sample Means

Table 2 presents some sample means for workers classified as documented. While worker and firm longitudinal characteristics are calculated beginning in 1990 (the first year of available data), estimations are performed on the sample period 1995-2005 to focus more acutely on the greater prevalence of undocumented workers during this time period, and because some geographic regressors are only available beginning in 1995. In addition, estimation is performed on single-establishment firms only. Given that there are over 178 million observations in the full sample, estimation with high order fixed effects is impossible using the full sample. Restricting the estimation to single-establishment firms allows us to avoid random sampling; results will be generalizable to single-establishment firms only. The undesirable consequences of sampling are highlighted in Abowd et. al (1999), specifically in the case of matched employer-employee data, and in Aydemir and Borjas (2010), specifically related to investigating the impact of immigrants. The first column of Table 2 contains means for the full sample, the second column contains means for single-establishment firms only, and the third and fourth columns contains means only for single-establishment firms that do and do not hire undocumented workers.

[Table 2 here]

There are some characteristic differences between single establishment firms and all firms; these differences should be kept in mind when interpreting the generalizability of the results. First of all, the worker level characteristics are all quite similar across both types of firms, although workers in single establishment firms have moderately less tenure and work experience. There is also somewhat greater variation in quarterly earnings among workers employed in single establishment firms.

Single establishment firms appear to be smaller and older and experience less churning

than other firms. The biggest difference comes in the distribution of workers across broad sectors. There seems to be a greater share of workers employed in single establishment firms found in construction, wholesale trade, professional and business services, and other services. There is a noticeably smaller share in retail trade and education and health services.

Turning to differences across firms that hire and don't hire undocumented workers, firms that hire tend to be larger, experience greater churning, and are likely to operate in industries that employ fewer workers with college degrees. The greater churning among firms that hire undocumented workers is consistent with earlier findings by Morales (1983) who suggests that these firms need greater workforce flexibility.[7] Workers in these firms also exhibit shorter tenure, lower wages, and are more likely to either be newly hired or separating from their employer.

Among firms that employ undocumented workers, workers are more concentrated in industries characterized as low-skill and less concentrated in high-skill industries, compared with workers employed by firms not hiring undocumented workers. The share of workers employed by firms who hire undocumented workers is much larger in agriculture, construction, manufacturing, and leisure and hospitality.

III. Empirical Specification

A number of different approaches have been taken to quantify the impact of immigration on native worker wages and employment. The most common strategy is used by Altonji and Card (1991) and in a number of papers by George Borjas (alone and with co-authors; 2003, 2005, 2006). The procedure makes use of decennial census data and standard linear regression

[7] Churning is measured as the difference between worker flows and job flows divided by the average employment during the period. Worker flows is the sum of hires and separations and job flows is net employment change. $CHURN_{jt} = \frac{[Hires+Separations]-[|N_{jt}-N_{jt-1}|]}{[(N_{jt}+N_{jt-1})/2]}$, N_t is the number of workers in time *t* (Burgess et al. 2001).

to identify a relationship between the difference in the density of immigrants and wages or employment across geographic areas (usually metropolitan statistical areas, MSAs). Various techniques (e.g., instrumental variables and fixed effects) have been employed to control for the endogeneity problem of immigrants selecting their geographic destination based on observed wages in those locations. Advantages of the analysis in this paper are that it is performed at the individual worker level and the panel nature of the data allow for fixed effects estimation.[8] This means the results are interpreted as within worker, within firm effects and won't suffer from composition bias, which may plague analyses at the broad geographic, industry, or firm level.

The estimating equation is specified as:

$$\ln w_{ijt} = \beta_0 U_{jt} + \beta_1 U_{jt} P_{jt} + \beta_2' x_{it} + \beta_3' y_{jt} + \delta_i + \theta_j + \tau_{ijt}, \quad (1)$$

where $\ln w_{ijt}$ is the log of the quarterly earnings of documented worker *i* at firm *j* at time *t*; U_{jt} is equal to one if any undocumented workers were identified working in firm *j* at time *t*, zero otherwise; P_{jt} is the percent of workers at firm *j* that is undocumented at time *t* (this is undefined if $U_{jt} = 0$, so it enters interactively); x_{it} are individual characteristics expected to influence the observed base wage level; y_{jt} are firm level characteristics expected to influence worker *i*'s observed wage; δ_i is an individual fixed-effect; θ_j is a firm fixed-effect; and τ_{ijt} is the random error. The equation will also include a broad sector industry fixed-effect when estimated on the full sample, and will also be estimated across categories of workers differentiated by sector, earnings, and firm size.[9] Year and quarter fixed effects are also included to control for cyclical and seasonal variation in wages.

[8] Malchow-Møller et al. (2007) use individual level, panel data to investigate the impact of immigrants on native wages in Denmark.

[9] One might expect that the firm fixed-effect would capture the sector effect, as a firm's industry would not be expected to change over time. However, firms do change industry from time to time as their primary business activity might change over time.

With this specification, we choose to focus on the workers' experiences within their employer; the analysis will have nothing to say about a more aggregated effect of undocumented workers at the industry or geographic level. However, we do investigate various alternative specifications with no appreciable difference in the conclusions. For example, additional controls were included to capture the hiring behavior of firms at the industry level, measured either through the share of workers in the industry or the share of firms in the industry hiring undocumented workers; these effects don't influence the conclusions about firm level effects. Other factors that we might think would modify the impact of undocumented workers on wages, such as a firm's "hiring intensity" (or, how often the firm hires undocumented workers), are captured by the firm fixed-effect. Unfortunately, there is rarely a clearly defined pre and post time period in which firm hires undocumented workers, making a difference-type analysis fruitless.

