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HOW DO REGULATED AND UNREGULATED LABOR MARKETS RESPOND TO SHOCKS? EVIDENCE FROM IMMIGRANTS DURING THE GREAT RECESSION

Sergei Guriev, Biagio Speciale and Michele Tuccio

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How do regulated and unregulated labor markets respond to shocks?
Evidence from immigrants during the Great Recession[*]

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July 2016

Abstract

We study wage adjustment during the recent crisis in regulated and unregulated labor markets in Italy. Using a unique dataset on immigrant workers, we show that before the crisis wages in the formal and informal sectors moved in parallel (with a 15 percent 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 percent. The difference was particularly salient for workers in "simple" occupations where there is high substitutability between immigrant and native workers. Calibrating a simple model of spillovers between formal and informal markets, we find that less than 10 percent 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 percent — much lower than 16 percent decline that we observe in the data.

JEL classification: E24; E26; J31; J61.

Keywords: Immigration, Labor market regulation, Wage rigidity, Great Recession.

1   Introduction

The Great Recession has brought a substantial increase in unemployment in Europe, with an average unemployment rate that has grown from 8 percent in 2008 to 12 percent 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 percent. At the same time, in Greece unemployment increased from 8 to 26 percent, in Spain from 8 to 24 percent, and in Italy from 6 to 13 percent.

Why have unemployment dynamics been so different in European countries? One of the most often cited explanation 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. Similar problems arise when comparing labor markets in different industries within the same country. In order to construct a convincing counterfactual for a regulated labor market, one would need to study a non-regulated labor market in the same sector within the same country. That is precisely the scope of this paper. 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 use a unique dataset that contains information on workers' informality status, 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 percent 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 percent 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 percent in 2008 to almost 9 percent 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 per cent 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 large to allow us comparing the evolution of wages in the formal and informal sectors controlling for household characteristics, occupation, skills and other individual

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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.

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 to 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, while wages in the informal sector decreased by about 20 percent 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.

Conventional wisdom relates the downward stickiness of wages to the minimum wage regulation. Unfortunately, it is impossible to carry out a randomized control trial to directly test this relationship, nor we are aware of natural experiments that exogenously change minimum wages in differential ways within the same industry and the same country. We thus construct sector-specific minimum wages using information from collective bargaining contracts at the industry level. We find that the effect in Figure 1 is similar in both occupations where the average wage is close to the minimum wage and in those where the average wage is far above the minimum wage. Therefore minimum wages do not seem to explain the downward stickiness of wages in the formal labor market.

We then test whether the effect is stronger in "simple" rather than "complex" occupations. The formers 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 while informal employment does not change. Since the aggregate demand shock affects both labor markets, this finding implies that upon losing a job in the formal sector at least some workers move to the informal sector. We calibrate a simple 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 percent rather than the

actual 16 percent).

Our paper contributes to several strands of research. First, we bring new evidence on the labor markets' reaction to recessions and the respective channels of adjustment. The seminal contribution by Blanchard & Katz (1992) studies the response of the US economy to regional shocks and points at inter-state 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, whilst the workers who cannot find jobs in the depressed states move out to other states. Decressin & Fatas (1995) carry out a similar analysis for European regions. They find that European workers are less mobile than their American counterparts, and adjustment mainly occurs through reduced labor force participation.

Mauro & 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.[2] Another study of the labor market adjustment during the Great Recession is Elsby et al. (2016), who analyze the experience of the US and the UK. They find that nominal wage rigidity played a role in the US during the Great Recession but not in the UK. Nevertheless, despite of different previous experiences, a recent contribution by Beyer & Smets (2015) suggests that declining interstate migration in the US 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 US and Europe.

We also contribute to a large literature using the difference-in-differences approach to analyze the impact of labor market institutions on employment. In particular, Card & Krueger (1994) compare the employment evolution in New Jersey after a 20 percent increase in the minimum wage with neighboring Pennsylvania (where the minimum wage did not change). The recent surveys of this literature by Neumark et al. (2014) and Neumark (2014) conclude that minimum wages do have a negative impact on employment.[3]

In addition, our paper brings new evidence on the recent literature on dual labor markets 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 percent in both France and Spain just before the Great Recession, but by 2011 it increased to 10 percent in France and 23 percent 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. The issue 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. Our paper 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.

