# How do Regulated and Unregulated Labor Markets Respond to Shocks? Evidence from Immigrants During the Great Recession

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We study wage adjustment during the recent crisis in Italy using a unique dataset on immigrant workers that includes those employed in formal and informal sector. We find that before the crisis immigrants' wages in the formal and informal sectors moved in parallel (with a 15% premium in the formal labor market). During the crisis, however, formal wages did not adjust down while wages in the unregulated informal labor market fell so that by 2013 the gap had grown to 32%. The difference was particularly salient for workers in occupations where the minimum wage is likely to be binding, and in "simple" occupations where there is high substitutability between immigrant and native workers. Calibrating a simple partial equilibrium model of spillovers between formal and informal markets, we find that less than 10% of workers who lost a formal job during the crisis move to the informal sector. We also find that if the formal sector wages were fully flexible, the decline in formal employment would be in the range of 1.5–4.5%—much lower than 16% decline that we observe in the data. (*JEL* E24, E26, J31, J61)

## 1. Introduction

The Great Recession has brought a substantial increase in unemployment in Europe, with an average unemployment rate that has grown from 8% in 2008 to 12% in 2014. The change has been very heterogeneous. In northern Europe, unemployment did not grow substantially or even fell: in Germany, for example, unemployment rate actually declined from 7% to 5%. At the same time, in Greece unemployment increased from 8% to 26%, in Spain from 8% to 24%, and in Italy from 6% to 13%.

Why have unemployment dynamics been so different in European countries? One of the most often cited explanations is the difference in

labor market institutions that prevents wages from adjusting downward. If wages cannot decline, negative aggregate demand shocks (such as the Great Recession) result in unemployment growth. On the other hand, if wages can fall, labor markets reach a new equilibrium with unemployment rates returning to normal levels. Downward adjustment of wages in response to macroeconomic shocks is especially important in the euro area where labor markets cannot accommodate shocks through exchange rate depreciation or through internal labor mobility (migration among EU countries is much more limited than, for example, labor mobility across US states).

Albeit straightforward, this argument is not easy to test empirically. Indeed, cross-country studies of labor markets are subject to comparability concerns. Another approach taken by the literature is comparing labor markets in different industries within the same country, although comparability issues still arise. In order to construct a convincing counterfactual for a regulated labor market, one would need to study a nonregulated labor market in the same sector within the same country. That is precisely the scope of this article. We compare formal and informal labor markets in Italy over the years 2001–13 considering informal employment as a proxy for unregulated counterfactual to the regulated formal labor market.[1] We are able to carry out this analysis as we use a unique dataset on immigrants who work both in formal and informal sector.[2]

We use a large annual survey of immigrants working in Lombardy carried out by the Foundation for Initiatives and Studies on Multi-Ethnicity (ISMU). Lombardy is the largest region of Italy in terms of population (10 million people, or one sixth of Italy's total) and GDP (one fifth of Italy's total GDP). It is also the region with the largest migrant population: in 2005, 23% of the entire migrant population legally residing in Italy were registered in Lombardy. It is also likely to be the largest host of undocumented migrants: in the last immigrants' regularization program in 2002, Lombardy accounted for 22% of amnesty applications. Although Lombardy has higher GDP per capita and lower unemployment rates than the Italian average, it has also suffered from the recent crisis. Unemployment increased from 4% in 2008 to almost 9% in 2013. Recession started in 2009, it was followed by a weak recovery in 2010–11 and resumed in 2012; in 2012 real GDP was 5% below its 2008 level.

Our data cover around 4000 full-time workers every year, a fifth of which works in the informal sector. The dataset is therefore sufficiently

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1. We define informal employment as employment without a legal work contract. We use the term "informal" as a synonym of "underground" and "unofficial." A key assumption of our analysis is that we consider the informal labor market to be less regulated than the formal labor market.

2. Information on native workers' informality status is not available from other datasets. In the concluding remarks, we discuss the external validity of our findings.

large to allow us comparing the evolution of wages in the formal and informal sectors controlling for household characteristics, occupation, skills, and other individual characteristics (age, gender, year of arrival to Italy, and country of origin). We adopt a difference-in-differences methodology in order to test our main hypothesis that a severe recession in Italy (and Lombardy) should have resulted in a larger decline of wages in the unregulated labor market (i.e. in the informal sector) compared with the regulated labor market (i.e. the formal sector).

Our main result is presented in Figure 1 which shows the wage trends in the formal and informal sectors controlling for occupation, gender, age, education, country of origin, and family characteristics. We find that the wage differential between formal/regulated and informal/unregulated sectors has increased after 2008. Moreover, although wages in the informal sector decreased by about 20% in 2008–13, wages in the formal sector virtually did not fall. This is consistent with the view of a substantial downward stickiness of wages in the regulated labor market. Importantly, before the recession, wages in the formal and informal sectors moved in parallel—confirming the validity of the parallel trends assumption required for a difference-in-differences estimation and showing that both regulated and unregulated labor markets have a similar degree of *upward* flexibility of wages.

In order to understand whether the downward stickiness of formal wages is related to the minimum wage regulation, we construct sector-specific minimum wages (using information from collective bargaining contracts at the industry level). We find that the effect in Figure 1 is stronger for workers with earnings closer to the minimum wage, while the effect disappears for workers earning far above the minimum wage. Therefore, minimum wages do seem to at least partially explain the downward stickiness of wages in the formal labor market.

We then test whether the effect is stronger in "simple" rather than in "complex" occupations. The former require only generic skills and allow for greater substitutability between workers (in particular, between natives and immigrants) within occupations and across occupations. In such jobs we should expect a greater downward adjustment in the absence of regulation. On the contrary, in complex occupations workers need specific skills and are harder to replace; therefore even in unregulated labor markets wages may not decline during recession. Our estimates are consistent with this prediction: the increase in wage differential between formal and informal sectors during the recession is stronger in simple than in complex occupations.

We also analyze the impact of the crisis on formal and informal employment. We find that formal employment decreases substantially, whereas informal employment does not change.[3] Since the aggregate

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3. The drop in formal employment and the heterogeneity of effects on earnings by distance from the minimum wage are consistent with the view that the regulations on firing workers are
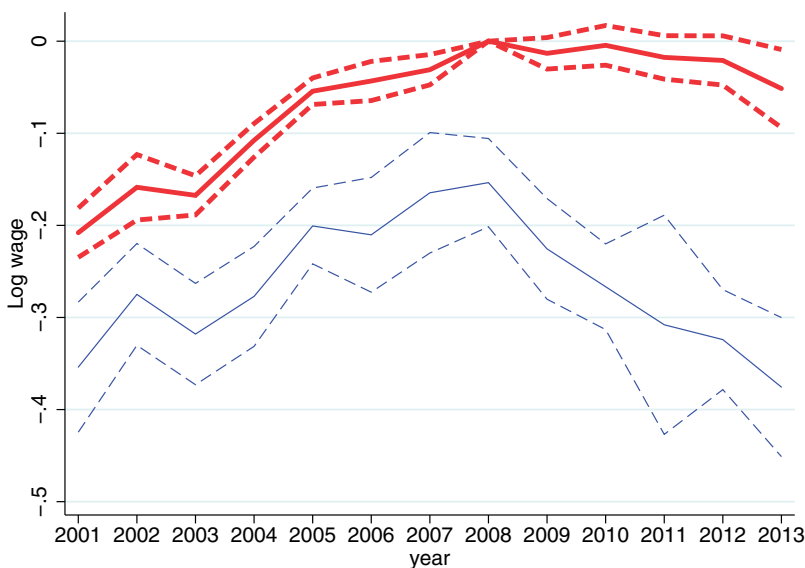
Figure 1. Wages in Formal and Informal Labor Markets in Lombardy. Logarithm of wages (relative to formal sector in 2008) controlling for gender, age, education, country of origin, family characteristics, occupation dummies, provinces of residence dummies. Thick line: formal sector. Thin line: informal sector. Dashed lines: 95% confidence interval.
*Source*: ISMU survey, authors' calculations.

demand shock affects both labor markets, the employment adjustment implies that upon losing a job in the formal sector at least some workers move to the informal sector. To disentangle this labor supply shock from the negative demand shock associated with the Great Recession, we calibrate a simple partial equilibrium model describing such spillovers between formal and informal labor markets. Using the existing estimates for demand and supply elasticities for the Italian labor market, we estimate the degree of integration of formal and informal sector (i.e. the share of workers who move from the formal to the informal labor market after the crisis). Our model also allows to carry out a counterfactual analysis of the formal sector's response to crisis in a scenario where formal wages were fully flexible. We find that in this case the crisis would have resulted in a much smaller decline in formal employment between 2008 and 2013 (1.5–4.5% rather than the actual 16%).

To verify the validity of our empirical strategy, we perform a number of checks. First, we run several placebo tests that provide support to the

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less relevant than the minimum wage regulation. However, these results may also be explained by the destruction of jobs due to the exit of firms that can neither reduce wages nor reduce employment. Since our dataset does not include detailed data on employers, we cannot distinguish between these two explanations.

parallel trends assumption required for difference-in-differences estimation. Second, we use the information we have on the immigrants' intentions to return to their origin country and show that informality is not associated with selection into return migration. Third, the use of panel data from alternative sources suggests that, in our setting, wage dynamics are not driven by composition effects. Fourth, we graphically show that key average observable characteristics—such as age, gender, and education—do not change in a relevant way after the crisis starts, which bolsters our confidence that the recession did not change the composition of the immigrants. Fifth, we confirm the results of the previous two checks relying on a test in the spirit of Altonji et al. (2005). Sixth, since the recession may in principle induce workers to move to lower paying occupations, we show that our results are remarkably similar when we run our specifications with or without occupation dummies. Finally, in addition to provide support to the empirical strategy, these checks are also consistent with our calibration exercise, showing small spillovers between informal and formal labor markets in our setting during the recession.

The rest of the article is structured as follows. We start with a brief overview of the relevant literature in Section 2. We then present the background information on the Italian labor market institutions in Section 3. In Section 4 we discuss our empirical methodology. The data are introduced in Section 5. Section 6 presents the econometric results, robustness checks, and placebo tests. Section 7 analyzes the impact of the crisis on the formal and informal employment and the spillover effects between formal and informal labor markets. Section 8 concludes, adds caveats on the external validity of our findings, lists the robustness checks that provide support to our empirical strategy, and briefly discusses the contribution of this work to the immigration literature.

## 2. Literature Review

Our article contributes to several strands of research. First, we bring new evidence on the evolution of labor market outcomes of immigrants through the business cycle. Dustmann et al. (2010) analyze differences in the cyclical pattern of employment and wages of immigrants and natives in Germany and the UK. They find significantly larger unemployment responses to economic shocks for immigrants relative to natives within the same skill group. Their estimates instead show little evidence for differential wage responses to economic shocks. Orrenius and Zavodny (2010) compare the impact of the Great Recession on Mexican-born immigrants and native US workers with similar characteristics. They find that immigrants' employment and unemployment rates are particularly affected by the recession; the impact is especially strong for low-skilled and illegal immigrants. The authors also argue that one of the major channels of adjustment is a great reduction of the inflow of Mexican immigrants during the recession. Lessem and Nakajima (2015)

confirm this finding using the data from the Mexican Migration Project based on the undocumented migrants' recollections of their dates of trips to the United States and the wages they earned there. They also show that undocumented Mexican immigrants' wages in the United States are negatively correlated with the US unemployment rate—unlike the wages of the legal migrants and the wages of the natives, including those of the Mexican origin. Their estimates stress the important role of occupational spillovers: during the US recessions, undocumented Mexican immigrants are more likely to shift to agricultural jobs. Our work adds to this first branch of literature by exploiting information from a unique dataset on immigrants working in the formal and informal labor markets, considering informal employment as a proxy for unregulated counterfactual to the regulated formal labor market. We also quantify the spillovers from formal to informal labor markets during periods of economic downturn.[4]

Second, we contribute to the literature on market outcomes of documented and undocumented immigrants. There are works showing how undocumented immigrants have on average worse labor market outcomes than documented immigrants (see, e.g., Borjas and Tienda (1993); Kossoudji and Cobb-Clark (2002); Kaushal (2006); Amuedo-Dorantes et al. (2007); Fasani (2015); Monras et al. (2018)). This effect of legal status on labor market outcomes may be related to the restricted set of job opportunities for undocumented immigrants or their bargaining power relative to employers, which is lower than the one of immigrants with a regular residence permit. These differential effects related to the labor market may affect other important outcomes, such as consumption behavior (Dustmann et al. 2017a) and propensity to commit crimes (Pinotti 2017). Our study shows important implications of labor market regulation for the economic integration of immigrants. During periods of crisis, labor market regulation can reduce the attractiveness of regularization programs, that is fewer undocumented immigrants would apply for getting legal status in the host country. Similarly, more regulated labor markets in destination countries can lower the expected value for potential migrants in source countries to choose the legal emigration option rather than emigration without a visa. A novelty of our analysis is to suggest that links between labor market regulation and effectiveness of immigration policies—among others those that affect immigrants' legal status—may have important consequences for immigrants' economic outcomes.