We do discuss results for different indicators of whether a firm hires undocumented workers or not. The baseline model assumes that the presence of even one undocumented worker (or the presence of one invalid SSN) in any quarter means the firm hired undocumented workers during that quarter. Recognizing that there may be a certain degree of measurement error in reporting and recording of SSNs, we investigate two alternative, more restrictive, definitions of hiring undocumented workers. First, we assume a firm hires undocumented workers only when the share of undocumented is ten percent or greater. Second, we assume a firm hires undocumented workers only when the share of undocumented workers is ten percent or greater *and* the firm hires undocumented workers at least 25 percent of the quarters it is observed in the data. The only appreciable effect of these stricter definitions of hiring behavior is to make the estimated wage impact stronger.

One question that presents itself in considering the impact of undocumented workers is what happens to workers who might be displaced when his/her employer begins hiring undocumented workers. The analysis in this paper does not speak to this question. Other work has compared the separation behavior of undocumented workers with that of documented workers (see Hotchkiss and Quispe-Agnoli 2009), but a full analysis of long-term labor market outcomes of potentially displaced documented workers will be the subject of a future investigation.

The issue of reverse causality through selection has been a significant concern of analyses estimating the impact of immigration on wages since one can reasonably expect that locations paying higher wages will attract more undocumented workers; so the share of undocumented workers becomes a function of the wage paid by the firm. Regarding this concern, the analysis in this paper has three advantages over these other studies. First, the analysis is not concerned with the impact of the supply of undocumented workers (which will be affected by selective migration decisions), but, rather, the demand for undocumented workers (measured by actual employment). Second, the estimation includes as a regressor the percent of K-12 students that is Hispanic in the county in which the firm is located in order to capture potential supply effects from the firm's wage setting policy. And, third, the estimation is performed at the individual level, where individual worker wages are modeled as a function of firm behavior. It's not likely that a firm bases its decision on whether to hire undocumented workers, or how many to hire, based on the observed wage of any single documented worker.

Endogeneity through omitted variables has also plagues studies of immigration effects on wages. For example, if there are unobservable factors that both increase a documented worker's wage and the probability that a firm hires undocumented workers (or hires more of them), this

will result in spurious positive correlations between U_{jt} and P_{jt} with w_{ijt}. One possibility is that the same unobservable factors that result in observing a high documented worker wage would also result in high undocumented worker wages, thus increasing the (unobserved) supply of undocumented workers to the firm, which might increase the probability that a firm hires undocumented workers, or hires more of them. If this is the case, estimates of the presence of undocumented workers on documented worker wages would be biased upward. If, however, a firm that is pre-disposed to pay lower wages is also pre-disposed to hire undocumented workers, the effect of the bias would be in a negative direction. Even though the data are not rich enough to allow for any attempts at instrumental variables estimation, both equations are estimated with as many other firm characteristics as possible that will proxy for unobservable firm characteristics, and estimations will control for both individual fixed effects, which will take care of time-invariant unobservable individual heterogeneity, and firm level fixed effects will control for time-invariant correlation between a firm's wage setting policy and its tendency to hire undocumented workers.

Worker tenure and labor market experience is expected to positively influence wages (at decreasing rates) through the presence of firm- and general-specific human capital (Campbell 1993 and Altonji and Shakatko 1987). Indicators for whether the worker is newly hired at the firm (not employed by the firm in the four preceding quarters) or is separating (not employed by the firm in the following four quarters) are also included; these workers are likely to not have received a full quarter's worth of wages.

Firm size (measured by log employment) is included with the expectation that larger firms pay higher wages (Oi and Idson 1999). Firm age (and its square) is also included, but the relationship between firm age and wages paid is less straightforward (Brown and Medoff 2003).

A firm level measure of worker churning (among documented workers only) is included as a measure of employment cost, which might suggest lower wages at firms with greater churning (Burgess et al. 2001, see footnote 9). By merging in additional data, we are able to assign rough measures of three or four digit industry level worker skill and labor intensity of the production process (see Appendix B). Firms who employ higher educated workers are expected to pay higher wages, and we would expect to observe lower wages for workers employed at firms with a more labor intensive production process, ceteris paribus. This is because capital is typically found to be complimentary with higher skilled labor (for example, see Krussel et al. 2000) suggesting that a production process that uses less capital (one that is labor intensive) will also employ lower skilled workers.

The unemployment rate in the county in which the firm is located and the population density of the county are included to capture overall worker demand and strength of consumer demand, along with potential alternative employment opportunities in the worker's geographic area. And, as mentioned before, the percent of students in the firm's county that is Hispanic is also included to capture the potential supply of undocumented workers to the firm, although, clearly, not all Hispanics are undocumented workers, and vice versa.

IV. Estimation Results

Table 3 contains parameter estimates for equation (1) estimated with the full set of firm and individual level fixed effects, as well as an estimation via OLS without fixed effects.

[Table 3 here]

A. Control Variables

The impact of the worker and firm characteristics on wages is as expected. Wages are increasing, at a decreasing rate, as tenure and overall work experience increases. Being either a

new hire or one about to separate leads to much lower observed wages. The sizes of the estimated coefficients reflect the high probability that these workers are likely to be working less than a full quarter during their employment transition. Workers can expect to earn higher wages if employed at larger and younger firms, firms that employ workers with more education, and firms that are less labor intensive. Higher wages are also found among workers employed at firms with higher levels of churning. The churning result suggests that firms with high levels of churning may pay an efficiency wage to reduce churning, which can be costly.

Workers facing a higher unemployment rate in the county and quarter in which their employer is located can expect to earn a lower, but wages are higher in more densely populated counties. In addition, wages are significantly lower in counties with higher levels of Hispanic populations.