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[2]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 & 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.

[3]In particular, Neumark et al. (2014) revisit the minimum wage-employment debate by evaluating the methodology of two recent studies that have shown no employment losses associated to minimum wage increases (Dube et al. (2010) and Allegretto et al. (2011)).

Meghir *et al.* (2015) develop a model with endogenous selection of firms and workers into the formal and informal sectors and calibrate it using Brazilian data. They show that on average firms in the formal sector are more productive and pay higher wages (which is consistent with our findings). Since we do not have data on informality at the firm level, we assume that the recession has a similar effect on the labor productivity in the formal and in the informal sector (controlling for industry and worker characteristics).

Since our data include only immigrants, a direct comparison of the effects of the recession on immigrant and native workers is not possible.[4] However, we use the insights from the literature on the impact of immigration on wages and employment of natives and on the evolution of labor market outcomes of immigrants versus natives through the business cycle. Orrenius & 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 & 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 US and the wages they earned there. They also show that undocumented Mexican immigrants' wages in the US are negatively correlated with the US unemployment rate — unlike the wages of the legal migrants and the wages of the natives, including those of 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. Cadena & 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.

Cortes (2008), Manacorda *et al.* (2012) and Ottaviano & Peri (2012) study the impact of immigration on the wages of natives and find that immigrant and native workers are imperfect substitutes. Using data on fifteen Western European countries during the 1996-2010 period, D'Amuri & Peri (2014) find that an inflow of immigrants generates a reallocation of natives to occupations with a stronger content of complex abilities. 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.

Our analysis complements the immigration literature by showing important implications of labor market regulation for the economic integration of immigrants. During periods of crisis, labor market regulation lowers immigrants' probability of formal employment by preventing downward wage adjustments. It also causes a switch from formal to informal employment, which implies lower labor income tax revenues. Remittance behavior may also change, because of a decrease in expected earnings. Since only documented immigrants can work in both the formal and informal sector, labor market regulation during

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[4]For instance, 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.

periods of crisis can also reduce the attractiveness of regularization programs, i.e. 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.

The rest of the paper is structured as follows. Section 2 presents background information on the Italian labor market. In Section 3 we discuss our empirical methodology. The data are introduced in Section 4. Section 5 presents the econometric results, robustness checks and placebo tests. Section 6 analyzes the spillover effects between formal and informal sectors. Section 7 concludes.

2 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. However, as Boeri (2014) documents, the percentage of firms relying on the two-tier bargaining decreased over time, down to less than 10 percent in 2006: employers in Italy typically prefer following the wages set by industry agreements, rather than through further negotiations at the plant level.

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.[5] 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.[6]

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 percent of the GDP (Orsi *et al.* (2014)). As Capasso & Jappelli (2013) describe, industries differ in terms of level of informality: measures of job informality are as high as 31 percent in the construction sector and 25 percent in the retail and tourism sectors and as low as 12 and 15 percent in finance and manufacturing, respectively. Capasso & Jappelli (2013) also document that informal labor markets are particularly well-developed in sectors with relatively low levels of competition and small firm sizes.

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[5]These indicators rank OECD members from countries with least restrictions to those with most restrictions.

[6]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 & Riphahn (2005), Kugler & Pica (2008), Cappellari *et al.* (2012), Leonardi & Pica (2013), and Cingano *et al.* (2016) 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 & Houseman (2010).

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 & 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.

3 Methodology

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

$$W_{iocpt} = \alpha Informal_i + \beta Crisis_t \, Informal_i + \gamma X_i + \delta_o + \delta_c + \delta_p + \delta_t + \varepsilon_{iocpt} \tag{1}$$

where W is the logarithm of after-tax 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 ($t = 2001, ..., 2013$).[7] We include dummy variables δ_o, δ_c, δ_p, and δ_t for occupations, countries of origin, provinces of residence and year fixed effects, respectively. Furthermore, control variables X_i include gender, age, age squared, years in Italy, education, dummy for being married, children abroad and children in Italy. We cluster the standard errors by province of residence, by simple/complex dummy and by before/after crisis dummy; we end up with 44 clusters (11 provinces times 2 types of occupations times 2 time periods).