Third, there is additional literature studying immigration during periods of economic downturn. Using data on 15 Western European countries before and during the Great Recession, D'Amuri and Peri (2014) find that an inflow of immigrants generates a reallocation of natives to occupations

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4. For the literature that analyzes informal labor markets in Latin American countries, see Bosch and Maloney (2010), Bosch and Esteban-Pretel (2015), Almeida and Carneiro (2012), and Meghir et al. (2015).

with a stronger content of complex abilities.[5] This reallocation is more salient in countries with low employment protection and for workers with low education levels. Their estimates also show that this process remained significant—even if it slowed down—during the first years of the Great Recession.

Another strand of literature analyzes the role of migration as a channel of adjustment during crisis. The seminal contribution by Blanchard et al. (1992) studies the response of the US economy to regional shocks and points at interstate labor mobility as the major channel of adjustment in the long run. For instance, after several years local economies adjust to aggregate demand shocks in terms of labor force participation and unemployment rates, while the workers who cannot find jobs in the depressed states move out to other states. Decressin and Fatas (1995) carry out a similar analysis for European regions. They find that the European workers are less mobile than their American counterparts, and adjustment mainly occurs through reduced labor force participation. Mauro and Spilimbergo (1999) consider the case of a single European country, Spain, focusing on the heterogeneity of the adjustment mechanisms across skills groups. Their results suggest that high-skilled Spanish workers respond with out-migration from the depressed provinces while the low-skilled drop out of the labor force or remain unemployed.[6] Beyer and Smets (2015) suggest that declining interstate migration in the United States since the 1980s and rising migration in Europe over the last 25 years are gradually leading to a convergence of the adjustment processes in the United States and Europe. Cadena and Kovak (2016) show that Mexican-born immigrants help to equalize spatial differences across local US labor markets. Interestingly, this takes place in both the high-skilled and low-skilled segments of the labor market. Low-skilled immigrants turn out to be very responsive to labor market shocks, which helps equilibrating local labor markets even though low-skilled natives are not mobile. This literature shares with our work the focus on immigrants during recessions, but – differently from these works – we analyze the evolution of immigrants' labor market outcomes during periods of negative demand shocks.

Although the main focus of our work is adding new evidence on market outcomes of documented versus undocumented immigrants and on the evolution of labor market outcomes of immigrants through the business cycle, our work is also related to several cross-country studies of labor markets' response to recessions: Nickell (1997) compares the labor

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5. Examples of other works analyzing the labor market impact of immigration are Card (1990), Borjas (2003), Cortes (2008), Farré et al. (2011), Glitz (2012), Manacorda et al. (2012), Ottaviano and Peri (2012), Dustmann et al. (2013), Facchini et al. (2013), Docquier et al. (2014), Dustmann et al. (2017b), and Foged and Peri (2016).

6. The analysis of the heterogeneity of the workforce and therefore of the labor market adjustments has greatly benefited from the development of measures of skill content of occupations by Autor et al. (2003), Peri and Sparber (2009), Goos et al. (2009), and Goos et al. (2014). We also adopt these measures to disaggregate the channels of adjustment in our data.

markets of Europe and North America; Card et al. (1999) analyze changes in wages and employment rates due to adverse demand shocks in the United States, Canada, and France; Botero et al. (2004) code the regulation of labor markets in 85 countries; Bentolila et al. (2012) compare labor markets institutions and unemployment rates during the Great Recession in France and Spain; Elsby et al. (2016) study wage adjustment during recessions in the United States and Great Britain. Hoffmann and Lemieux (2016) compare unemployment rates during the Great Recession in Canada, Germany and the United States. Another approach taken by the literature is comparing labor markets in different industries within the same country. For instance, Besley and Burgess (2004) present evidence on the effects of labor regulation on economic performance across Indian states, comparing agriculture and nonagricultural occupations, as well as registered and unregistered sectors. Pischke (2016) analyzes how the housing cycle affects wage and employment responses of three occupations in the housing market: real estate agents, architects, and construction workers. Fougère et al. (2016) study the effect of minimum wage on wage bargaining, using data from 350 industries in France. Our contribution to this literature is that we study regulated and unregulated labor markets within the same occupation within the same country, thus addressing major cross-country and cross-industry comparability concerns.

In addition, our article brings new evidence on the recent literature on dual labor markets in Europe. The peculiarity of the dual labor market in Europe is discussed in detail by Boeri (2011), who provides a comprehensive survey of the literature on the impact of recent labor market reforms in Europe. Bentolila et al. (2012) compare labor market institutions in France and Spain to explain the strikingly different evolution of unemployment during the Great Recession in the two countries. In fact unemployment rate was around 8% in both France and Spain just before the Great Recession, but by 2011 it increased to 10% in France and 23% in Spain. The authors explain the differential with the larger gap between firing costs in permanent and temporary contracts, and the laxer rules on the use of the latter in Spain. Our article also considers dual labor markets, although we study the duality of formal/regulated versus informal/unregulated markets rather than the duality between permanent and temporary contracts. We also complement this literature by suggesting an identification strategy that is less subject to comparability concerns, which are common to cross-country studies of labor markets.

## 3. Background Information on the Italian Labor Market

The Italian formal labor market has centralized collective bargaining institutions. After the abolishment of the automatic indexation of wages to past inflation (the so-called *scala mobile*) in 1992, Italy created a two-tier bargaining structure where wages are determined via both plant-level and industry-level/centralized negotiations. In particular, nation-wide sectoral

collective agreements between employers' associations and trade unions (*Contratto Collettivo Nazionale di Lavoro*, CCNL) specify job titles in each industry and decide specific minimum wages that apply to each job title, regardless of a worker's union membership. Firms cannot deviate from the sector-wide agreements through "opting-out" clauses, but in principle, on top of the industry-minimum wage, they can add a wage premium related to performance. However, as Boeri (2014) documents, the percentage of firms relying on the two-tier bargaining – both plant-level and industry-level – decreased over time, down to less than 10% in 2006: employers in Italy typically prefer following the wages set by industry agreements, rather than through further negotiations at the plant level. Devicienti et al. (2016) discuss available evidence suggesting that this decline over time in the incidence of firm-level agreements in Italy was partly a consequence of a reduction in unionization rates.

Italy's formal labor market is also characterized by relatively high levels of employment protection, and relatively low levels of both unemployment benefits and active labor market policies (such as training programs, job search assistance, counseling, etc.). According to the 2013 OECD indicators of employment protection, Italy ranks 30 out of the 34 OECD members in terms of protection of permanent workers against individual and collective dismissals, and 27 out of 34 in terms of regulation of temporary employment.[7] These features make the Italian context different for instance from the flexicurity of Scandinavian countries. However, over the last decades, and similarly to other European countries, several reforms aimed at introducing various types of temporary contracts and increasing labor market flexibility.[8]

Italy has a large informal labor market. In the period considered in our study—from 2001 to 2013—both left- and right-wing governments adopted several pieces of legislation to reduce informality. Nonetheless, these policies have not been particularly effective in tackling the issue of informal employment. In fact, according to recent estimates the Italian underground economy accounts for about 25% of the GDP (Orsi et al. 2014). As Capasso and Jappelli (2013) describe, industries differ in terms of level of informality: measures of job informality are as high as 31% in the construction sector and 25% in the retail and tourism sectors and as

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7. These indicators rank OECD members from countries with least restrictions to those with most restrictions.

8. Examples of these reforms are the law no. 196/1997 ("Treu law"), decree law no. 368/2001, law no. 30/2003 ("Biagi law"), and law 78/2014 ("Poletti decree"). See Ichino and Riphahn (2005), Kugler and Pica (2008), Cappellari et al. (2012), Leonardi and Pica (2013), Cingano et al. (2016), and Daruich et al. (2017) for works on the effects of changes in employment protection legislation. For empirical evidence on the consequences of temporary work employment on subsequent labor market outcomes, see Booth et al. (2002), Ichino et al. (2008), and Autor and Houseman (2010). For works on the impact of labor market institutions on employment, see also Card and Krueger (1994), Dube et al. (2010), Allegretto et al. (2011), Neumark et al. (2014), and Neumark (2014).

low as 12% and 15% in finance and manufacturing, respectively. Capasso and Jappelli (2013) also document that informal labor markets are particularly well-developed in sectors with relatively low levels of competition and small firm sizes.

The large size of the informal labor market implies that immigrants who reside in Italy without a regular residence permit (we will refer to these as "undocumented" or "illegal" immigrants) have a relatively high probability of finding a job. Given that they are not entitled to work in the formal sector, illegal immigrants might prefer to locate in countries like Italy with a large shadow economy. In terms of labor market outcomes, both documented and undocumented immigrants lag behind natives with similar levels of education. For instance, Accetturo and Infante (2010) show that returns to schooling for immigrants are much lower than the ones for native Italians. Moreover, immigrants residing in Italy are likely to work in occupations that are not appropriate to their level of education. As the OECD (2008) report suggests, one of the reasons why immigrants' over-qualification occurs lies in the fact that Italy is a relatively new immigration country. Given that an appropriate match between jobs and immigrants' qualifications takes time—because for instance immigrants do not have well-developed professional networks in the host country or they lack complementary skills such as the knowledge of the host country language—upon arrival immigrant workers are likely to accept unskilled jobs with the hope of upward professional mobility as their stay in Italy continues.

## 4. Methodology

We use the difference-in-differences methodology to analyze the evolution of wages in the formal and informal labor markets before and during the crisis. Our benchmark specification is the following:

$$W_{iocpt} = \alpha \text{Informal}_i + \beta \text{Crisis}_t \text{ Informal}_i + \gamma X_i + \delta_o + \delta_c + \delta_p + \delta_t + \epsilon_{iocpt}, \quad (1)$$

where $W$ is the logarithm of the after-tax monthly wage of a full-time employed worker $i$ from country of origin $c$ working in occupation $o$ and residing in province $p$ at the time of the interview $t$ ($t = 2001, \ldots,$ 2013).[9] Control variables $X_i$ include gender, age, age squared, years in Italy, education, dummy for being married, children abroad, and children in Italy. We include dummy variables $\delta_o$, $\delta_c$, $\delta_p$, and $\delta_t$ for occupations, countries of origin, provinces of residence, and year fixed effects, respectively. We cluster the standard errors by province of residence, by simple/complex dummy and by before/after crisis dummy; we end up

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9. Conditioning on full-time employment, the estimated coefficient at the interaction term does not include the differential effect of informality during the crisis through changes in working hours. In Table A7 (Supplementary Appendix) we show regressions where we use information on individuals who are employed on part-time basis. The ISMU dataset does not include information on hourly wages or the number of hours worked.

with 44 clusters (11 provinces times 2 types of occupations times 2 time periods).[10]

A potential threat to the identification might arise if the formal and informal sectors have been distinctively hit by the Great Recession due to preexisting differences in industry specialization. Our benchmark specification, however, partially takes this into account by controlling for occupation fixed effects. In fact, the definition of "occupation" provided by the ISMU survey differs from the standard international classifications of occupations, such as the ISCO or SOC codings. For instance, 17 occupations can be tracked over time (see Table A3 in Supplementary Appendix): unskilled workers, skilled workers, building workers, farm workers, cleaners, warehouse and custody workers, clerical workers, sales workers, food and beverage workers, craftsmen, truck workers, house helpers, home-based caregivers, baby sitters, social assistance operators, medical and paramedical, intellectual professions. The ISMU classification is therefore a mix between occupations and industries, and as such controlling for it takes into account both dimensions. This is particularly important given that the Great Recession may have affected asymmetrically tradable and nontradable sectors. As a further robustness test, column 1 of Table A11 in Supplementary Appendix shows that results are robust to the inclusion of interaction variables between the crisis dummy and occupations.

Our main variables of interest are $Informal_i$ (dummy for employment in the informal sector) and $Crisis_t$ $Informal_i$—the interaction term of $Informal_i$ and $Crisis_t$. The latter is a dummy for years after 2009: $Crisis_t = 1(t \geq 2009)$.[11] As the informal labor market is unregulated, we should expect $\beta < 0$—during the crisis wages in the informal sector should adjust downward to a greater extent than wages in the regulated formal sector.

Following Donald and Lang (2007), we carry out a two-stage procedure as well, where in the first stage we regress wages on individual characteristics (gender, age, age squared, education, family status, children in Italy, children in the home country, years in Italy, dummies for country of origin, and province of residence) controlling for precrisis occupation-

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10. It is not clear whether 44 should be considered a small number of clusters, thereby resulting in biased estimates. For instance, the seminal papers by Bertrand et al. (2004) and Cameron et al. (2008) show that clustered standard errors perform quite well with as low as 20 and 30 clusters, respectively. Nevertheless, we also perform a wild-bootstrap procedure, which has good size properties with small numbers of clusters. In line with the recommendations of Cameron et al. (2008), Rademacher weights (+1 with probability 0.5 and −1 with probability 0.5) are used when resampling residuals, and the null hypothesis of zero treatment effect is imposed. Estimates (available upon request) suggest robustness of our findings.