The importance of controlling for individual and firm level fixed effects is apparent even before considering the impact of the presence of undocumented workers on wages. While most of the point estimates across the two columns are similar in sign and magnitude, there are some exceptions. For example, the estimated impact of tenure is roughly four times larger when one does not control for individual fixed effects. In addition, the relationship between churning and wages is negative when firm level fixed effects aren't included, the OLS results would suggest that workers earn a higher wage working in a county with a higher share of Hispanics, and the role of the unemployment rate and population density is much larger in the absence of individual and firm level fixed effects.

B. Impact of Undocumented Workers on Wages

Turning now to the estimates of particular interest, Table 4 reports the marginal effects for the full sample, across sectors, and worker income groups. The OLS results would suggest

that a worker employed at a firm that hires undocumented workers can expect to earn wages 9.4 percent *lower* than the same worker employed at a firm that does not hire undocumented workers.[10] This is opposite of what the fixed effects results indicate. The overall expected impact of being employed by a firm that hires undocumented workers ($\partial \ln w_{ijt} / \partial U_{jt}$) is 0.0054, meaning that a worker employed by a firm that hires undocumented workers can expect to earn a wage that is 0.54 percent higher than if he/she were employed by a firm that does not hire an undocumented worker. This amounts to approximately $185 per year; arguably a negligible amount.

[Table 4 here]

This positive expected wage impact is consistent with results of Peri (2006) and Peri and Sparber (2009), who conclude that increased immigration leads to increased efficiency and productivity through task specialization. At the firm level this might manifest itself in native manual laborers being reassigned to tasks that require more communication skills (or oversight of the new immigrant labor), while the immigrants specialize in the manual labor tasks. The net result is a more efficient production process, and native workers (especially low-skill native workers) that are more productive and earning higher wages (also see Orrenius and Zavodny 2007, and Hanson 2007).[11] In addition, Brown et. al (2008) find that firms who hire undocumented workers have a competitive advantage and employers may share rents from this advantage with their documented workforce. Further, the availability of lower cost, low-skill workers could result in a scale effect with firms producing more, using more capital, and hiring workers complementary to capital (native, higher-skilled workers); see Ottaviano and Peri (2006) and Brown et. al (2010).

[10] The expected impact is simply calculated as $\partial \ln w_{ijt} / \partial U_{jt} = \hat{\beta}_0 + \hat{\beta}_1 \bar{P}_{jt}$.

[11] Iskander (2011) suggests that this productivity gain may derive from the transformation of immigrants' tacit knowledge in a new environment into innovation and improved production processes.

The results in this paper, however, suggest that these positive immigration wage effects, as they may apply to undocumented workers, are eroded as the share of undocumented workers in the firm's workforce increases. Conditional on the firm hiring undocumented workers, a one percentage point increase in the firm's share of workers that is undocumented reduces wages among documented workers by 0.016 percent ($5.50 per year). The implication for the full sample is that after the firm's undocumented workforce reaches about 45 percent of the total, any additional increases in the share of undocumented workers will actually decrease documented worker wages. Given that the average share of undocumented workers (among firms who hire them) is roughly 11 percent, this could take a while. However, the expected effect varies across sectors and worker income levels. For example, firms in seven of the 12 sectors, such as Agriculture, Professional & Business Services, and Construction, have, on average, reached the share of undocumented worker employment such that overall expected effect of being employed by a firm that hires undocumented workers is negative, although still quantitatively small. In Manufacturing and Retail Trade, however, growing shares of undocumented workers continue to benefit wages of documented workers; although we would caution about predicting too far out of sample.

To help visualize the estimated impact of undocumented workers on wages, Figure 3 illustrates the impact estimated for low-wage and high-wage workers separately; high-wage workers are expected to be more educated, or have higher skills (recall that we do not have a measure of worker education, skill, or occupation).[12] The impact of working for a firm that hires undocumented workers is much more dramatic for low-wage workers, with the impact on high-wage workers barely noticeable. This analysis might help us distinguish between the competing

[12] Low- and high-wage workers are differentiated based on less or more than $3,000 of earnings in one quarter; the estimation excludes workers either separating or newly hired by their employer, since even "high-wage" earners could easily earn less than $3,000 during the quarter in which they separated or were newly hired.

theories for positive wage effects from immigration (or, undocumented workers, in this case). If the positive wage effect derives from a scale effect, increased production and capital usage should increase demand for workers most complementary with capital -- high-skilled/wage workers. If successful employers are sharing rents with their documented workforce, the wage impact should be similar across worker skill levels. The explanation that would predict a more dramatic effect on wages of low-skilled workers is that of Peri (2009) and Peri and Sparber (2009) who predict efficiency and productivity gains through specialization among low-skilled workers -- low-skill workers have the most to gain from shifting their labor toward more productive tasks. It's also of interest to note that the overall wage effect estimated here (0.54%) is remarkably close to the 0.5% increase in wage estimated by Peri (2009) resulting from a one percent increase in immigrants.

[Figure 3 here]

C. Robustness and Other Considerations

If this analysis was being performed at the firm level, rather than at the individual level, we might be concerned that estimation of an overall expected positive wage impact was merely reflecting a composition bias. In other words, if undocumented workers were to displace any documented workers at all, it would likely be the lower-skilled, lower-paid workers, which would essentially cut off the lower tail of the wage distribution among documented workers, raising the average *firm-level* wage among documented workers. This analysis, however, is performed at the individual level, controlling for individual fixed effects making the results interpretable as if we are comparing the same individual in two different circumstances -- working for a firm that does hire and working for a firm that does not hire undocumented workers, so concerns for composition bias are unwarranted.