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: $Crisis_t = \mathbf{1}(t \geqslant 2009)$.[8] 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 & Lang (2007), we carry out a two-stage procedure as well, where in the first

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[7]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 5 we show regressions where we use information on individuals who are employed on part-time basis.

[8]In section 5.1, 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 $Crisis_t = \mathbf{1}(t \geqslant 2008)$ (i.e., assuming that the crisis started a year before).

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 pre-crisis occupation-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 between occupations where the minimum wage is likely to be binding and those where wages are safely above the minimum wage. For each profession we calculate the average pre-crisis wage in 2007 and divide it by the occupation-specific minimum wage. We then rank occupations by the ratio of average wage to minimum wage and check whether results differ for professions above and below the median of this ratio. More precisely, we estimate a difference-in-difference-in-differences specification similar to equation (1), including three additional interaction terms: the interaction of high average wage to minimum wage dummy with crisis dummy $Crisis_t\,High\,avg.\,wage/min.\,wage_o$, the interaction of high average wage to minimum wage dummy with informal employment dummy $Informal_i\,High\,avg.\,wage/min.\,wage_o$, and the triple interaction $Crisis_t\,Informal_i\,High\,avg.\,wage/min.\,wage_o$. 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 for $Crisis_t\,Informal_i\,High\,avg.\,wage/min.\,wage_o$, i.e. 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, i.e. a negative sign of the coefficient at the triple interaction term $Crisis_t\,Informal_i\,Simple\,occupations_o$.

We also use 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.

4 Data

Our main database comes from the annual survey of immigrants undertaken by an independent Italian non-profit 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.[9] 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), while 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 immigrant population residing in Lombardy.[10]

Table A1 in the 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.[11] Approximately 6 percent of legal immigrants work in the informal sector. The informal sector accounts for around 12 percent of the overall (documented and undocumented) foreign-born workforce.

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 the following three categories: regular part-time workers, irregular workers in unstable employment, and subaltern employment (e.g. collaborations). According to this definition, there are about 4,000 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 Appendix. Table A3 in the Appendix presents the breakdown of the sample by occupations, as well as formal and informal employment for each occupation. The table also includes average wages in the formal and informal sector and the minimum wage for each occupation.[12]

There is no national minimum wage in Italy (even though Article 36 of the Constitution states that

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[9]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.

[10]See Fasani (2015) and Dustmann *et al.* (2016) for a more detailed description of these data. Mastrobuoni & Pinotti (2015) also use data from the ISMU survey.

[11]Throughout the paper 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.

[12]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. We restrict the sample to Lombardy only and to the period 2000-2012, so that descriptives are comparable with the ISMU data. Table A4 in the 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). Moreover, Figure A1 suggests that, after controlling for observables, wages in ISMU and in SHIW moved in parallel in 2000-2012, and their difference was statistically different from zero until 2004.

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 contracts impose minimum salaries for employees at different skill levels in numerous economic activities, covering both unionized and non-unionized workers (Manacorda (2004)). 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 Appendix). To our knowledge, there has been no previous study attempting to collect so many collective bargaining agreements and compute occupation-wide minimum wages for Italy.

In order to time the beginning of the recession, we use official macroeconomic data on Lombardy and its eleven provinces.[13] Figure 2 plots quarterly data on unemployment rate in Lombardy at regional level for the period considered in the regression analysis (2001-2013). 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). While 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 & Sparber (2009) and D'Amuri & 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 & 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 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", whilst high levels of manual skill intensity refer to "simple" jobs. Finally, we compute the median value for the index and distinguish between simple and complex occupations (i.e. jobs whose values are above the median are considered simple, and vice versa).

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[13]The province of Monza e della Brianza was officially created by splitting the north-eastern 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.

5 Results

5.1 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 two columns of Table 1 we use data from 2001 to 2007. The placebo treatment variable *Placebo* is equal to 1 for the year 2007 in column 1 and for the years 2006 and 2007 in column 2. In the last three columns of Table 1 we use data from 2001 to 2008. The *Placebo* variable is equal to 1 for the year 2008 in column 3, for the years 2007 and 2008 in column 4, and for the years 2006, 2007 and 2008 in column 5. 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 1 also show the absence of an "Ashenfelter's dip" (see Ashenfelter (1978)): the wage differential does not change just prior to the crisis.