11. In Section 6.1, we show that the crisis significantly affected labor market outcomes from 2009 onwards. However, we find qualitatively similar results, but smaller magnitudes, when we consider an alternative proxy for $Crisis$ using $Crisis_t = 1(t \geq 2008)$ (i.e., assuming that the crisis started a year before). In our robustness checks, we also use a province-level unemployment rate as a continuous measure of recession.

specific linear trends. In the second stage, instead, we regress the residuals on informal sector dummy and $Crisis_t$ $Informal_i$ interaction term (controlling for year dummies, occupation dummies, province dummies).

In order to understand what drives the wage adjustment or the lack thereof, we also investigate the heterogeneity of treatment effects. First, we distinguish workers for whom the minimum wage is likely to be binding and those whose wages are safely above the minimum wage. We define as "just above the minimum wage" those earnings up to 17% greater than the national minimum wage for that specific occupation—17% being the reduction that informal earnings experienced due to the crisis.[12] We then estimate a difference-in-difference-in-differences specification similar to equation (1), including three additional interaction terms: the interaction of earnings safely above the minimum wage with crisis dummy, the interaction of earnings safely above the minimum wage with informal employment dummy, and the triple interaction. The coefficient of interest in these specifications is the one at the triple interaction term: if the minimum wage prevents downward adjustment of wages in the formal sector, we should find a positive sign, that is a stronger effect of the crisis on the wage differential between formal and informal employment for those occupations where wages before the crisis were not too far from the minimum wages.

We also distinguish "simple" and "complex" occupations. Since simple occupations involve generic skills, there is a greater extent of substitutability between workers (including immigrant and native workers) within such occupations—as well as across such occupations. Therefore in the absence of regulation, such occupations should undergo a more substantial downward wage adjustment during recession. On the other hand, in complex occupations, skills are more specific and workers are less substitutable. In these complex occupations, even unregulated labor markets may not see large drops in wages in times of recession and high unemployment. To check this, we add three interaction terms to the specification (1): the triple interaction term $Crisis_t$ $Informal_i$ $Simple\ occupations_o$ and two double interaction terms $Crisis_t$ $Simple\ occupations_o$, and $Informal_i$ $Simple\ occupations_o$. In this difference-in-difference-in-differences specification, the coefficient at $Crisis_t$ $Informal_i$ allows quantifying the effect of the recession on the wage differential between formal (regulated) and informal (unregulated) employment for complex occupations. We expect to find a stronger effect for simple rather than complex occupations, that is a negative sign of the coefficient at the triple interaction term $Crisis_t$ $Informal_i$ $Simple\ occupations_o$. We adopt the same approach to check whether the effects vary across occupations with different degree of informality. Finally, we study heterogeneity of effects by education, age, and gender.

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12. As a robustness check, we tried other thresholds for the definition of binding minimum wages, such as 10%, 20%, and 30%. The results (available upon request) are similar.

Figure 1 and placebo regressions confirm the validity of the parallel trends assumption required for a difference-in-differences estimation. Still it is worth noting that our estimates would be biased if unobservable characteristics of formal and informal workers changed during the crisis, thereby affecting the composition of the sample. For instance, workers' risk aversion might be somehow impacted by negative demand shocks such as the Great Recession, so that more risk-averse individuals may prefer employment in the formal labor market during crisis. To check whether our findings are due to changes in unobservables over time, we test if the coefficient of interest at the interaction term $Crisis_t$ $Informal_i$ remains stable once including control variables sequentially. Indeed, individual characteristics such as gender, age, and education have been shown to be important correlates of the level of risk aversion (see Guiso and Paiella (2008) and Borghans et al. (2009) among others). In addition, following Altonji et al. (2005), we report a test assessing the severity of the time-varying selection on unobservables. This analysis shows that changes in risk aversion or other unobservables of similar nature during the Great Recession are not significant drivers of our findings.

We also exploit panel data information from alternative sources to verify that the wage dynamics of Figure 1 are not due to low ability people switching from the formal to the informal labor market during crisis. Our check shows that this potential composition effect does not play a relevant role in our context. Finally, we calibrate a simple model to quantify the spillovers between regular and irregular labor markets.

## 5. Data

Our main database comes from the annual survey of immigrants undertaken by an independent Italian nonprofit organization called Foundation for Initiatives and Studies on Multi-Ethnicity (ISMU). This survey provides a large and representative sample of both documented and undocumented immigrants residing in Lombardy and working in formal and informal sectors.[13] The ISMU survey adopts an intercept point sampling methodology, where the first step involves listing a series of locations typically frequented by immigrants (such as religious sites, ethnic shops, or healthcare facilities), whereas in a second step both meeting points and migrants to interview are randomly selected. At each interview, migrants are asked how often they visit the other meeting points, which permits to compute ex-post selection probabilities into the sample. This approach allows the ISMU survey to produce a representative sample of the total

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13. In other datasets containing information on natives' labor market outcomes—such as the Survey on Household Income and Wealth (SHIW) by the Bank of Italy or the Labor Force Survey by ISTAT—the informality status is either confidential or not available.

immigrant population residing in Lombardy.[14] The latter is the richest region in Italy, after the self-governing province of Bolzano. Eurostat statistics show that in 2015 Lombardy's real GDP per capita was comparable to the one of Denmark.

As Dustmann et al. (2017a) point out, to elicit truthful reporting of characteristics such as undocumented status and informal employment, the ISMU questionnaire does not ask for any sensitive information, such as the home addresses and the names, and the data are collected in public spaces by foreign-born interviewers who emphasize the independence of ISMU from the Italian government. Intercepting immigrants in public places allows to survey individuals who would be difficult to find in their homes.

Table A1 in the Supplementary Appendix presents descriptive statistics on immigrants working in the formal sector (regular workers) and the informal sector (irregular workers) as well as on legal (documented) and illegal (undocumented) immigrants.[15] The vast majority of our sample is formed by migrants with valid residence permit and work contract (82%). In contrast, around 8% of the sample consists of illegal migrants in informal employment. The remaining individuals are equally shared between legal migrants working in the informal sector (5%) and undocumented migrants working in regular employment. Overall, the informal sector accounts for around 13% of the overall (documented and undocumented) foreign-born workforce. Table A1 in Supplementary Appendix shows that 94% of the documented immigrants work in the formal labor market. The descriptive statistics in the same table also point out that 38% of the undocumented immigrants report to work with a regular job contract. This large percentage is partly due to our definition of undocumented immigrants, which also includes those whose residence permit has expired, but they are renewing it at the time of the interview. If we classify these immigrants as documented, then rather than 38%, about 13% of the undocumented immigrants report to work with a formal employment contract.[16] The latter percentage is consistent with the descriptive statistics of

14. See Fasani (2015) and Dustmann et al. (2017a) for a more detailed description of these data. Mastrobuoni and Pinotti (2015) also use data from the ISMU survey. McKenzie and Mistiaen (2009) compare intercept point surveys with census-based and snowball surveys.

15. Throughout the article, we refer to those employed in the formal sector as "regular workers" and those employed in the informal sector as "irregular workers." Similarly, we use "illegal" and "undocumented" interchangeably to denote immigrants residing in Italy without a regular residence permit.

16. Migration policies in Italy do not allow foreigners without valid residence permit to have a formal work contract. The fact that 5% of our sample work in the formal sector but reside illegally in Italy is mostly due to three factors. First, as Fasani (2015) argues, some of the ISMU respondents may confound stable employment with having a valid employment contract. Second, migrants may use fictitious documents in order to stipulate a formal work contract. Third, among the undocumented immigrants there are as well those individuals whose residence permit expired, but who signed a regular labor contract before expiration of the residence permit. In order to ensure that our results are not biased by these measurement

Fasani (2015), who uses the same dataset and shows 15% for a similar statistic considering a shorter time period (from 2001 to 2007).

In our main regressions, we focus on full-time workers to abstract from changes in hours worked (although we show robustness of our findings to the inclusion of part-time employment as well). We consider the following categories of workers: full-time permanent and fixed-term regular workers, irregular workers in stable employment, regular self-employment, and irregular self-employment. Conversely, part-time employment includes regular part-time workers and irregular workers in unstable employment. According to this definition, there are about 4000 full-time-employed respondents in each year. Respondents also provide information about their occupation, country of origin, year of arrival to Italy, monthly earnings, family status, etc. Summary statistics are in Table A2 in the Supplementary Appendix. Table A3 in the Supplementary Appendix presents the breakdown of the sample by occupations, as well as regular and irregular employment for each occupation. The table also includes average wages in the formal and informal sector and the minimum wage for each occupation.[17]

There is no national minimum wage in Italy (even though Article 36 of the Constitution states that salaries must be high enough to provide a decent subsistence for the worker and his family). Instead, minimum wages are set through collective bargaining agreements between employers associations and trade unions. In particular, national collective

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issues linked to eliciting illegal/irregular situations in surveys, we perform two robustness checks. First, we replicate our main results restricting the estimation sample to documented immigrants only. Tables A13, A14, A15, and A16 in Supplementary Appendix —as well as a replication of the benchmark estimations of Table 1 available upon request—all show that results are robust to this check. Second, we replicate our main results (Table 1) considering all undocumented migrants as working in the informal sector (tables available upon request). This does not affect our main results (the wage differential between formal and informal sector significantly rises during the crisis) as well.

17. The ISMU dataset contains information on immigrants only. In order to compare the labor market dynamics during the recession for the whole Italian workforce with those for the immigrant population, we exploit data from the Survey on Household Income and Wealth (SHIW) by the Bank of Italy. This survey is administered every two years and provides information on a representative sample of natives and foreign born workforce, even if for confidentiality issues the variable on nationality is not publicly available. SHIW includes information on wages along several individual characteristics, although it does not include the informality variable which is key to our analysis. Cappariello and Zizza (2010) use information on payment of pension contributions to build a proxy of irregular labor market status throughout the entire career. However, this information does not allow to characterize the current informality status or to link the informality status to business cycle conditions. We restrict the sample to Lombardy only and to the period 2000–12, so that descriptives are comparable with the ISMU data. Table A4 in the Supplementary Appendix shows that average monthly net wages by occupation in the SHIW survey are directly comparable to those of immigrants from the ISMU (see last column of Table A3 in Supplementary Appendix). Moreover, Figure A1 in Supplementary Appendix suggests that, after controlling for observables, wages in ISMU and in SHIW moved in parallel in 2000–12, and their difference was statistically different from zero until 2004.

contracts impose minimum salaries for employees at different skill levels in numerous economic activities, covering both unionized and non-unionized workers. We collect and reconstruct minimum wages from over 140 nationwide collective contracts in effect in 2007, just before the start of the crisis. We then aggregate minimum wages in order to match the professions included in the ISMU dataset (see Table A3 in Supplementary Appendix).[18]

In order to time the beginning of the recession, we use official macroeconomic data on Lombardy and its 11 provinces.[19] Figure 2 plots quarterly data on unemployment rate in Lombardy at regional level for the period considered in the regression analysis (2001–13). The increase in unemployment in Lombardy started in the beginning of 2009 and continued until the end of 2013. Figure 3 presents the evolution of unemployment rates in Lombardy's provinces (this information is available only since 2004). Although there is substantial heterogeneity in levels and dynamics of unemployment, most Lombardian provinces have experienced sharp increase in unemployment since 2009.

To differentiate between simple and complex occupations, we follow Peri and Sparber (2009) and D'Amuri and Peri (2014) and exploit the US Department of Labor's O*NET abilities survey to gain information on the abilities required by each occupation. This database estimates the importance of 52 skills required in each profession. We merge information from the ISMU survey with the O*NET values and select 23 O*NET variables which are supposed to provide an adequate representation of simple/complex jobs (Peri and Sparber (2009) carry out a similar procedure). In particular, we distinguish between two types of skills: manual (or physical) skills represent limb, hand and finger dexterity, as well as body coordination, flexibility and strength; conversely, communication (or language) skills include oral and written comprehension and expression. Once the 23 variables have been selected (see the Table A5 in the Supplementary Appendix), we normalize them to [0, 1] scale. Importantly, we invert the scale for the four communication skills (oral comprehension, written comprehension, oral expression, written expression) and then calculate the average of the 23 variables. The resulting index ranks professions in order of complexity where a profession with a high communication skill intensity is considered as "complex"while high levels of manual skill intensity refer to "simple" jobs. Finally, we compute the median value for the index and distinguish between simple (above the median) and complex (below the median) occupations.

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18. Examples of other works that use information from collective bargaining agreements (*Contratto Collettivo Nazionale di Lavoro*, CCNL) are Cappellari et al. (2012), Card et al. (2013), and Daruich et al. (2017).