A second issue of potential concern is the generous way in which we identify a firm who hires an undocumented worker. If even one invalid SSN shows up on the firm's payroll in a quarter, that firm is classified as hiring undocumented workers (U_{jt}=1). We recognize that there is a certain amount of measurement error in recording SSNs, so that a documented worker is actually labeled as undocumented because of a reporting error. Of course, that error would have to be repeated at least twice for the person to show up at all in the fixed effects analysis. However, we test the potential impact of measurement error by re-estimating the model under more restrictive definitions of undocumented worker hiring activity. We first require that at least 10 percent of a firm's workforce is undocumented before setting U_{jt}=1; we then require that at least 10 percent of the workforce is undocumented *and* the firm has consistently hired undocumented workers throughout its life (hired undocumented workers in at least 25 percent of the quarters it has been in business). These alternative definitions increase the overall expected impact of being employed by a firm that hires undocumented workers from 0.54 percent to 1.01 percent and 1.26 percent respectively. In addition, the marginal impact of an additional percentage point increase in the share of undocumented workers in the firm goes from -0.016 percent to roughly -0.05 percent in both cases; the impact of undocumented workers becomes more dramatic, as we might expect with the restricted definition of which firm actually hire. All of these alternative estimates are significantly different from zero at the 99 percent confidence level.

We also estimated specifications that included a measure of industry level penetration of undocumented workers. The effects at the industry level were also small and positive, and the inclusion of that regressor did not impact the estimated marginal effects reported here.

V. Conclusions and Implications for Policy

Using individual-level data, linked to employer characteristics, the analysis in this paper finds that documented workers employed at a firm that also hires undocumented workers can expect to earn a wage *premium* of about 0.7 percent compared to a similar worker employed by a firm that does not hire undocumented workers. Additionally, however, an increase by one percentage point in the share of workers at those firms that is undocumented reduces that premium and eventually decreases wages when the share of undocumented workers becomes large enough. Combining the two effects, the expected overall impact of working for a firm that hires undocumented workers is an increase in wages by about 0.54 percent. The expected overall impact, however, varies across sectors and is negative in those sectors where the average share of undocumented workers in a firm (among those that hire) has reached a more significant level.

Given the pattern of effects across worker characteristics, the most likely explanation for the expected small positive impact of undocumented workers on the wages of documented workers is the efficiency and productivity gains predicted by Peri (2009) and Peri and Sparber (2009) that derive from task specialization. This is suggested by the larger initial premium and steeper decline as the share of undocumented workers increases among low-wage workers, compared to the effect among high-wage workers. The steeper decline also suggests that there is a limit to task specialization among low-skilled workers, and, eventually, gains are eroded. Of course, this analysis is a partial equilibrium analysis and does not consider the long-run implications for technology or capital usage by the firm. In addition, the analysis in this paper says nothing about the impact of the presence of undocumented workers on overall employment, prices, or economic growth.

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Figure 1.