5.2 Main results

Our main results are presented in Table 2. 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 percent before 2009, while it raises by 12 percentage points to 27 percent 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 piecewise-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 2 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.

Controls are statistically significant, and the coefficients have the expected sign. Other things being equal, women earn 17 percent less than men. The effect of age is non-linear: an additional year increases earnings by 1 percent at the age of 18 but has negative effect after the age of 43; at the age of 55, an additional year of age decreases earnings by about 0.5 percent. Each year spent in Italy raises wages by 1.1 percent. Completion of compulsory school increases wages by 2.2 percent (relative to no schooling), higher education — by another 5 percent. 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 percent higher than those of other workers.

Table 3 reports the results of our two-stage procedure described in Section 3 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 percent; after the crisis it increases by additional 12-15 percentage points.

5.3 Heterogeneity of treatment

As discussed in Section 3, 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 between occupations in which average wage in the formal sector is close to the occupation-specific minimum wage and occupations where average wage is substantially higher than the minimum wage. For each of the 18 occupations we calculate the average pre-crisis wage in 2007 (in the formal sector only) and divide it by minimum wage. Estimates in column 3 of Panel A of Table 4 show that our findings do not differ according to whether this ratio is below or above the median (the coefficient at the interaction term $Crisis_t$ $Informal_i$ $High\ avg.wage/min.wage_o$ is not statistically different from zero). Therefore the minimum wage is not an important driver of our results. This finding is confirmed by the first two columns of Panel A where we estimate our baseline specification for the subsample with high average-to-minimum wage ratios and for the subsample with low average-to-minimum wage ratios; the coefficient at the *Crisis*Informal* interaction term is the same in the two regressions.

We also assess whether there exists a differential impact for individuals working in occupation highly prone to informality. Specifically, we calculate the median value of the amount of informal workers in the economy and distinguish occupations between those below and above the median.[14] Results in columns

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[14]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 likely to be more tightly regulated. However, lack

4-6 of Panel A are strikingly homogeneous, with a wage gap for informal workers during the crisis of about 10-12 percent.

We then rank occupations according to complexity. As discussed in Section 4, we refer to occupations with high intensity of communications skills and low intensity of manual skills as "complex" and the others as "simple".[15] We again run two checks: the regressions for subsamples of simple and complex occupations (columns 1 and 2 of Panel B of Table 4) 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 $Crisis_t*Informal_i$ 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).

On the contrary, 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 of informality is stable at around 11-13 percent during the crisis (columns 4-6 of Panel B). Similarly, there appears to be no significant difference for women and men (columns 1-3 of Panel C Table 4) nor between young and old workers, defined as those below/above the median age of the sample (columns 4-6 of Panel C).

Our main results are obtained for the whole sample of documented and undocumented immigrants in full-time employment. Columns 1-3 of Table 5, instead, focuses on illegal and legal immigrants separately. Results are similar to our benchmark specification, although documented migrants seems to bear more negative impacts from the recession (with an additional wage reduction in the informal sector during crisis of about 8 percent). Similarly, self-employed workers in the shadow economy have also been hit harder by the 2009 crisis, with their wages reduced by an additional 15 percent (columns 4-6). Finally, in columns 7-9, we look at part-time and full-time workers separately and in a difference-in-difference-in-differences specification. 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). [16]

5.4 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.[17]

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of information on the number of employees by firm in the ISMU dataset does not allow such analysis.

[15] "Simple" occupations include unskilled workers, building workers, farm workers, cleaners, craftsmen, and truck workers.

[16] 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.

[17] 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 & Hanson (2005). This exercise shows that workers

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 6 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 & 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).[18] 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 β_r. The value of the test is then calculated as the absolute value of $\beta_f/(\beta_r - \beta_f)$, where β_f is the coefficient at the interaction term in column 6 of Table 6, i.e. 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, i.e. 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 A6 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 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 (Yang (2006)), we investigate whether results from this check differ depending on the length of stay in Italy: in column 1 of Table A6 there

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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.

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

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.

5.5 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 A2, which shows that the distribution of permanence in Italy is more skewed towards 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 7 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 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 Table A7 in 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 sub-samples, 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.