19. The province of Monza e della Brianza was officially created by splitting the northeastern part from the province of Milan on May 12, 2004, and became fully functional after the provincial elections of June 7, 2009. For consistency with pre-2009 data, we consider the newly-created province of Monza e della Brianza as part of Milan province.
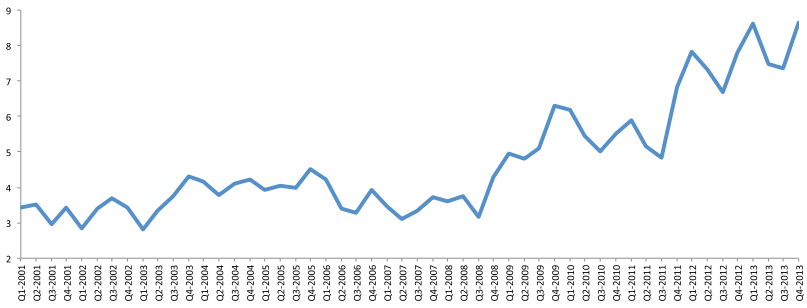
Figure 2. Unemployment Rate in Lombardy by Quarters (2001–13).
*Source*: ISTAT.
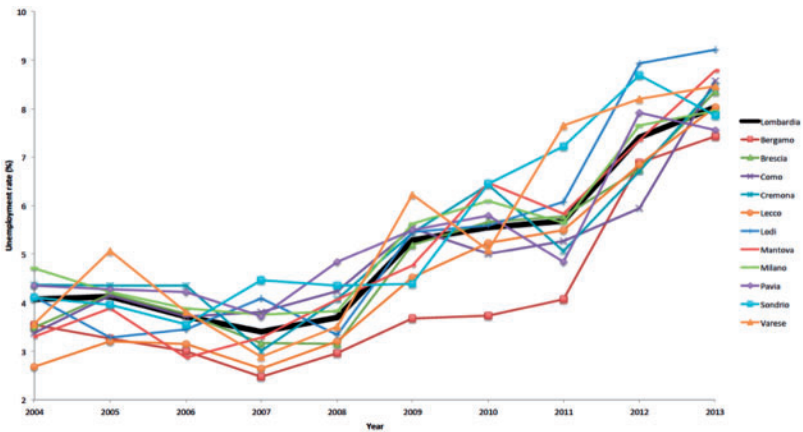


Figure 3. Unemployment by Province within Lombardy.
*Source*: ISTAT.

## 6. Results

### 6.1 Placebo Tests

The identifying assumption of our difference-in-differences specification is that wages of workers in the formal and informal sectors would have followed the same time trend in the absence of the Great Recession. If this parallel trends assumption holds, our empirical strategy allows to control for all unobserved differences between formal and informal workers that remain constant over time.

Figure 1 has already provided visual support to the main identifying hypothesis, showing that wages moved in parallel in formal and informal sectors before the recession. For further verification of the common trends assumption, we run several placebo tests. The rationale behind these checks is to use only data before the recession and create a placebo

treatment that precedes the crisis. This exercise also allows to provide additional confirmation on the timing of the beginning of the crisis in Lombardy—2009 rather than 2008—a finding that is consistent with the evolution of unemployment over time in Figure 2.

In the first three columns of Table A6 in Supplementary Appendix we use data from 2001 to 2007. The placebo treatment variable *Placebo* is equal to 1 for the year 2004 in column 1, for the year 2007 in column 2 and for the years 2006 and 2007 in column 3. In the last three columns of Table A6 in Supplementary Appendix we use data from 2001 to 2008. The *Placebo* variable is equal to 1 for the year 2008 in column 4, for the years 2007 and 2008 in column 5, and for the years 2006, 2007, and 2008 in column 6. Indeed, throughout all specifications, the interaction term between the *Informal* dummy and the *Placebo* variable is not statistically significant, implying the validity of our difference-in-differences strategy. Importantly, the estimation results in Table A6 (Supplementary Appendix) also show the absence of an "Ashenfelter's dip" (see Ashenfelter (1978)): the wage differential does not change just prior to the crisis.

## 6.2 Main Results

Our main results are presented in Table 1. The first column reports the estimation of specification (1), considering 2009 as the beginning of the crisis. Results are in line with our hypotheses: the wage differential between formal and informal sector is 15% before 2009, whereas it raises by 12 percentage points to 27% during the crisis (the difference is statistically significant).

In order to measure the wage differential between formal and informal sectors in every year, in the second column we include interaction terms of the dummy for the informal sector with year dummies. The coefficients of these interaction terms are not significant before the crisis but become significant after the crisis. The wage differential increases by 6 percentage points in 2009 relative to 2008 (however the increase is not statistically significant); the wage differential grows to 11 percentage points in 2010, then to 14 percentage points in 2011, to 15 percentage points in 2012, and to 17 percentage points in 2013 (all statistically significant).

In the third column, we approximate the wage differential with piece-wise-linear function of time allowing for a discontinuous shift at 2009 and a change in the slope afterwards. Once again, we find that in 2009 the wage differential between formal and informal sectors increases by 6 percentage points and then rises by 2.5 percentage points every year. In the last column of Table 1 we assume that the crisis started in 2008 rather than in 2009. Results are qualitatively similar, but the magnitude of the coefficient of interest is smaller: a 9-percentage point increase in the wage differential between formal and informal workers during the crisis, which is smaller than the 12-percentage point increase in the benchmark specification.

Table 1. Wage Differential Between Formal (Regulated) and Informal (Unregulated) Sector: Difference-in-Differences Estimations

|  | (1) Crisis≥ 2009 | (2) Crisis≥ 2009 | (3) Crisis≥ 2009 | (4) Crisis≥ 2008 |
|---|---|---|---|---|
| Informal X Crisis | −0.119*** | | −0.059* | −0.089*** |
|  | (0.035) | | (0.034) | (0.022) |
| Informal | −0.145*** | −0.154*** | −0.150*** | −0.144*** |
|  | (0.017) | (0.024) | (0.018) | (0.017) |
| Informal X Year2001 | | 0.008 | | |
|  | | (0.029) | | |
| Informal X Year2002 | | 0.037 | | |
|  | | (0.041) | | |
| Informal X Year2003 | | 0.003 | | |
|  | | (0.032) | | |
| Informal X Year2004 | | −0.016 | | |
|  | | (0.031) | | |
| Informal X Year2005 | | 0.007 | | |
|  | | (0.020) | | |
| Informal X Year2006 | | −0.013 | | |
|  | | (0.025) | | |
| Informal X Year2007 | | 0.020 | | |
|  | | (0.032) | | |
| Informal X Year2009 | | −0.059 | | |
|  | | (0.036) | | |
| Informal X Year2010 | | −0.109*** | | |
|  | | (0.036) | | |
| Informal X Year2011 | | −0.137** | | |
|  | | (0.066) | | |
| Informal X Year2012 | | −0.150*** | | |
|  | | (0.036) | | |
| Informal X Year2013 | | −0.171*** | | |
|  | | (0.044) | | |
| Informal X max{Year − 2009, 0} | | | −0.025*** | |
|  | | | (0.007) | |
| Female | −0.167*** | −0.167*** | −0.165*** | −0.167*** |
|  | (0.008) | (0.008) | (0.008) | (0.008) |
| Age | 1.659*** | 1.649*** | 1.601*** | 1.658*** |
|  | (0.330) | (0.329) | (0.321) | (0.334) |
| Age squared | −1.936*** | −1.923*** | −1.843*** | −1.938*** |
|  | (0.373) | (0.370) | (0.358) | (0.377) |
| Years in Italy | 0.010*** | 0.010*** | 0.010*** | 0.010*** |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| Compulsory school | 0.022*** | 0.022*** | 0.020*** | 0.022*** |
|  | (0.007) | (0.007) | (0.007) | (0.007) |
| High school | 0.033*** | 0.032*** | 0.032*** | 0.032*** |
|  | (0.008) | (0.008) | (0.007) | (0.008) |
| Tertiary education | 0.073*** | 0.073*** | 0.071*** | 0.073*** |
|  | (0.008) | (0.008) | (0.008) | (0.008) |
| Married | 0.017** | 0.017** | 0.015* | 0.016** |
|  | (0.008) | (0.008) | (0.008) | (0.008) |
| Children abroad | −0.001 | −0.001 | −0.002 | −0.001 |

(continued)

Table 1. Continued

|  | (1) Crisis ≥ 2009 | (2) Crisis ≥ 2009 | (3) Crisis ≥ 2009 | (4) Crisis ≥ 2008 |
|---|---|---|---|---|
|  | (0.003) | (0.003) | (0.003) | (0.003) |
| Children in Italy | 0.005** | 0.005** | 0.005** | 0.005** |
|  | (0.002) | (0.002) | (0.002) | (0.002) |
| Observations | 49, 193 | 49, 193 | 49, 193 | 49, 193 |
| $R^2$ | 0.333 | 0.333 | 0.342 | 0.332 |

*Notes*: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy. All regressions include year dummies, occupation dummies, dummies for country of origin, province dummies.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Data are from the ISMU survey (2001–13). We restrict the sample to immigrants residing in Italy for at most 30 years. The sample includes full-time workers only. The dependent variable is the logarithm of after-tax wage.

Controls are statistically significant, and the coefficients have the expected sign. Other things being equal, women earn 17% less than men. The effect of age is nonlinear: an additional year increases earnings by 1% at the age of 18 years but has negative effect after the age of 43 years; at the age of 55 years, an additional year of age decreases earnings by about 0.5%. Each year spent in Italy raises wages by 1.1%. Completion of compulsory school increases wages by 2.2% (relative to no schooling), higher education—by another 5%. Such low returns to education are not surprising given that most immigrants are employed in low-skilled and middle-skilled jobs. Married workers earn wages that are 2% higher than those of other workers.

Table 2 reports the results of our two-stage procedure described in Section 4 where we first estimate a Mincerian equation for wages and then run the residuals from the Mincerian equation on Crisis$_t$ Informal$_i$ interaction term. We run regressions separately with and without sample weights. We also check whether the results are similar if we group the data into occupation-province cells (for each year and for formal and informal sector separately) or whether we use individual data (in the latter case we cluster standard errors by province, occupation, year, and informal sector dummy). The results are similar. Before the crisis, the wage differential between formal and informal sector is 14–21%; after the crisis it increases by additional 12–15 percentage points.

## 6.3 Heterogeneity of Treatment

As discussed in Section 4, in order to analyze the role of the minimum wage regulations, we estimate a difference-in-difference-in-differences specification similar to equation (1), but where we allow for a differential effect for workers whose earnings are close to the occupation-specific minimum wage and workers whose earnings are substantially higher than the minimum wage. Estimates in column 3 of Panel A of Table 3 show that the minimum wage is an important driver of our results. This finding is

Table 2. Wage Differential Between Formal (Regulated) and Informal (Unregulated) Sector: Two-Stage Difference-in-Differences Estimation

| | Individual data | | Province-occupation cells | |
|---|---|---|---|---|
| | Unweighted (1) | Weighted (2) | Unweighted (3) | Weighted (4) |
| Crisis X Informal | −0.12*** | −0.15*** | −0.15*** | −0.14*** |
| | (0.025) | (0.041) | (0.037) | (0.042) |
| Informal | −0.16*** | −0.21*** | −0.18*** | −0.14*** |
| | (0.012) | (0.021) | (0.017) | (0.020) |
| Observations | 60322 | 60322 | 1960 | 1960 |
| $R^2$ | 0.492 | 0.424 | 0.284 | 0.207 |

*Notes*: In the first stage, we estimate the relationship between the logarithm of after-tax wage and individual characteristics (gender, age, age squared, education, family status, children in Italy, children in the home country, years in Italy, pre-crisis linear trends, dummies for country of origin, occupation-specific pre-crisis time trends, province dummies). In the second stage, we regress the residuals on informal sector dummy and Crisis X Informal interaction term (controlling for year dummies, occupation dummies, province dummies). Robust standard errors in parentheses. In the first two columns, standard errors are clustered by province times occupation times year times informal sector dummy.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Data are from the ISMU survey (2001–13). We restrict the sample to immigrants residing in Italy for at most 30 years. The sample includes full-time workers only.

confirmed by the first two columns of Panel A where we estimate our baseline specification for the subsample of migrants with earnings safely above the minimum wage, and for the subsample with lower earnings; the coefficient at the Crisis*Informal interaction term is significant only for this latter subsample.

We also assess whether there exists a differential impact for individuals working in occupation highly prone to informality. Specifically, we rank occupations by the share of informal workers and distinguish occupations between those below and above the median share.[20] Results in columns 4–6 of Panel A are strikingly homogeneous, with a wage gap for informal workers during the crisis of about 10–12%. These estimates rule out that the differences in wage adjustment between the two labor markets are simply due to differences in the size of the negative demand shock affecting the two markets.

We then rank occupations according to complexity. As discussed in Section 5, we refer to occupations with high intensity of communications skills and low intensity of manual skills as "complex" and the others as "simple."[21] We again run two checks: the regressions for subsamples of simple and complex occupations (columns 1 and 2 of Panel B of Table 3)

20. Another way to distinguish between jobs differently prone to informality would be to separate the analysis for workers in small versus large-size firms, as companies with a larger workforce are more likely to be in the formal sector. However, ISMU dataset does not include information on firm size.

21. "Simple" occupations include unskilled workers, building workers, farm workers, cleaners, craftsmen, and truck workers.