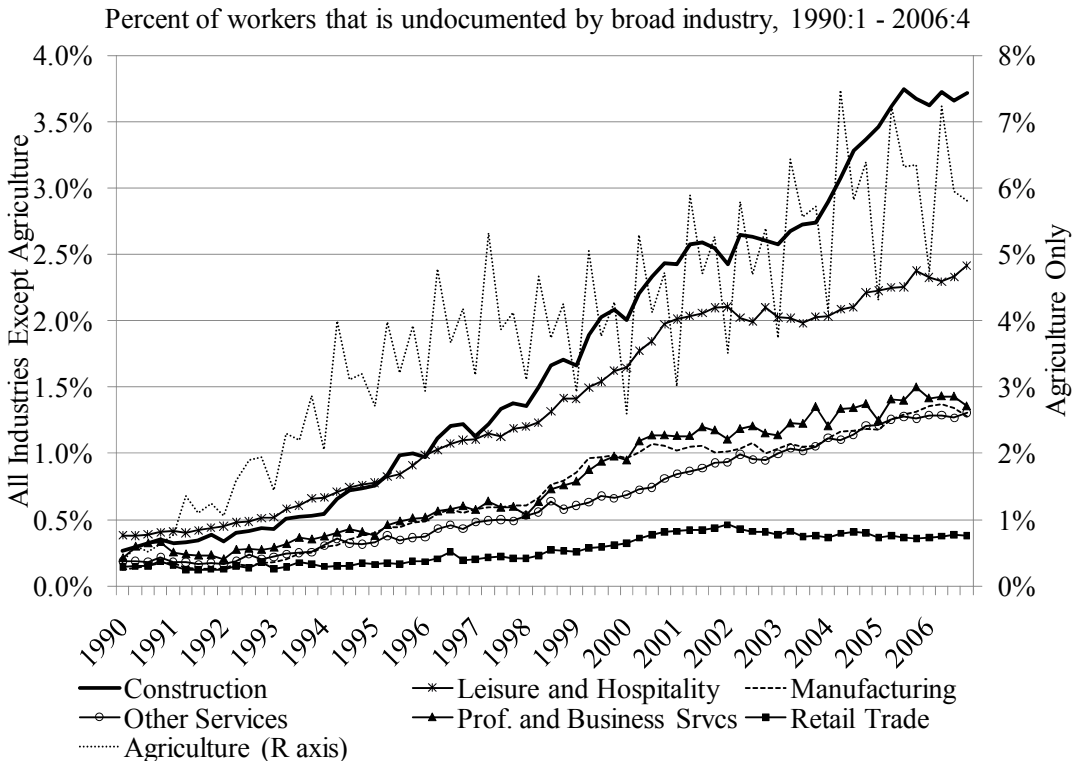
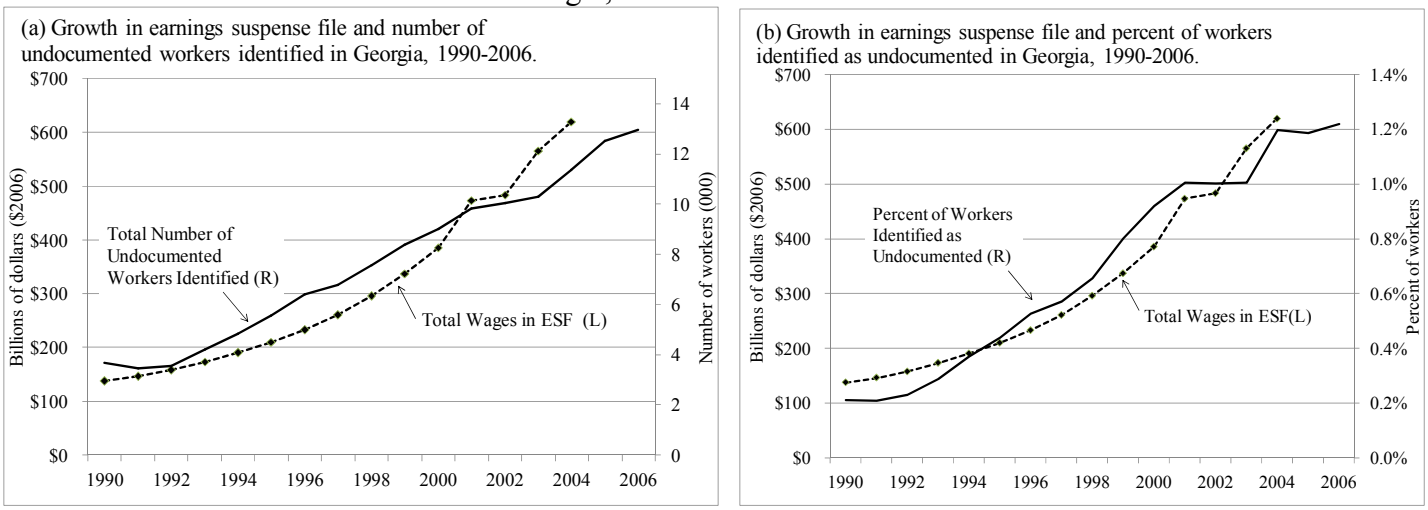
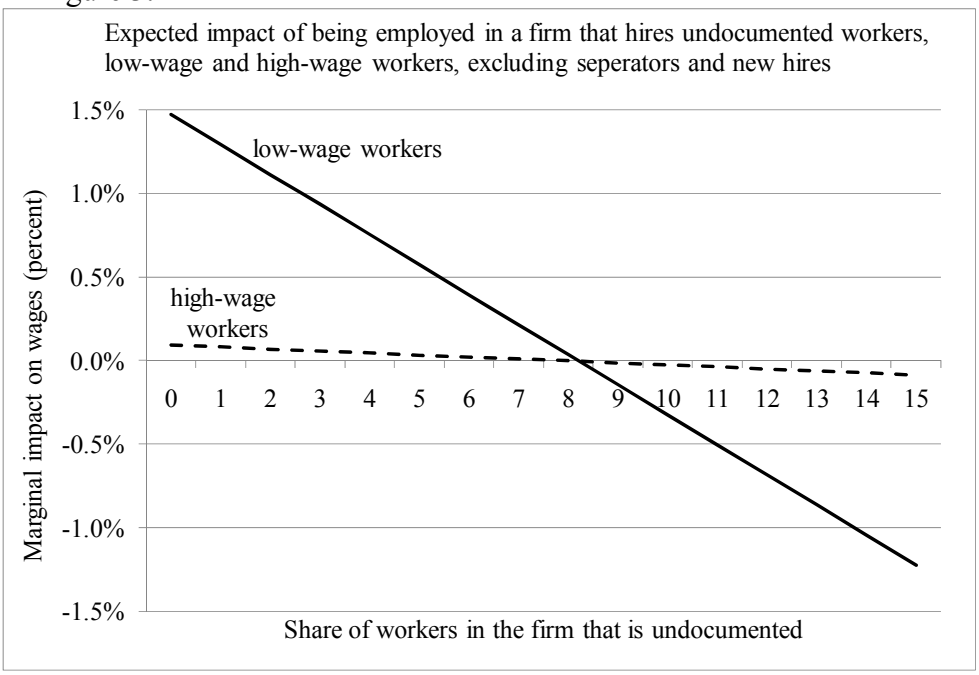


Figure 2. Growth in the earnings suspense file and the total number and percent of workers identified as undocumented in Georgia, 1990-2006.



Source: Huse (2002) for estimates 1990-2000, Johnson (2007) for estimates 2001-2004, and authors' calculations. Dollar estimates reflect 2006 values, using the PCE chain-weighted deflator.

Figure 3.



Note: Workers are differentiated based on earning less (low-wage) or earning more (high-wage) than $3,000 per quarter. Analysis excludes workers separating or newly hired by their employer.

Table 1. Average annual growth, 1994-2006, in US and GA employment, Hispanic workers, and workers identified as undocumented.

Average Annual Growth Rate of:	
Total number of workers in the U.S.	1.48%
Total number of foreign born, Hispanic workers in the U.S.	8.03%
Total number of foreign born, Hispanic workers with less than a high school degree in Georgia	7.28%
Total number of workers in Georgia	2.92%
Total number of foreign born, Hispanic workers in Georgia	26.82%
Total number of foreign born, Hispanic workers with less than a high school degree in Georgia	21.48%
Total number of workers in GA identified as undocumented	*25.29%*

Source: Current Population Survey, Basic Survey (March), 1994-2006; and authors' calculations.
Note: 1994 is used as starting year since is the first year the Current Population Survey has a reliable indicator of Hispanic ethnicity.