6 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 increases labor supply in the informal sector and results in further downward pressure on informal wages (in addition to the compression due to the demand shock).[19] In this Section, we consider a

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[19] 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 & Nakajima (2015)). In order to reject this hypothesis, we re-run our benchmark specification (Table 2) without occupation dummies. Results in Table A8 in Appendix show that the coefficient at the interaction term between the informality dummy and the crisis variable is remarkably similar to the one in Table 2 throughout

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.

6.1 Model

We consider two imperfectly integrated labor markets: formal F and informal I. We assume that α percent of workers are perfectly mobile between the two sectors while the remaining $1 - \alpha$ percent 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.[20]

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 (see Figure 4). We assume that the shock is proportional so in both sectors the labor demand curves move down by x percent. The wage in the formal sector is downward sticky so the following number of workers are displaced:[21]

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

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 percent down) and an 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) while 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, whilst the second term is the increase in employment due to the increase in labor supply.

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all specifications.

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

[21]In what follows, we assume that changes are small and that elasticities are constant in the neighborhood of the equilibrium.

6.2   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. Table A9 in the 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 A10, A11, and A12 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 percent in 2009, 4 percent in 2010, 12 percent in 2011, 15 percent in 2012 and 16 percent in 2013 (relative to 2008). 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 percent in 2012, whilst male employment is hit already in 2010 and reaches a reduction of 20 percent in 2013. Importantly, in the informal sector the crisis increases men's employment (by 3 percentage points only) while there is no significant effect on female rates.

6.3   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.[22]

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 6.1 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

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[22]More specifically, formal employment falls by 16 percent between 2008 and 2013 (see column 1 of Table A10) and informal wages drop by 17 percent during the same period (see column 2 of Table 2).

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)-(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,[23] 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.[24]

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 $\frac{x e_D^F}{e_D^F + e_S^F}$ percent. Using the data from the informal sector, we find that if formal wages were flexible, they would have fallen by 15.5 percent between 2008 and 2013. On the other hand, the percentage change in the formal employment is $\frac{x e_D^F e_S^F}{e_D^F + e_S^F}$, 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 percent between 2008 and 2013, formal employment would have declined only by 1.5 percent. If we assume that elasticity of labor supply is 0.65 then the change in formal employment would be 4.5 percent — still much lower than the 16 percent that we observe in the data (Table A10).

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[23] In our estimation sample, the share of workers in the informal market is 15 percent.

[24] 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 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.

7 Conclusions

In this paper we study the process of wage adjustment in formal and informal labor markets in Italy. We show that despite substantial growth of unemployment in the period 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 percent throughout 2001-08, has grown rapidly after 2009 and reached 32 percent 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 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 percent 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 percent decline in formal employment — much less substantial than the 16 percent we actually observe the data.

Our results are based on data on immigrants rather than the general labor force. We also 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. We also 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 with high levels of labor market regulation decrease immigrants' employment in the formal sector and generate a switch from formal to informal employment, with potential implications for public finance, remittances behavior, and immigrant regularization programs.

While 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.