Table 3. Heterogeneity of the Impact of the Crisis on the Wage Differential Between Formal (Regulated) and Informal (Unregulated) Sector: Difference-in-Differences Estimations

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Panel A | | | | | | |
| Crisis X Informal | −0.001 | −0.081** | −0.371*** | −0.125*** | −0.103*** | −0.117*** |
| | (0.012) | (0.033) | (0.034) | (0.036) | (0.035) | (0.039) |
| Informal | −0.025*** | −0.143*** | 0.269*** | −0.151*** | −0.145*** | −0.160*** |
| | (0.009) | (0.019) | (0.050) | (0.020) | (0.016) | (0.018) |
| Crisis X Informal X X Above min.wage. | | | 0.307*** | | | |
| | | | (0.043) | | | |
| Crisis X Above min.wage. | | | −0.348*** | | | |
| | | | (0.018) | | | |
| Informal X Above min.wage. | | | −0.514*** | | | |
| | | | (0.044) | | | |
| Crisis X Informal X X Above med. informal | | | | | | 0.011 |
| | | | | | | (0.049) |
| Crisis X Above med. informal | | | | | | −0.038** |
| | | | | | | (0.017) |
| Informal X Above med. informal | | | | | | 0.016 |
| | | | | | | (0.021) |
| Sample | Above min. wage | Below min. wage | Full sample | Below med. informality | Above med. informality | Full sample |
| Observations | 7, 881 | 41, 312 | 52, 579 | 25, 713 | 23, 480 | 49, 193 |
| $R^2$ | 0.763 | 0.379 | 0.391 | 0.293 | 0.361 | 0.333 |
| Panel B | | | | | | |
| Crisis X Informal | −0.179*** | −0.072 | −0.078** | −0.128*** | −0.111*** | −0.118*** |
| | (0.039) | (0.050) | (0.035) | (0.040) | (0.033) | (0.029) |
| Informal | −0.092*** | −0.179*** | −0.170*** | −0.148*** | −0.143*** | −0.164*** |
| | (0.008) | (0.026) | (0.016) | (0.024) | (0.016) | (0.016) |
| Crisis X informal X Simple | | | −0.095* | | | |
| | | | (0.050) | | | |
| Crisis X Simple | | | 0.013 | | | |
| | | | (0.018) | | | |
| Informal X Simple | | | 0.054*** | | | |
| | | | (0.021) | | | |
| Crisis X informal X Unskilled | | | | | | −0.024 |
| | | | | | | (0.036) |
| Crisis X Unskilled | | | | | | −0.007 |
| | | | | | | (0.009) |
| Informal X Unskilled | | | | | | −0.030 |
| | | | | | | (0.020) |

(continued)

Table 3. Continued

|  | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Panel C |  |  |  |  |  |  |
| Crisis X Informal | −0.089* | −0.139*** | −0.157*** | −0.120*** | −0.111** | −0.103*** |
|  | (0.049) | (0.031) | (0.032) | (0.032) | (0.043) | (0.032) |
| Informal | −0.167*** | −0.106*** | −0.189*** | −0.140*** | −0.159*** | −0.252*** |
|  | (0.021) | (0.014) | (0.031) | (0.019) | (0.021) | (0.038) |
| Crisis X Informal X Female |  |  | 0.057 |  |  |  |
|  |  |  | (0.044) |  |  |  |
| Crisis X Female |  |  | −0.012 |  |  |  |
|  |  |  | (0.015) |  |  |  |
| Informal X Female |  |  | 0.026 |  |  |  |
|  |  |  | (0.036) |  |  |  |
| Crisis X informal X Young |  |  |  |  |  | −0.021 |
|  |  |  |  |  |  | (0.030) |
| Crisis X Young |  |  |  |  |  | 0.013 |
|  |  |  |  |  |  | (0.009) |
| Informal X Young |  |  |  |  |  | 0.118*** |
|  |  |  |  |  |  | (0.038) |
| Sample | Female | Male | Full sample | Young | Old | Full sample |
| Observations | 15,684 | 33,509 | 52,579 | 25,995 | 23,198 | 52,579 |
| $R^2$ | 0.254 | 0.300 | 0.327 | 0.320 | 0.331 | 0.329 |

Notes: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy in subsamples, by province times occupation in columns 3 and 6. All regressions include individual characteristics (gender, age, age squared, years in Italy, education, marital status, number of children), year dummies, occupation dummies, dummies for country of origin, province dummies.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Data are from the ISMU survey (2001–13). We restrict the sample to immigrants residing in Italy for at most 30 years. The sample includes full-time workers only. The dependent variable is the logarithm of after-tax wage.

and difference-in-difference-in-differences specification (column 3 of Panel B). We find that our main result is driven by simple occupations (where the effect is both large and statistically significant). In the subsample of complex occupations (column 2 of Panel B) the coefficient at the $Crisis_i$*$Informal_i$ interaction term is not statistically significant. The results from the difference-in-difference-in-differences specification are similar. A possible reason for the larger downward wage adjustment during the recession in simple occupations is that they involve generic skills, which may imply a higher degree of substitutability between workers (including immigrant and native workers).

While the previous checks concern differences in labor market characteristics, we have also analyzed heterogeneity of effects by individual characteristics. In particular, three potentially important dimensions of different labor market responses are education, gender, and age. Distinguishing between unskilled and skilled workers (the latter having attained secondary or higher education) suggests no differential impact of

the crisis on the wages of the workforce by skill level: the wage gap between the informal and formal sector is stable at around 11–13% during the crisis (columns 4–6 of Panel B). On the other hand, there is literature showing that most recessions—and the Great Recession represents no exception—affected male workers disproportionately and the unemployment rate among 16 to 24 year old workers increased significantly more than aggregate unemployment (see Elsby et al. (2010)). However, our estimates in Table 3 show no significant difference for women and men (columns 1–3 of Panel C) nor between young and old workers, defined as those below/above the median age of the sample (columns 4–6 of Panel C).

In Table A7 in the Supplementary Appendix, we check two other potential dimensions of heterogeneity of effects.[22] First, we distinguish between self-employed and wage workers (columns 1–3). The sample of self-employed is small and the differential effect of the crisis on the earnings gap between self-employed and wage workers is not statistically significant. Secondly, we look at part-time and full-time workers separately and in a difference-in-difference-in-differences specification (columns 4–6 respectively). Again, the wage differential after the recession remains similar to the benchmark results when we consider part-time or full-time workers only (−0.13 and −0.12 respectively). The coefficient of the triple interaction term in the difference-in-difference-in-differences specification is not statistically different from zero.[23]

## 6.4 Time-varying Selection on Unobservables

Our difference-in-differences approach provides unbiased results as long as unobserved omitted differences between formal and informal workers remain constant over time. If this assumption holds, then—conditional on all control variables in our specifications—our identification strategy controls for immigrants self-selecting into informal work depending on their unobserved and observed characteristics, and therefore workers can be considered exogenously assigned to the treatment group.[24]

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22. We do not consider heterogeneity of the effects between temporary and permanent workers, because there is no such distinction among the informal workers who cannot secure a permanent position.

23. We have also estimated a specification similar to the one in column 1 of Table 2, except that we consider as dependent variable a dummy variable equal to 1 if the worker is employed full-time and 0 if she is employed part-time. The probability of being part-time versus full-time does not differentially change with the crisis for formal and informal workers (results available on request).

24. To investigate the sign of the potential bias from selection into informal sector, we have compared actual and counterfactual wage distributions, following DiNardo et al. (1996) and Chiquiar and Hanson (2005). This exercise shows that workers are positively selected into the formal employment: high-ability workers are more likely to work in the formal sector. Part of the difference in earnings between formal and informal workers depends on this positive selection. Our estimation strategy controls for the selection into the informal sector.

We illustrate this identifying assumption with an example. Suppose that workers choose between formal and informal jobs depending on some unobserved factors, such as their level of risk aversion. For instance, more risk-averse workers might be more likely to prefer employment in the formal sector. Our difference-in-differences estimates remain unbiased if differences in risk aversion between formal and informal workers remain similar before and after the crisis. To check whether our findings are due to changes that occurred after the crisis in the composition of the immigrant population with respect to their risk aversion, in Table 4 we show that results remain similar when control variables are added sequentially. We include observables such as gender, age, and education, which are important correlates of the level of risk aversion, as previous literature shows (see for instance Barsky et al. (1997), Guiso and Paiella (2008), and Borghans et al. (2009)). Estimates of the coefficient at the interaction term $Informal_i$ $Crisis_t$ are remarkably similar across all specifications.

The table also reports a test in the spirit of Altonji et al. (2005).[25] After estimating the equation using a restricted set of control variables—as in columns 1–5, where we choose to exclude observed variables that are good predictors of the unobserved risk aversion—denote the estimated coefficient of interest (i.e. the coefficient at the interaction term) as $\beta_r$. The value of the test is then calculated as the absolute value of $\beta_f/(\beta_r - \beta_f)$, where $\beta_f$ is the coefficient at the interaction term in column 6 of Table 4, that is the estimation that includes the full set of covariates. The median value of the test is 12: considering that age, gender, and education are variables that are highly correlated with risk aversion—as previous literature shows—selection on unobserved risk aversion would have to be at least 12 times greater than selection on observables to attribute the entire difference-in-differences estimates to selection effects. This check provides some indirect confirmation that the $Crisis_t$ dummy is orthogonal to the individuals' risk aversion, that is that the composition of formal and informal workers with respect to risk aversion remained very similar before and after the crisis, which is an important identifying assumption in our regressions.

Another potential source of selection is the effect of the Great Recession on return migration. It is worth stressing that this effect would only strengthen our results. By definition, immigrants are the most mobile category of workers. If during the crisis the least successful informal workers are more likely to go back to their home country, the coefficient at the interaction term in equation (1) would *underestimate* the true magnitude of the wage reduction for informal workers.

To check whether this may represent an issue in our context, in Table A8 (Supplementary Appendix) in the Appendix we run regressions similar to our main specification, except that we use the information we have on the immigrants' intentions to return to their origin country. More

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25. See Bellows and Miguel (2009) and Nunn and Wantchekon (2011) for a similar use of the test to assess the bias from unobservables using selection on observables.

Table 4. Wage Differential Between Formal (Regulated) and Informal (Unregulated) Sector: Difference-in-Differences Estimation. Regressions with Gradual Inclusion of Control Variables. Altonji et al.'s (2005) test

|  | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Crisis X Informal | −0.081** | −0.085*** | −0.088*** | −0.077** | −0.088*** | −0.093*** |
|  | (0.033) | (0.030) | (0.033) | (0.033) | (0.030) | (0.028) |
| Informal | −0.21*** | −0.20*** | −0.18*** | −0.20*** | −0.18*** | −0.15*** |
|  | (0.016) | (0.016) | (0.016) | (0.016) | (0.015) | (0.018) |
| Female |  | yes |  |  | yes | yes |
| Age |  |  | yes |  | yes | yes |
| Age squared |  |  | yes |  | yes | yes |
| Years in Italy |  |  |  |  |  | yes |
| Compulsory school |  |  |  | yes | yes | yes |
| High school |  |  |  | yes | yes | yes |
| Tertiary education |  |  |  | yes | yes | yes |
| Married |  |  |  |  |  | yes |
| Children abroad |  |  |  |  |  | yes |
| Children in Italy |  |  |  |  |  | yes |
| Altonji test | 7.75 | 11.63 | 18.60 | 5.81 | 18.60 |  |
| Observations | 49193 | 49193 | 49193 | 49193 | 49193 | 49193 |
| $R^2$ | 0.282 | 0.306 | 0.302 | 0.285 | 0.327 | 0.344 |

*Notes*: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy. All regressions include year dummies, occupation dummies, dummies for country of origin, province dummies.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.
Data are from the ISMU survey (2001–13). We restrict the sample to immigrants with permanence in Italy equal to or less than 30 years. The sample includes full-time workers only. The dependent variable is the logarithm of after-tax wage. In columns 1–5, we exclude observed variables that are good predictors of the unobserved risk aversion. We denote the estimated coefficient of interest (i.e. the coefficient at the interaction term) in these specifications as $\beta_r$. The value of the Altonji et al.'s (2005) test is then calculated as the absolute value of $\beta_f / (\beta_r - \beta_f)$, where $\beta_f$ is the coefficient at the interaction term in column 6, that is from the estimation that includes the full set of covariates. Whenever covariates are included, we also include their interaction with the "Crisis" dummy.

precisely, the dependent variable in these regressions is a dummy equal to 1 if the immigrant intends to return to her home country. This question is only available in the 2010, 2011, 2012, and 2013 waves of our survey. Therefore we focus on the coefficient at the Informal$_i$ variable, and we cannot add the interaction term Informal$_i$ Crisis$_t$ variable. Given that long stay in the host country is likely to affect intentions to return (see Yang (2006) and Dustmann and Görlach (2016)), we investigate whether results from this check differ depending on the length of stay in Italy: in column 1 of Table A8 in Supplementary Appendix there is no restriction on residence in the host country, column 2 includes individuals whose

permanence in Italy is equal to or less than 30 years (as in our benchmark specification), 25 years in column 3, 20 years in column 4, and 15 years in column 5. In all specifications, the coefficient of interest is not statistically significant. This finding suggests that selection into return migration does not represent an issue in our context.