Table 2. Sample means, documented workers, 1995-2005.

			Single Estab. Firms	
	Full Sample	**Single Establish-ment Firms Only**	**Workers employed at firms with at least one undocumented worker ($U_{jt} = 1$)**	**Workers employed at firms with no undocumented workers ($U_{jt} = 0$)**
Worker Characteristics				
Quarterly wages	\$8,277 (11,522)	\$8,547 (12,741)	\$6,520 (9,711)	\$9,272 (13,589)
Worker tenure (quarters)	13 (14)	11 (13)	9 (12)	12 (13)
Worker experience (quarters)	26 (16)	25 (16)	22 (16)	26 (16)
Worker is a new hire = 1	0.17	0.18	0.26	0.16
Worker is separating = 1	0.17	0.18	0.25	0.16
Firm Characteristics (firm-level means)				
Percent of firms hiring undoc (U_{jt})		5.0%	--	--
Percent of workers at firm that is undoc. (P_{jt})	0.56% (2.79)	0.54% (3.4)	11% (10.9)	--
Firm size (number of workers)	21 (207)	15 (87)	83 (287)	12 (58)
Age of firm (quarters)	16 (14)	25 (17)	28 (18)	25 (17)
Churning at worker's firm (doc. workers only)	0.24 (0.38)	0.14 (0.29)	0.34 (0.33)	0.13 (0.29)
Share of workers with college degree or higher (determined at 3-digit NAIC level)[a]		24% (0.16)	15% (0.12)	25% (0.16)
Labor share in production process (determined at 3- or 4-digit NAIC level)[a]		40% (0.15)	38% (0.12)	40% (0.15)
Geographic Controls				
Population density (population/sq mi)	1,032 (770)	981 (770)	1,082 (757)	945 (772)
County unemployment rate	4.49 (1.30)	4.49 (1.35)	4.42 (1.26)	4.51 (1.39)
Percent of county school enrolment that is Hispanic	5% (5)	5% (5)	5% (5)	5% (5)
Distribution of workers earnings				
Wages < \$3,000	31%	32%	41%	28%
Wages ≥ \$3,000	69%	68%	59%	71%

NAICS Sector Employment Shares				
Natural Resources and Agriculture	0.9%	1.4%	2.4%	1.0%
Construction	5.1%	8.9%	10.3%	8.4%
Manufacturing	13.5%	13.5%	16.2%	12.5%
Transportation and Utilities	4.4%	3.8%	2.5%	4.3%
Wholesale Trade	4.8%	7.0%	3.4%	8.3%
Retail Trade	13.4%	9.1%	5.1%	10.5%
Financial Activities	5.3%	5.8%	2.1%	7.1%
Information	3.4%	3.0%	2.7%	3.1%
Professional and Business Services (includes temporary services)	14.8%	17.8%	22.9%	16.0%
Education and Health Services	17.2%	15.7%	14.4%	16.2%
Leisure and Hospitality	10.4%	10.0%	16.0%	7.8%
Other Services (includes private household, laundry, and repair and maintenance services)	2.6%	4.0%	1.9%	4.7%
No. of observations	178m	99,868,841	26,313,397	73,555,444

Notes: Wages are real quarterly earnings, deflated by the chained price index for personal consumption expenditure $2006Q4. Individual sample means are across workers. All averages reflect four quarters of data for each year. Standard errors are in parentheses. Note in comparing values across years that 1990 is the first year in which any firm or worker is observed in the data. See Appendix B for details related to the construction of high education, labor intensity, and broad sector classifications.

[a]The variables are only merged into the single establishment data.

Table 3. Linear, fixed effects estimation of log wages.

Dependent variable = $\ln w_{ijt}$	Includes individual and firm level fixed effects (1)	OLS estimation (no fixed effects) (2)
Firm hires undocumented wrkrs: (U_{jt}) = 1 if P_{jt}>0 in t	0.00703*** (0.00029)	-0.1387*** (0.00034)
Firm hires, percent undocumented interaction $(U_{jt}P_{jt})$	-0.000158*** (0.000055)	0.00421*** (0.000046)
Worker Characteristics		
Worker tenure (in quarters)	0.0077*** (0.000042)	0.0341*** (0.000032)
Worker tenure squared / 1000	-0.1138*** (0.00053)	-0.4228*** (0.00065)
Worker experience (in quarters)	0.011*** (0.00011)	0.00767*** (0.000028)
Worker experience squared / 1000	-0.0752*** (0.00058)	-0.0185*** (0.00049)
Worker is new hire = 1	-0.6723*** (0.00025)	-0.6947*** (0.00035)
Worker is separating = 1	-0.8588*** (0.00024)	-1.0304*** (0.00032)
Firm Characteristics		
Age of firm (in quarters)	-0.0034*** (0.00016)	-0.01105*** (0. 000029)
Age of firm squared / 100	0.000089*** (5.4x10-6)	0.000101*** (4.7x10-7)
Log total employment (firm size)	0.1221*** (0.00032)	0.0433*** (0.000072)
Churning at worker's firm (among documented workers only)	0.0817*** (0.00056)	-0.5791*** (0.00051)
Share of workers with higher education	0.0152*** (0.0054)	0.9298*** (0.00104)
Labor intensity	-0.0133* (0.0071)	-0.4548*** (0.0012)
Geographic Controls		
County unemployment rate	-0.003*** (0.00011)	-0.0269*** (0.000093)
Population density /1000	0.000016*** (6.9x10-6)	0.00019*** (1.6x10-7)

Percent of students that is Hispanic	-0.0527*** (0.0059)	0.3942*** (0.0026)
Intercept	--	8.1358*** 0.0013
R-squared	0.85	0.42
No. of Observations Number of unique workers Number of unique employers	95,646,748 7,543,327 367,062	

Notes: Standard errors in parentheses. Analysis includes documented workers employed in Georgia 1995-2005 inclusive. Also included as regressors are broad sector industry fixed effects (see Appendix B) and year and quarter fixed effects. P_{jt} is measured from 0 to 100. *** statistically significantly different from zero at the 99% confidence level, ** statistically significantly different from zero at the 95% confidence level, and * statistically significantly different from zero at the 90% confidence level.