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Figure 1: Wages in formal and informal labor markets in Lombardy
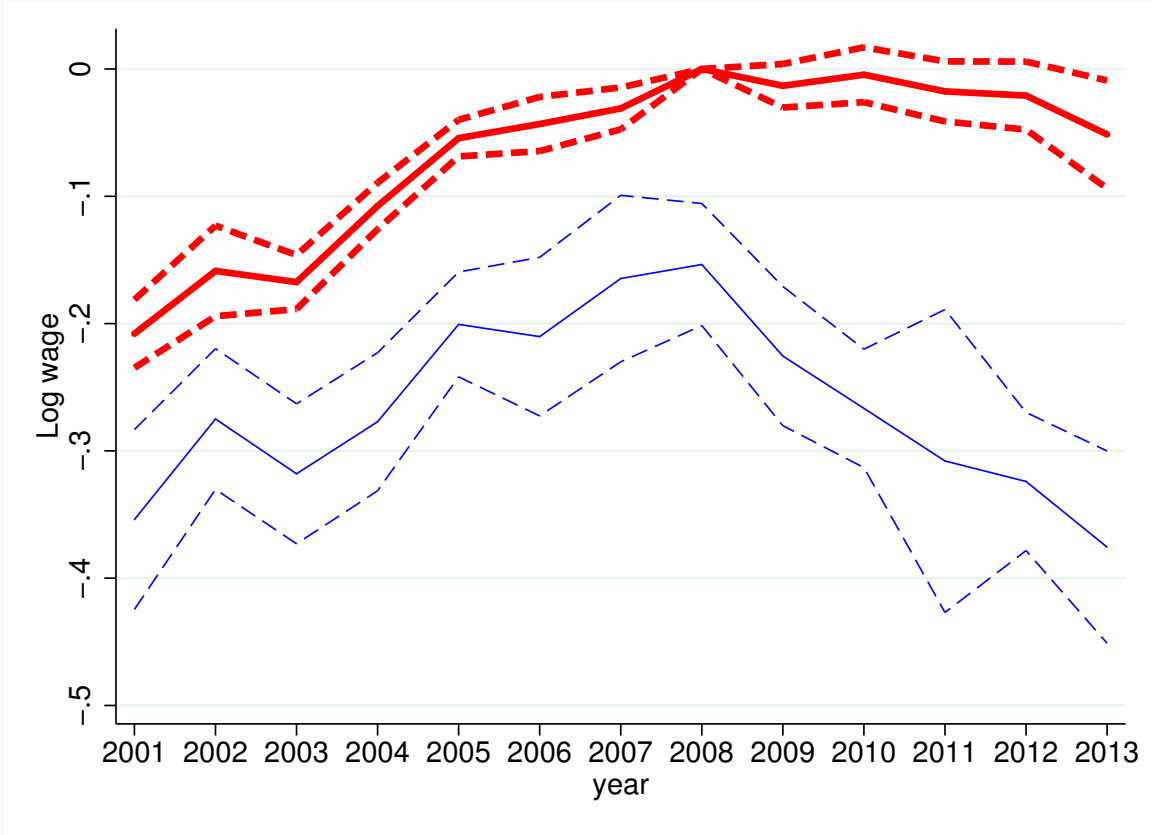
Logarithm of wages (relative to formal sector in 2008) controlling for gender, age, education, country of origin, family characteristics, occupation dummies, provinces of residence dummies.
Thick red line: formal sector. Thin blue line: informal sector. Dashed lines: 95% confidence interval.
Source: ISMU survey, authors' calculations.

Figure 2: Unemployment rate in Lombardy by quarters (2001-2013)
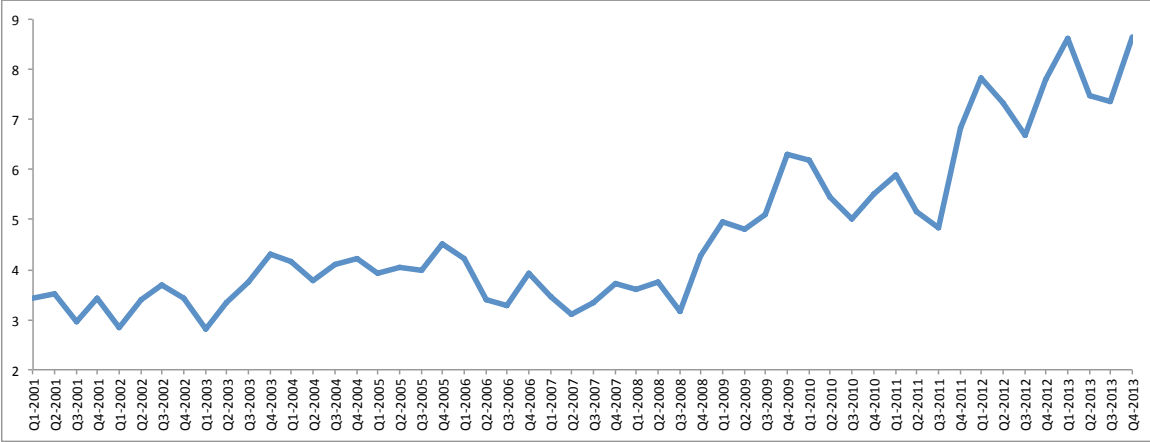
Source: ISTAT.