Selection may also occur if during the crisis people with low ability – which is another unobserved characteristic – switch from the formal to the informal market. This composition effect could influence the wage dynamics of Figure 1 during the recession, by artificially increasing average wages of formal workers. This is a potential problem because of the repeated cross-sectional nature of the ISMU data. To check whether the composition effect represents an issue, in Figure A2 in Supplementary Appendix we exploit the panel dimension of the SHIW dataset of the Bank of Italy. Although the latter dataset allows us to control for unobserved heterogeneity, it does not contain information on the informality status. In addition to the other time-varying controls, in Figure A2 in Supplementary Appendix we condition on individual fixed effects. The wage adjustment during the crisis is relatively similar to the one we have in Figure 1 and Figure A1 in Supplementary Appendix, which suggests that the pattern of average wages after the negative demand shock is not due to selection-into-irregular-status due to unobserved ability. Moreover, Figure A2 in Supplementary Appendix shows a lower degree of upward flexibility of wages before the recession starts.

To further explore whether the composition of migrants changed as a result of the crisis, in Figure A3 in Supplementary Appendix we present the evolution over time of key average characteristics (age, gender, and education, see as well Table 4), for informal and formal workers. The figure shows no relevant change in the composition of migrants after the crisis starts. In addition, we perform a difference-in-differences model where the individual characteristics of the workers are used as dependent variables. Results presented in Table A9 in Supplementary Appendix show that the crisis did not affect the composition of workers in the informal sector, confirming the robustness of our main findings.

## 6.5 Robustness Checks

In our benchmark specifications, we restrict the estimation sample to immigrants whose length of stay in Italy does not exceed 30 years. This choice is motivated by Figure A4 in Supplementary Appendix, which shows that the distribution of permanence in Italy is more skewed toward the left for informal workers. This restriction aims at ensuring common support for the distributions of formal and informal workers. In columns 1–4 of Table 5 we show that our results remain very similar when we do not consider any restriction on length of stay in Italy (column 1) or when we consider different maximum permanence durations: 25 years (column 2), 20 years (column 3), and 15 years (column 4). Results are comparable

Table 5. Wage Differential Between Formal (Regulated) and Informal (Unregulated) Sector: Difference-in-Differences Estimation. Robustness Checks

| | (1) No restriction years in Italy | (2) Years in Italy 25 | (3) Years in Italy 20 | (4) Years in Italy 15 | (5) 2001–13 except 2002 | (6) 2001–13 except 2005 | (7) 2006–13 | (8) Unemployment rate |
|---|---|---|---|---|---|---|---|---|
| Crisis X Informal | −0.115*** | −0.116*** | −0.113*** | −0.105*** | −0.115*** | −0.118*** | −0.113*** | −0.182*** |
| | (0.034) | (0.035) | (0.036) | (0.037) | (0.035) | (0.035) | (0.039) | (0.017) |
| Informal | −0.164*** | −0.144*** | −0.143*** | −0.139*** | −0.147*** | −0.144*** | −0.139*** | −0.027** |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.019) | (0.017) | (0.024) | (0.017) |
| Informal X Unemployment rate | | | | | | | | −0.027** |
| | | | | | | | | (0.012) |
| Unemployment rate | | | | | | | | 0.010 |
| | | | | | | | | (0.006) |
| Observations | 49,285 | 48,918 | 47,838 | 44,129 | 45,098 | 45,452 | 29,977 | 35,793 |
| $R^2$ | 0.323 | 0.332 | 0.328 | 0.324 | 0.332 | 0.335 | 0.317 | 0.317 |

*Notes:* Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy. All regressions include individual characteristics (gender, age, age squared, years in Italy, education, marital status, number of children), year dummies, occupation dummies, dummies for country of origin, province dummies.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.
Data are from the ISMU survey (2001–13). We restrict the sample to immigrants residing in Italy for at most 30 years (unless otherwise specified in columns 1–4). The sample includes full-time workers only. The unemployment rate varies by province and year, and is computed as deviation from the mean value (4.59848). The dependent variable is the logarithm of after-tax wage.

across all specifications and provide additional confirmation that our findings are not driven by selection into return migration.

In columns 5–7 we present additional checks. We estimate a specification similar to our benchmark, but we exclude year 2002 (column 5). This check is particularly meaningful because in 2002 there was a large immigrant regularization program that legalized about 700,000 immigrants residing in Italy without a regular residence permit. In column (6) we exclude year 2005, while in column (7) we consider an estimation sample from 2006 to 2013 (rather than from 2001 to 2013 as in the benchmark regressions). Results are very similar throughout all robustness checks.

In column 8, we have checked whether our findings are robust to the use of a continuous measure of crisis. Rather than considering the recession as a binary shock, we have estimated a specification similar to the one of column 1 of Table 1, but without including the $Informal_i$ $Crisis_t$ interaction term; instead, we have added the unemployment rate (which varies by province and year, and is computed as deviation from its mean value 4.598) and its interaction term with the $Informal_i$ dummy. The estimated coefficient of the latter interaction term suggests that one percentage point increase in the unemployment rate in the province of residence increases the wage differential between formal and informal sectors by 3 percentage points. At the mean value of province-level unemployment, the wage gap is 18%.

In Table A10 in the Supplementary Appendix, we measure the wage differential between formal and informal sector in each year by subsamples. Specifically, we distinguish between female and male (columns 1 and 2 respectively), unskilled and skilled workers (columns 3–4), young and old (columns 5–6). Results are overall robust to the different subsamples, although they shed additional light on the heterogeneous impact of the crisis on different segments of the workforce. Indeed, the negative and significant effect of the Great Recession on the wages of informal workers seems to have started few years later, around 2011–12, for women, unskilled, and older workers. Moreover, the magnitude of such effect is smaller for these subsamples.

A potential confounding factor of our findings is the possibility that immigrants who work in the informal sector have characteristics that expose them to greater cyclical risk regardless the level of wage protection they may have. For instance, Hoynes et al. (2012) find that, in the US context, demographic characteristics such as age, race, gender and education, predict people's experiences over the business cycle. To address this potential issue, in Table A11 in Supplementary Appendix we include as control variables interactions of key demographics, country of origin dummies, province of residence dummies, and occupation dummies with the crisis variable. All specifications of Table A11 in Supplementary Appendix show that our results are robust to this check.

## 7. Spillovers between Formal and Informal Sectors

In the analysis above we treated formal and informal sectors separately. However, it may well be the case that these two labor markets are at least partially integrated: some of the formal workers that lose their jobs due to macroeconomic shocks and downward wage stickiness may be able to reallocate to the informal sector. This would increase labor supply in the informal sector and result in further downward pressure on informal wages (in addition to the compression due to the demand shock).[26] In this section, we consider a parsimonious partial equilibrium model to illustrate these effects. We then carry out an empirical analysis of the changes in employment in the formal and informal sectors during the Great Recession. Finally, we use our model to reconcile the empirical findings and estimate the degree of integration between the two sectors.

### 7.1 Model

We consider two imperfectly integrated labor markets: formal $F$ and informal $I$. We assume that $\alpha$% of workers are perfectly mobile between the two sectors while the remaining $(1 - \alpha)$% cannot move across sectors. (If $\alpha = 0$, the two markets are perfectly segmented, if $\alpha = 1$ the markets are perfectly integrated.) We assume that the mobility shock is independent of all other parameters. The elasticities of labor supply and demand in formal and informal markets are $e_S^k$, $e_D^k$, $k = F, I$, respectively.[27]

Initially, both markets are in equilibrium, and employment in formal and informal sectors is $L^F$ and $L^I$, respectively. Then an aggregate demand shock shifts labor demand curves down in both formal and informal sectors (Figure 4). We assume that the shock is proportional so in both sectors the labor demand curves move down by $x$%. The wage in the formal sector is downward sticky so the following number of workers are displaced:[28]

$$\Delta L^F = x e_D^F L^F. \tag{2}$$

Given the imperfect integration of formal and informal markets, $\alpha \Delta L^F$ displaced workers move to the informal sector while the others are unemployed or leave the labor force.

Let us now consider the informal labor market. This market experiences a decrease in demand (the labor demand curve shifts by $x$% down) and an

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26. Another potential source of spillovers is linked to the fact that recessions may induce workers to move to lower paying occupations, such as agriculture (Lessem and Nakajima 2015). In order to reject this hypothesis, we rerun our benchmark specification (Table 1) without occupation dummies. Table A12 in Supplementary Appendix shows that the coefficient at the interaction term between the informality dummy and the crisis variable is remarkably similar to the one in Table 1 in all specifications.

27. The microfoundations for labor demand and labor supply are provided in Appendix B. See also Boeri and Garibaldi (2005) for a fully-specified matching model with heterogenous workers and their sorting into formal and informal employment.

28. In what follows, we assume that changes are small and that elasticities are constant in the neighborhood of the equilibrium.
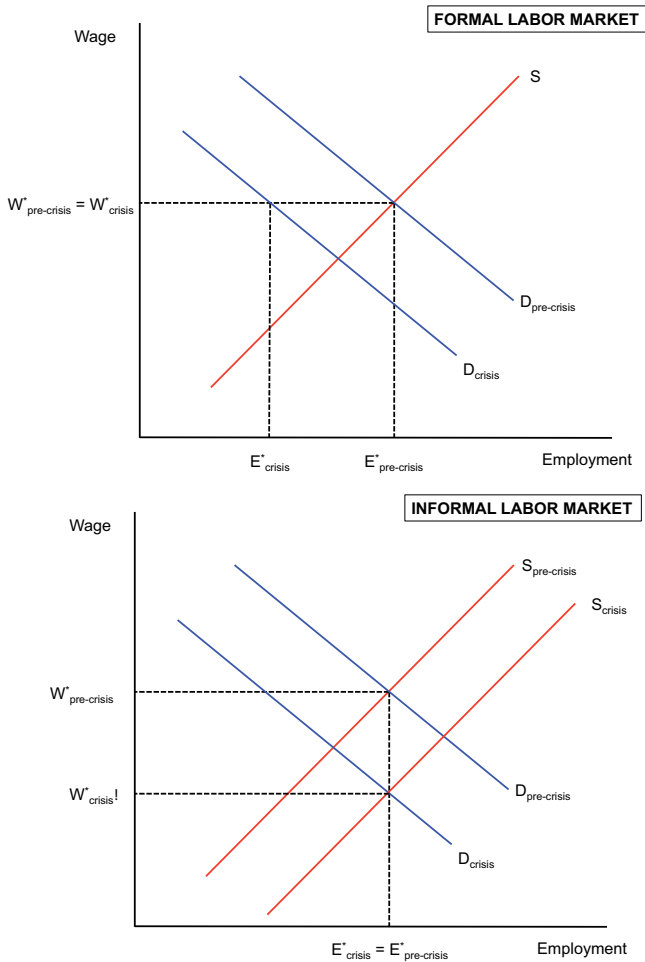
Figure 4. Adjustments in the Formal and Informal Labor Markets. Labor supply and demand graphs for the formal market (left) and the informal market (right). We assume that both markets experience a negative labor demand shock. As the wage in the formal market is rigid, this results in underemployment of workers in the formal market, some of whom move to the informal labor market therefore shifting the informal labor supply curve rightwards.

increase in labor supply (labor supply curve moves rightwards by $\alpha \Delta L^F$ workers). Both of these shocks drive wages down. The overall reduction in wages of the informal sector is:

$$\frac{\Delta w^I}{w^I} = \frac{x e_D^I}{e_D^I + e_S^I} + \frac{\alpha L^F}{L^I} \frac{x e_D^F}{e_D^I + e_S^I}. \tag{3}$$

The first term is the reduction in wage due to the decrease in labor demand (driven by the macroeconomic shock), whereas the second one

is due to the increase in labor supply (the reallocation of workers from the formal sector).

The change in employment in the informal sector is as follows:

$$\frac{\Delta L^I}{L^I} = -x\frac{e_D^I e_S^I}{e_D^I + e_S^I} + x\frac{\alpha L^F}{L^I}\frac{e_D^F}{e_D^I(e_D^I + e_S^I)}. \tag{4}$$

The first term is the reduction of employment due to the decrease in demand for labor, whereas the second term is the increase in employment due to the increase in labor supply.

## 7.2 Employment in Formal and Informal Sector: Empirical Facts

In this subsection, we analyze the changes in employment in the formal and the informal sectors after the crisis.[29] Table A13 in the Supplementary Appendix presents the regressions where the dependent variables are employment in the formal sector and in the informal sector, conditional and not conditional on labor force participation; we also analyze the change in the share of the informal employment conditional on employment (column 5). We show that employment in the formal sector after the crisis declines by 9 percentage points (7 percentage points if conditional on labor force participation). There is no change in the informal employment (unconditional or conditional on labor force participation).

In the Tables A14, A15, and A16 in Supplementary Appendix and Figure 5 we take a more granular look at the evolution of the formal and informal employment controlling for year dummies and splitting the sample by gender. In all specifications, the coefficients of the year dummies are never significantly different from zero before the beginning of the recession (year 2008 is the omitted category). The situation changes after the crisis. The employment rate in the formal sector decreases by 3% in 2009, 4% in 2010, 12% in 2011, 15% in 2012, and 16% in 2013 (relative to 2008).[30] There is no significant change in the informal employment.