Table 4. Marginal effects on documented worker wages across worker and firm characteristics.

Dependent variable = $\ln w_{ijt}$	Average Firm Level Share of Workers that is Undocumented, among firms that hire undocumented workers	$\frac{\partial \ln w_{ijt}}{\partial U_{jt}}$	$\left.\frac{\partial \ln w_{ijt}}{\partial P_{jt}}\right\|_{U_{jt}=1}$
Full Sample, fixed effects	10.6%	0.0054***	- 0.00016***
Full Sample, OLS	10.6%	-0.0942***	0.0042***
Broad Sector			
Agriculture and Natural Resources	12.2%	-0.0249***	-0.0035***
Construction	12.0%	-0.0040***	-0.00052***
Manufacturing	8.1%	0.0109***	0.00097***
Transportation and Utilities	7.7%	0.0059***	-0.0024***
Wholesale Trade	10.8%	0.0072*	-0.00033*
Retail Trade	11.5%	0.0166***	0.00066***
Financial Activities	12.4%	-0.00052**	-0.00048
Information	6.3%	-0.0025***	-0.0061***
Professional and Business Services (includes temporary services)	11.4%	-0.0042***	-0.00063***
Education and Health Services	6.8%	-0.0026***	-0.00072***
Leisure and Hospitality	9.4%	0.0104***	-0.0011***
Other Services (includes private household, laundry, and repair and maintenance services)	15.0%	-0.0008***	-0.0012***
Worker Earnings Level (excluding separators and newly hired)[a]			
Wages < $3,000	9.2%	0.00023***	- 0.0018***
Wages ≥ $3,000	10.0%	-0.00024***	- 0.0001***

See notes to Table 3. A Wald test is used to determine the significance of the marginal effects (which are linear combinations of the parameter estimates).

$\left(\partial \ln w_{ijt} / \partial\, U_{jt}\right)$ = Wage impact of being employed by a firm that hires undocumented workers = $\hat{\beta}_0 + \hat{\beta}_1 \bar{P}_{jt}\big|_{U_{jt}=1}$

$\left(\partial \ln w_{ijt} / \partial\, P_{jt}\right)\big|_{U_{jt}=1}$ = Wage impact on workers employed by firms that <u>hire</u> undocumented workers as the percent of undocumented workers in the firm increases by one percentage point = $\hat{\beta}_1$

[a] Even "high-wage" workers who separate or are newly hired could easily have quarterly earnings less than $3,000 since the data would reflect only a partial quarter payment to those worker, so separators and the newly hired are excluded for these estimations.

Appendix A: Using SSNs to Identify Undocumented Workers

A.1. Identifying Invalid Social Security Numbers

Every quarter employers must file a report with their state's Department of Labor detailing all wages paid to workers who are covered under the Social Security Act of 1935. Each worker on this report is identified by his/her social security number (SSN). There are a number of ways in which one can establish that a reported social security number is invalid. The Social Security Administration provides a service by which an employer can upload a file of SSNs for checking, but one must register as an employer to obtain this service.[i] In addition, there are several known limitations on what can be considered a valid social security number, so a simple algorithm is used to check whether each number conforms to the valid parameters.

There are three pieces to a SSN.[ii] The first three numbers are referred to as the Area Number. This number is assigned based on the state in which the application for a SSN was made; it does not necessarily reflect the state of residence. The lowest Area Number possible is 001 and the highest Area Number ever issued, as of December 2006, is 772. Using information provided by the SSA, the dates at which area numbers between 691 and 772 are first assigned can be determined. Any SSN with an Area Number equal to 000, greater than 772, or which shows up before the officially assigned date, will be considered invalid.

The second piece of a SSN consists of the two-digit Group Number. The lowest group number is 01, and they are assigned in non-consecutive order. Any SSN with a Group Number equal to 00 or with a Group Number that appears in the data out of sequence with the Area Number will be considered invalid.

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[i] See Social Security Number Verification Service <http://www.ssa.gov/employer/ssnv.htm>.

[ii] Historical information and information about valid SSNs can be found at the Social Security Administration's web sites: <http://www.ssa.gov/history/ssn/geocard.html>, <http://www.xocialsecurity.gov/employer/stateweb.htm>, and <http://www.socialsecurity.gov/employer/ssnvhighgroup.htm >.

The last four digits of a SSN are referred to as the Serial Number. These are assigned consecutively from 0001 to 9999. Any SSN with a Serial Number equal to 0000 is invalid.

In 1996 the Internal Revenue Service (IRS) introduced the Individual Tax Identification Number (ITIN) to allow individuals who had income from the U.S. to file a tax return (the first ITIN was issued in 1997). It is simply a "tax processing number," and does not authorize an individual to work in the U.S. Employers are instructed by the IRS to "not accept an ITIN in place of a SSN for employee identification for work. An ITIN is only available to resident and nonresident aliens who are not eligible for U.S. employment and need identification for other tax purposes."[iii] ITIN numbers have a "9" in the first digit of the Area Number and a "7" or "8" in the first digit of the Group Number. Anyone with this numbering scheme will be identified as having an invalid Area Number; the percent of SSNs with high area numbers that also match the ITIN numbering scheme has risen from about one percent in 1997 to over 60 percent by the end of 2006.