The decline in formal employment is larger for men than for women. Female employment rates in the formal sector start decreasing significantly in 2011 with a maximum reduction of 12% in 2012, whereas male employment is hit already in 2010 and reaches a reduction of 20% in 2013. Importantly, in the informal sector the crisis increases men's employment

29. To be consistent with the other estimates in the article, Tables A13–A16 in Supplementary Appendix consider full-time employment only. In unreported regressions, we have checked the robustness of our results to the inclusion in the estimation sample of workers employed in part-time jobs as well. Part-time employment can be considered as a shock absorber during crisis. Results from this check are qualitatively similar to those presented in Tables A13–A16 (Supplementary Appendix).

30. Unemployment benefits and learning about job opportunities in the informal market may explain the gradual decline in employment in the formal market at the beginning of the crisis (see panel A of Figure 5). See Kolsrud et al. (2018) for an analysis of the dynamic features of unemployment insurance.
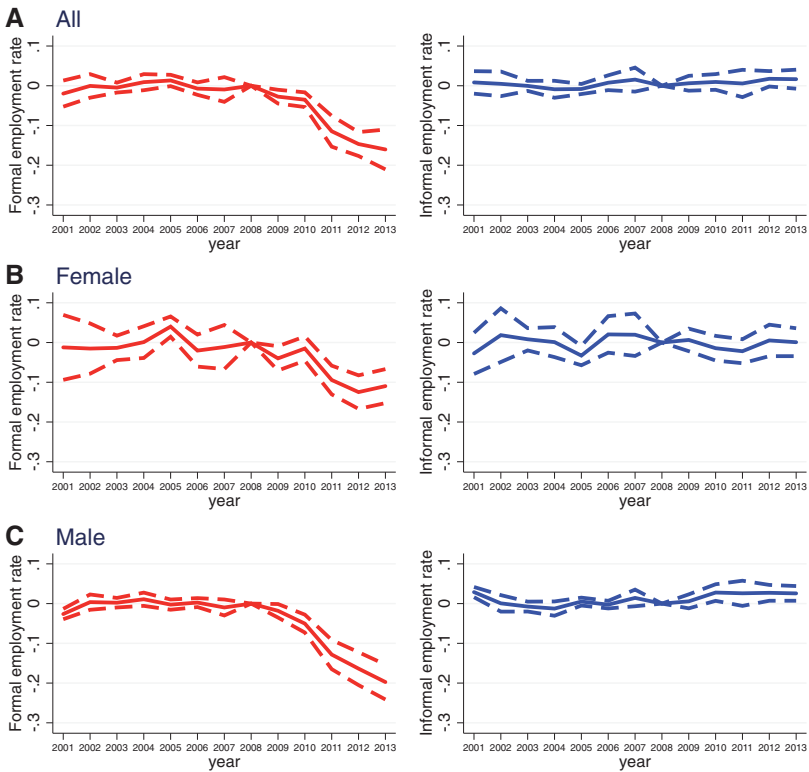
Figure 5. Employment in Formal and Informal Markets, by Gender. Employment rate (relative to 2008) controlling for gender (in panel A), age, education, country of origin, family characteristics, occupation dummies, provinces of residence dummies. Left-hand side: formal sector. Right-hand side: informal sector. Dashed lines: 95% confidence interval.
*Source*: ISMU survey, authors' calculations, see Tables A14, A15, and A16 in the Supplementary Appendix.

(by 3 percentage points only) while there is no significant effect on female rates.

## 7.3 Discussion and Counterfactual Analysis

Our empirical results imply three stylized facts about the formal and informal labor markets in Italy during the Great Recession. First, in the formal sector wages do not change while employment declines. Second, in the informal sector wages decline while employment does not change. Third, the percentage change in employment in the formal sector is roughly equal to the percentage change of the wage in the informal sector.[31]

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31. More specifically, formal employment falls by 16% between 2008 and 2013 (see column 1 of Table A14 in Supplementary Appendix) and informal wages drop by 17% during the same period (see column 2 of Table 1).

These facts directly give rise to two important results. On the one hand, the informal labor market is flexible—otherwise informal wages would have not declined. On the other hand, as long as the informal labor supply is elastic, the formal and informal markets are at least partially integrated; if they were perfectly segmented, employment in the informal market would have declined—while we observe no change or even an increase in the informal employment.

Our simple model in subsection 7.1 reconciles the stylized facts from our empirical findings in both qualitative and quantitative terms. First, consider the fact that the employment in the informal sector does not change. By setting the right-hand side in (4) to zero, we find $\frac{e_D^I e_S^I}{e_D^I + e_S^I} = \frac{\alpha L^F}{L^I} \frac{e_D^F}{e_D^I(e_D^I + e_S^I)}$ or

$$\frac{\alpha L^F}{L^I} = \frac{e_D^I e_S^I}{e_D^F / e_D^I}. \tag{5}$$

The second empirical observation is that the percentage change in the informal wage is roughly equal to the percentage change in the formal employment. Using equations (2) and (3), we find:

$$e_D^F = \frac{e_D^I + e_D^F \frac{\alpha L^F}{L^I}}{e_D^I + e_S^I}. \tag{6}$$

Equations (5) and (6) imply that:

$$\alpha = \frac{L^I}{L^F} \frac{e_D^I e_S^I(e_D^I + e_S^I)}{e_D^I e_S^I + 1} \tag{7}$$

$$e_D^F = \frac{e_D^I(e_D^I e_S^I + 1)}{e_D^I + e_S^I}. \tag{8}$$

Thus if we know the elasticities of demand and supply, we can estimate the degree of integration of the formal and informal labor markets.

We will assume that the elasticity of demand in the formal sector $e_D^F$ is close to 1 (the exact point estimate from Navaretti et al. (2003) is 0.96 but the confidence interval includes 1). Equation (8) then implies $e_D^I = 1$ as well.

The survey of Bargain et al. (2014) shows that the labor supply elasticity in Italy is in the range of 0.1–0.65. Taking $L^I = 0.15 L^F$ from the data,[32] and elasticity of supply equal to 0.1, we obtain $\alpha = 0.015$. If the elasticity of supply is equal to 0.65, then $\alpha = 0.097$. In both cases, only a very small share of displaced formal workers move from the formal to the informal sector.[33]

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32. In our estimation sample, the share of workers in the informal market is 15%.

33. If we assume that the informal labor supply is perfectly inelastic, $e_S^I = 0$, then our empirical findings are consistent with the setting where formal and informal labor markets are perfectly separated $\alpha = 0$. For this to be the case, the elasticity of the formal labor market

These results allow us predicting the reaction of formal labor markets to the labor demand shock in a counterfactual scenario should the formal wages be fully flexible. It turns out that in such a scenario the decline of labor demand would be mostly accommodated through drop in wages while the decrease in employment would be much smaller than in the actual data. Indeed, let us once again assume that the elasticity of demand is 1 and the elasticity of supply is 0.1. Then in the counterfactual scenario the formal wages would fall by $\frac{xe_D^F}{e_D^F + e_S^F}$%. Using the data from the informal sector, we find that if formal wages were flexible, they would have fallen by 15.5% between 2008 and 2013. On the other hand, the percentage change in the formal employment is $\frac{xe_D^F e_S^F}{e_D^F + e_S^F}$, hence 11 times smaller than the actual observed change ($\frac{e_S^F}{e_D^F + e_S^F} = \frac{0.1}{1+0.1} = \frac{1}{11}$). Instead of falling by 16% between 2008 and 2013, formal employment would have declined only by 1.5%. If we assume that elasticity of labor supply is 0.65 then the change in formal employment would be 4.5%—still much lower than the 16% that we observe in the data (Table A14 in Supplementary Appendix).

## 8. Conclusions

In this article, we study the process of wage adjustment in formal and informal labor markets for immigrants in Italy. We show that despite substantial growth of unemployment in 2009–13, wages in the regulated formal labor market have not adjusted. At the same time, wages in the unregulated informal labor market have declined dramatically. The wage differential between formal and informal markets, which has been relatively constant at 15% throughout 2001–08, has grown rapidly after 2009 and reached 32% in 2013. We show that the wage adjustment in the informal sector takes place along with a shift from formal to informal employment. These results are consistent with the view that regulation is responsible for the lack of wage adjustment and for the increase in unemployment during recessions.

Using estimates of elasticities of labor demand and labor supply from the existing literature, we calibrate a simple model of spillovers between formal and informal labor markets. Our calibration implies that such spillovers are not trivial but small: only 1.5–9.7% of workers who lost a formal job move to the informal sector. Our model also allows estimating the potential change in formal employment in the counterfactual scenario where formal wages were fully flexible. We find that in this case the crisis would have resulted in 1.5–4.5% decline in formal employment—much less substantial than the 16% we actually observe in the data.

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demand must be equal to one, $e_D^F = 1$ (which is in line with Navaretti et al. (2003)); there are no constraints on the elasticity of demand in the informal sector $e_D^I$.

To verify the validity of our empirical strategy, we run several placebo tests, check for time-varying selection on unobservables, analyze migrants' intentions to return to their home countries, use panel data from alternative sources to explore changes in composition, show the evolution over time of average characteristics before and during the crisis, and control for selection into occupations. All these checks provide support to the validity of our empirical strategy and are consistent with the results from the calibration exercise showing that spillovers between formal and informal labor markets are small.

Our results are based on data on immigrants rather than the general labor force, and therefore one should be careful in drawing general conclusions about regulated labor markets. We find that our results are more pronounced for individuals in simple occupations. These are the occupations with relatively easy substitutability between immigrants and natives, and allow us to speculate that our findings can be generalized for low-skilled natives as well. There is however research showing that the effects of a recession on labor market outcomes of immigrants may differ from those on natives (Dustmann et al. 2010). A possible reason why immigrants and natives differ during crisis is that foreign workers' bargaining power with their employers might change during the recession, if being employed is a condition required to extend the residence permit.

Although the external validity and generalization of our findings should then be taken with caution, we believe that the analysis on foreign workers is interesting *per se*, as labor market outcomes are a good proxy of economic integration at destination. Our estimates show how recessions in highly regulated labor markets decrease immigrants' employment in the formal sector and generate a shift from formal to informal employment, with potential implications for public finance, behavior of remittances, and immigrant regularization programs. The link between labor market regulation in host countries and the effectiveness of immigration policies is a novel contribution to the literature on the economics of migration.

Although we do find that in unregulated labor markets wages adjust down during the recession, the 2009–13 period does not provide an exhaustive answer with regard to the speed and nature of this adjustment. In fact, our data show that wages in the informal sector continue to fall throughout the period. We cannot yet judge whether this continuing decrease in wages is the delayed response to the initial one-off shock or every subsequent decrease is a reaction to the next round of aggregate demand decline. In order to address this important question, we would need to collect data on both formal and informal labor markets for several years after the economy starts to recover.

## Supplementary material

Supplementary material is available at *Journal of Law, Economics, & Organization* online.

# References

Accetturo, A. and L. Infante, 2010. "Immigrant Earnings in the Italian Labor Market," 69 *Giornale degli Economisti e Annali di Economia* 1–27.

Allegretto, S.A., A. Dube and M. Reich. 2011. "Do Minimum Wages Really Reduce Teen Employment? Accounting for Heterogeneity and Selectivity in State Panel Data," 50 *Industrial Relations: A Journal of Economy and Society* 205–40.

Almeida, R. and P. Carneiro. 2012. "Enforcement of Labor Regulation and Informality," 4 *American Economic Journal: Applied Economics* 64–89.

Altonji, J.G., T.E. Elder and C.R. Taber. 2005. "Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools," 113 *Journal of Political Economy* 151–84.

Amuedo-Dorantes, C., C. Bansak and S. Raphael. 2007. "Gender Differences in the Labor Market: Impact of Irca," 97 *American Economic Review* 412–16.

Ashenfelter, O. 1978. "Estimating the Effect of Training Programs on Earnings," 60 *The Review of Economics and Statistics* 47–57.

Autor, D.H. and S.N. Houseman. 2010. "Do Temporary-Help Jobs Improve Labor Market Outcomes for Low-Skilled Workers? Evidence from Work First," 2 *American Economic Journal: Applied Economics* 96–128.

Autor, D.H., F. Levy and R.J. Murnane. 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration," 118 *Quarterly Journal of Economics* 1279–333.

Bargain, O., K. Orsini and A. Peichl. 2014. "Comparing Labor Supply Elasticities in Europe and the United States: New Results," *Journal of Human Resources* 49, 723–838.

Barsky, R.B., F.T. Juster, M.S. Kimball and M.D. Shapiro. 1997. "Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study," *Quarterly Journal of Economics* 112, 537–79.

Bellows, J. and E. Miguel. 2009. "War and Local Collective Action in Sierra Leone," *Journal of Public Economics* 93, 1144–57.

Bentolila, S., P. Cahuc, J.J. Dolado and T. Le Barbanchon. 2012. "Two-Tier Labour Markets in the Great Recession: France Versus Spain," *The Economic Journal* 122, F155–87.

Bertrand, M., E. Duflo and S. Mullainathan. 2004. "How Much Should We Trust Differences-in-Differences Estimates?" *Quarterly Journal of Economics* 119, 249–75.

Besley, T. and R. Burgess. 2004. "Can Labor Regulation Hinder Economic Performance? Evidence from India," *Quarterly Journal of Economics* 119, 91–134.

Beyer, R.C. and F. Smets. 2015. "Labor Market Adjustments and Migration in Europe and the United States: How Different?" *Economic Policy* 30, 643–82.

Blanchard, O. J., L. F. Katz, R. E. Hall, and B. Eichengreen. 1992. "Regional Evolutions," *Brookings Papers on Economic Activity* 1, 1–75.

Boeri, T. 2011. "Institutional Reforms and Dualism in European Labor Markets," *Handbook of Labor Economics* 4b, 1173–236.

———. 2014. Two-tier bargaining. IZA Discussion Paper No. 8358.

Boeri, T. and P. Garibaldi. 2005. *Shadow Sorting, in NBER International Seminar on Macroeconomics 2005*, 125–63. Cambridge, MA: MIT Press.

Booth, A.L., M. Francesconi and J. Frank. 2002. "Temporary Jobs: Stepping Stones or Dead Ends?" *The Economic Journal* 112, 189–213.

Borghans, L., J.J. Heckman, B.H. Golsteyn and H. Meijers. 2009. "Gender Differences in Risk Aversion and Ambiguity Aversion," *Journal of the European Economic Association* 7, 649–58.

Borjas, G.J. 2003. "The Labor Demand Curve Is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market," *Quarterly Journal of Economics* 118, 1335–74.

Borjas, G.J. and M. Tienda. 1993. "The Employment and Wages of Legalized Immigrants," *International Migration Review* 27, 712–747.

Bosch, M. and J. Esteban-Pretel. 2015. "The Labor Market Effects of Introducing Unemployment Benefits in an Economy with High Informality," *European Economic Review* 75, 1–17.

Bosch, M. and W.F. Maloney. 2010. "Comparative Analysis of Labor Market Dynamics Using Markov Processes: An Application to Informality," *Labour Economics* 17, 621–31.

Botero, J.C., S. Djankov, R. La Porta, F. Lopez-de Silanes and A. Shleifer. 2004. "The Regulation of Labor," *Quarterly Journal of Economics* 119, 1339–82.

Cadena, B.C. and B.K. Kovak. 2016. "Immigrants Equilibrate Local Labor Markets: Evidence from the Great Recession," *American Economic Journal: Applied Economics* 8, 257–90.

Cameron, A.C., J.B. Gelbach and D.L. Miller. 2008. "Bootstrap-Based Improvements for Inference with Clustered Errors," *Review of Economics and Statistics* 90, 414–27.

Capasso, S. and T. Jappelli. 2013. "Financial Development and the Underground Economy," *Journal of Development Economics* 101, 167–78.

Cappariello, R. and R. Zizza. 2010. "Dropping the Books and Working off the Books," *Labour* 24, 139–62.

Cappellari, L., C. Dell'Aringa and M. Leonardi. 2012. "Temporary Employment, Job Flows and Productivity: A Tale of Two Reforms," *The Economic Journal* 122, 188–215.

Card, D. 1990. "The Impact of the Mariel Boatlift on the Miami Labor Market," *Industrial & Labor Relations Review* 43, 245–57.

Card, D., F. Devicienti and A. Maida. 2013. "Rent-Sharing, Holdup, and Wages: Evidence from Matched Panel Data," *Review of Economic Studies* 81, 84–111.

Card, D., F. Kramarz and T. Lemieux. 1999. "Changes in the Relative Structure of Wages and Employment: A Comparison of the United States, Canada, and France," *Canadian Journal of Economics* 32, 843–77.

Card, D. and A.B. Krueger. 1994. "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania," *American Economic Review* 84, 772.

Chiquiar, D. and G.H. Hanson. 2005. "International Migration, Self-Selection, and the Distribution of Wages: Evidence from Mexico and the United States," *Journal of Political Economy* 113, 239–81.

Cingano, F., M. Leonardi, J. Messina and G. Pica. 2016. "Employment Protection Legislation, Capital Investment and Access to Credit: Evidence from Italy," *Economic Journal* 126, 1798–822.

Cortes, P. 2008. "The Effect of Low-Skilled Immigration on Us Prices: Evidence from Cpi Data," *Journal of Political Economy* 116, 381–422.

D'Amuri, F. and G. Peri. 2014. "Immigration, Jobs, and Employment Protection: Evidence from Europe Before and During the Great Recession," *Journal of the European Economic Association* 12, 432–64.

Daruich, D., S. Di Addario and R. Saggio. 2017. The effects of partial employment protection reforms: Evidence from Italy. Mimeo, Princeton University.

Decressin, J. and A. Fatas. 1995. "Regional Labor Market Dynamics in Europe," *European Economic Review* 39, 1627–55.

Devicienti, F., B. Fanfani and A. Maida 2016. "Collective Bargaining and the Evolution of Wage Inequality in Italy." IZA Discussion Paper No. 10293.

DiNardo, J., N.M. Fortin and T. Lemieux. 1996. "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach," *Econometrica* 64, 1001–44.

Docquier, F., Ç. Ozden and G. Peri. 2014. "The Labour Market Effects of Immigration and Emigration in OECD Countries," *The Economic Journal* 124, 1106–45.

Donald, S.G. and K. Lang. 2007. "Inference with Difference-in-Differences and Other Panel Data," *The Review of Economics and Statistics* 89, 221–33.

Dube, A., T.W. Lester and M. Reich. 2010. "Minimum Wage Effects across State Borders: Estimates Using Contiguous Counties," *The Review of Economics and Statistics* 92, 945–64.

Dustmann, C., F. Fasani and, B. Speciale. 2017a. "Illegal Migration and Consumption Behavior of Immigrant Households," *Journal of the European Economic Association* 15, 654–91.

Dustmann, C., T. Frattini and I.P. Preston. 2013. "The Effect of Immigration Along the Distribution of Wages," *The Review of Economic Studies* 80, 145–73.

Dustmann, C., A. Glitz and T. Vogel. 2010. "Employment, Wages, and the Economic Cycle: Differences between Immigrants and Natives," *European Economic Review* 54, 1–17.

Dustmann, C. and J.S. Görlach. 2016. "The Economics of Temporary Migrations," *Journal of Economic Literature* 54, 98–136.

Dustmann, C., U. Schönberg and J. Stuhler. 2017b. "Labor Supply Shocks, Native Wages, and the Adjustment of Local Employment," *Quarterly Journal of Economics* 132, 435–83.

Elsby, M.W., B. Hobijn and A. Şahin. 2010. "The Labor Market in the Great Recession," *Brookings Papers on Economic Activity* 1–48.

Elsby, M.W., D. Shin and, G. Solon. 2016. "Wage Adjustment in the Great Recession and Other Downturns: Evidence from the United States and Great Britain," *Journal of Labor Economics* 34, S249–91.

Facchini, G., A.M. Mayda and M. Mendola. 2013. South-South Migration and the Labor Market: Evidence from South Africa. CEPR Discussion Paper 9450.

Farré, L., L. González and F. Ortega. 2011. "Immigration, Family Responsibilities and the Labor Supply of Skilled Native Women," *The BE Journal of Economic Analysis & Policy* 11, 1–46.

Fasani, F. 2015. "Understanding the Role of Immigrants Legal Status: Evidence from Policy Experiments," *CESifo Economic Studies* 61, 722–63.

Foged, M. and G. Peri. 2016. "Immigrants' Effect on Native Workers: New Analysis on Longitudinal Data," *American Economic Journal: Applied Economics* 8, 1–34.

Fougère, D., , E. Gautier and S. Roux. 2016. The Impact of the National Minimum Wage on Industry-Level Wage Bargaining in France. CEPR Discussion Paper No. 11234.

Glitz, A., 2012. "The Labor Market Impact of Immigration: A Quasi-Experiment Exploiting Immigrant Location Rules in Germany," *Journal of Labor Economics* 30, 175–213.

Goos, M., A. Manning and A. Salomons. 2009. "Job Polarization in Europe," *American Economic Review* 99, 58–63.

———. 2014. "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring," *American Economic Review* 104, 2509–26.

Guiso, L. and M. Paiella. 2008. "Risk Aversion, Wealth, and Background Risk," *Journal of the European Economic Association* 6, 1109–50.

Hoffmann, F. and T. Lemieux. 2016. "Unemployment in the Great Recession: A Comparison of Germany, Canada, and the United States," *Journal of Labor Economics* 34, S95–139.

Hoynes, H., D.L. Miller and J. Schaller. 2012. "Who Suffers during Recessions?" *Journal of Economic Perspectives* 26, 27–48.

Ichino, A., F. Mealli and T. Nannicini. 2008. "From Temporary Help Jobs to Permanent Employment: What Can We Learn from Matching Estimators and Their Sensitivity?" *Journal of Applied Econometrics* 23, 305–27.

Ichino, A. and R.T. Riphahn. 2005. "The Effect of Employment Protection on Worker Effort: Absenteeism During and After Probation," *Journal of the European Economic Association* 3, 120–43.

Kaushal, N. 2006. "Amnesty Programs and the Labor Market Outcomes of Undocumented Workers," *Journal of Human Resources* 41, 631–47.

Kolsrud, J., C. Landais, P. Nilsson and J. Spinnewijn. 2018. "The Optimal Timing of Unemployment Benefits: Theory and Evidence from Sweden*," American Economic Review* 108, 985–1033.

Kossoudji, S.A. and D.A. Cobb-Clark. 2002. "Coming out of the Shadows: Learning about Legal Status and Wages from the Legalized Population," *Journal of Labor Economics* 20, 598–628.

Kugler, A. and G. Pica. 2008. "Effects of Employment Protection on Worker and Job Flows: Evidence from the 1990 Italian Reform," *Labour Economics* 15, 78–95.

Leonardi, M. and G. Pica. 2013. "Who Pays for It? The Heterogeneous Wage Effects of Employment Protection Legislation," *The Economic Journal* 123, 1236–78.

Lessem, R. and K. Nakajima. 2015. Immigrant Wages and Recessions: Evidence from Undocumented Mexicans. Mimeo, Carnegie Mellon University.

Manacorda, M., A. Manning and J. Wadsworth. 2012. "The Impact of Immigration on the Structure of Male Wages: Theory and Evidence from Britain," *Journal of the European Economic Association* 10, 120–51.

Mastrobuoni, G. and P. Pinotti. 2015. "Legal Status and the Criminal Activity of Immigrants," *American Economic Journal: Applied Economics* 7, 175–206.

Mauro, P. and A. Spilimbergo. 1999. "How Do the Skilled and the Unskilled Respond to Regional Shocks? The Case of Spain," *IMF Staff Papers* 46, 1–17.

McKenzie, D.J. and J. Mistiaen 2009. "Surveying Migrant Households: A Comparison of Census-Based, Snowball and Intercept Point Surveys," *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 172, 339–60.

Meghir, C., R. Narita and J.M. Robin. 2015. "Wages and Informality in Developing Countries," *American Economic Review* 105, 1509–46.

Monras, J., J. Vázquez-Grenno and F. Elias Moreno. 2018. Understanding the Effects of Legalizing Undocumented Immigrants.

Navaretti, G.B., D. Checchi and A. Turrini. 2003. "Adjusting Labor Demand: Multinational versus National Firms: A Cross-European Analysis," *Journal of the European Economic Association* 1, 708–19.

Neumark, D. 2014. "Employment Effects of Minimum Wages," *IZA World of Labor* 6, 1–10.

Neumark, D., J.I. Salas and W. Wascher. 2014. "Revisiting the Minimum Wage–Employment Debate: Throwing out the Baby with the Bathwater?" *Industrial & Labor Relations Review* 67, 608–48.

Nickell, S. 1997. "Unemployment and Labor Market Rigidities: Europe Versus North America," *Journal of Economic Perspectives* 11, 55–74.

Nunn, N. and L. Wantchekon. 2011. "The Slave Trade and the Origins of Mistrust in Africa," *American Economic Review* 101, 3221–52.

OECD. 2008. A Profile of Immigrant Populations in the 21st Century: Data from OECD Countries. Paris: OECD.

Orrenius, P.M. and M. Zavodny. 2010. "Mexican Immigrant Employment Outcomes over the Business Cycle," *American Economic Review: Papers & Proceedings* 100, 316–20.

Orsi, R., D. Raggi and F. Turino. 2014. "Size, Trend, and Policy Implications of the Underground Economy," *Review of Economic Dynamics* 17, 417–36.

Ottaviano, G. and G. Peri. 2012. "Rethinking the Effect of Immigration on Wages," *Journal of the European Economic Association* 10, 152–97.

Peri, G. and C. Sparber. 2009. "Task Specialization, Immigration, and Wages," *American Economic Journal: Applied Economics* 1, 135–69.

Pinotti, P. 2017. "Clicking on Heaven's Door: The Effect of Immigrant Legalization on Crime," *American Economic Review* 107, 138–68.

Pischke, J.S. 2016. Wage Flexibility and Employment Fluctuations: Evidence from the Housing Sector. NBER Working Paper No. 22496.

Yang, D. 2006. "Why Do Migrants Return to Poor Countries? Evidence from Philippine Migrants' Responses to Exchange Rate Shocks," *The Review of Economics and Statistics* 88, 715–35.