A series of SSNs were de-commissioned by the Social Security Administration because they had been put on fake Social Security Cards used as props to sell wallets.[iv] Apparently, some people who purchased the wallets thought the fake Social Security Cards were real and started using them as their own. If any of these 21 "pocketbook" SSNs appear in the data, they are considered invalid, although their frequency is so low as to be inconsequential. In addition, a number of SSNs are exactly equal to the employer identification number. These are invalid, primarily because they have too few digits. In any instance where a SSN is used for more than one person on a firm's UI wage report or does not have the required number of digits (including

[iii] "Hiring Employees," <http://www.irs.gov/businesses/small/article/0,,id=98164,00.html>. Also see, "Individual Taxpayer Identification Number (ITIN)," <http://www.irs.gov/individuals/article/0,,id=96287,00.html>.
[iv] See "Disclosure and Verification of Social Security Numbers (SSNs) for the Section 235 Program" (9 November 1990), <http://www.hud.gov/offices/adm/hudclips/letters/mortgagee/files/90-39ml.txt> (accessed 8 February 2011).

zeros), the SSN is considered invalid.

The possibility that someone fraudulently uses a valid SSN assigned to someone else poses a special problem. First of all, the SSN will show up multiple times across firms in one quarter for workers with different surnames (the wage report includes the first three characters of the workers' surnames). With this information alone, it is not possible to know which worker is using the SSN fraudulently and who the valid owner of the number is. If one of the SSN/surname pairs shows up in the data initially in a quarter by itself, this is the pair that is considered valid and all other duplicates (with different surnames) are considered invalid.

A.2. Does "Invalid" mean "Undocumented?"

Not all invalid SSN are classified as undocumented workers; examining the patterns of incidence of different types of invalid SSNs suggests that some types are firm generated rather than worker generated. Figure 1 illustrates the incidence patterns across types of invalid SSNs in construction. The percent of workers with SSNs having a high area number or out-of-sequence group number displays the expected growth in undocumented workers, whereas the incidence of SSNs for other reasons exhibits a flat to declining, highly seasonal pattern (this seasonality appears in all other sectors, as well).[v] The strong seasonal nature of the other invalid reasons suggests that firms are temporarily assigning invalid SSN numbers to workers before having time to gather the information for the purpose of record keeping/reporting. Or, firms may decide to not bother obtaining a SSN for workers who will only be employed a very short time.[vi] The high degree of churning (see footnote 7) observed among workers with invalid SSNs for these

[v] Documentation of growth in undocumented workers can be found in Michael Hoefer, Nancy Rytina, and Christopher Campbell, "Estimates of the Unauthorized Population Residing in the United States: January 2006," *Population Estimates* (Washington D.C.: US Department of Homeland Security, Office of Immigration Statistics, February 2009).

[vi] Indeed, a worker has 90 days to resolve a discrepancy that results in the receipt of a "no-match" letter from the Social Security Administration. The employee may be long gone before such a letter is even received.

other reasons is consistent with either of these practices.

[Figure A1 here]

Since there is no way to know whether a temporary assignment by the firm of an invalid SSN is to merely cover for temporary employment of an undocumented worker or to allow the firm to file its wage report before having had a chance to record the worker's valid SSN, the analysis below takes the conservative tack by considering as undocumented only those workers whose SSNs are classified as invalid because the area number is too high or the group number is assigned out of sequence; workers with invalid SSNs for any other reason are considered neither undocumented nor documented and, thus, are excluded from the analysis. This will clearly undercount the actual number of undocumented workers. However, all workers, regardless of SSN classification, are included in counts of aggregate firm employment.

Figure A1.

Appendix B: Definitions of broad sectors, industry skill, and industry labor intensity.

B.1. Definitions of Broad Sectors

Throughout this paper, regressors are measured at different levels of industry aggregation. The process of matching is performed at the broad sector level, which are defined based on two-digit NAICS classifications. These classifications are designed to match as closely as possible the former SIC classifications and are reported in Table A1.

Table B1: Definitions of broad sectors based on 2-digit NAICS classifications.

Sector	Included 2-digit NAICS
Agriculture and Natural Resources	11, 21
Construction	23
Manufacturing	31-33
Transportation and Utilities	22, 48-49
Wholesale Trade	42
Retail Trade	44-45
Financial Activities	52-53
Information	51
Professional and Business Services (includes temporary services)	54-56
Education and Health Services	61-62
Leisure and Hospitality	71-72
Other Services (includes private household, laundry, and repair and maintenance services)	81

B.2. Construction of the Measure of Industry Labor Intensity

Labor intensity for each industry is based on coefficients from the U.S. Input-Output (I-O) Benchmark Tables 2002 (http://www.bea.gov/industry/index.htm#benchmark_io). The labor intensity coefficient is defined as the share of compensation of employees (wage bill) in total industry output. Compensation of employees includes wages and salaries and their supplements. Total industry output is the sum of the products consumed by the industry, compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.

B.3. Construction of Industry Skill

Each industry is assigned a skill intensity based on the weighted average of educational attainment of workers in that industry, using the Current Population Survey for 1994. This year was chosen since this is the first year in which the nativity (place of birth) of respondents is reported. For each industry, the percent of workers with less than a high school education (LTHS), a high school education (HS), some college (SCOLL), college degree (COLL), and graduate education (GRAD) is calculated. The regressor *HigherEducation* is the share of workers in the firm's industry with a college or graduate education.