Figure 3: Unemployment by province within Lombardy
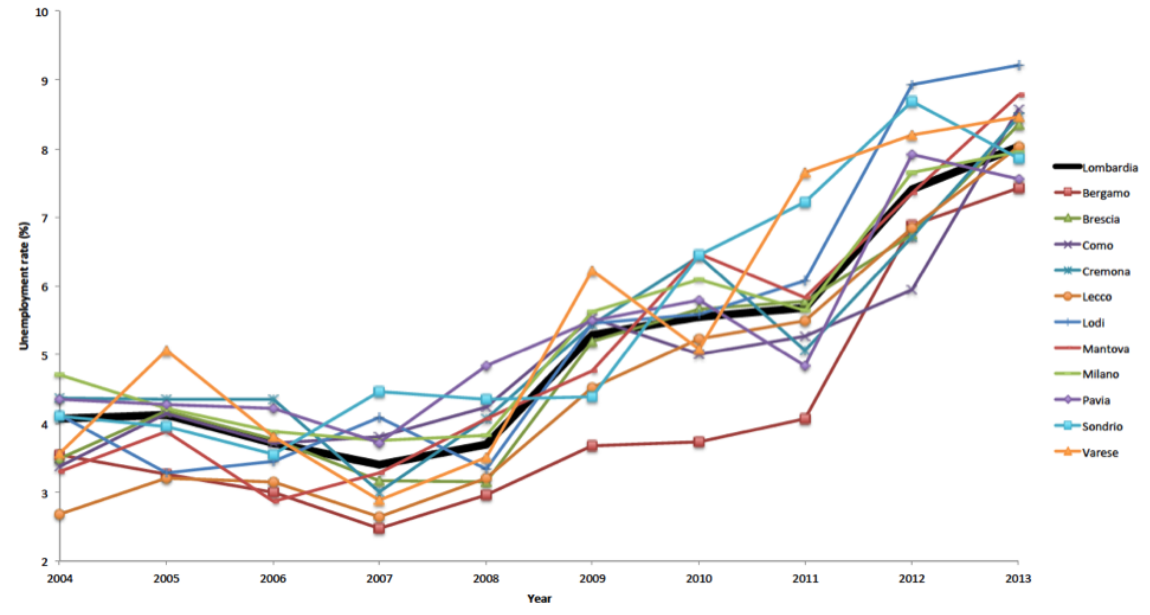
Source: ISTAT.

Figure 4: Adjustments in the formal and informal labor markets
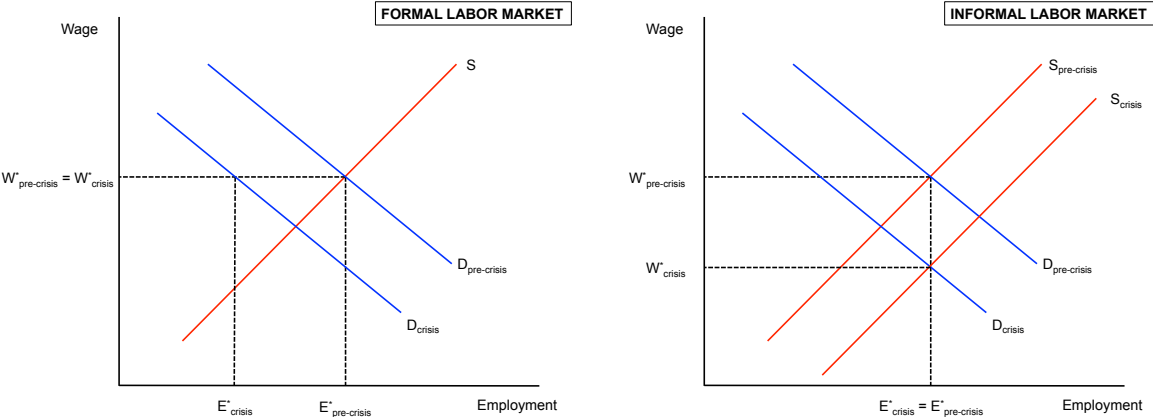
Labor supply and demand graphs for the formal market (left) and the informal market (right). We assume that both markets experience a negative labor demand shock. As the wage in the formal market is rigid, this results in underemployment of workers in the formal market, some of whom move to the informal labor market therefore shifting the informal labor supply curve rightwards.

Figure 5: Employment in formal and informal markets, by gender
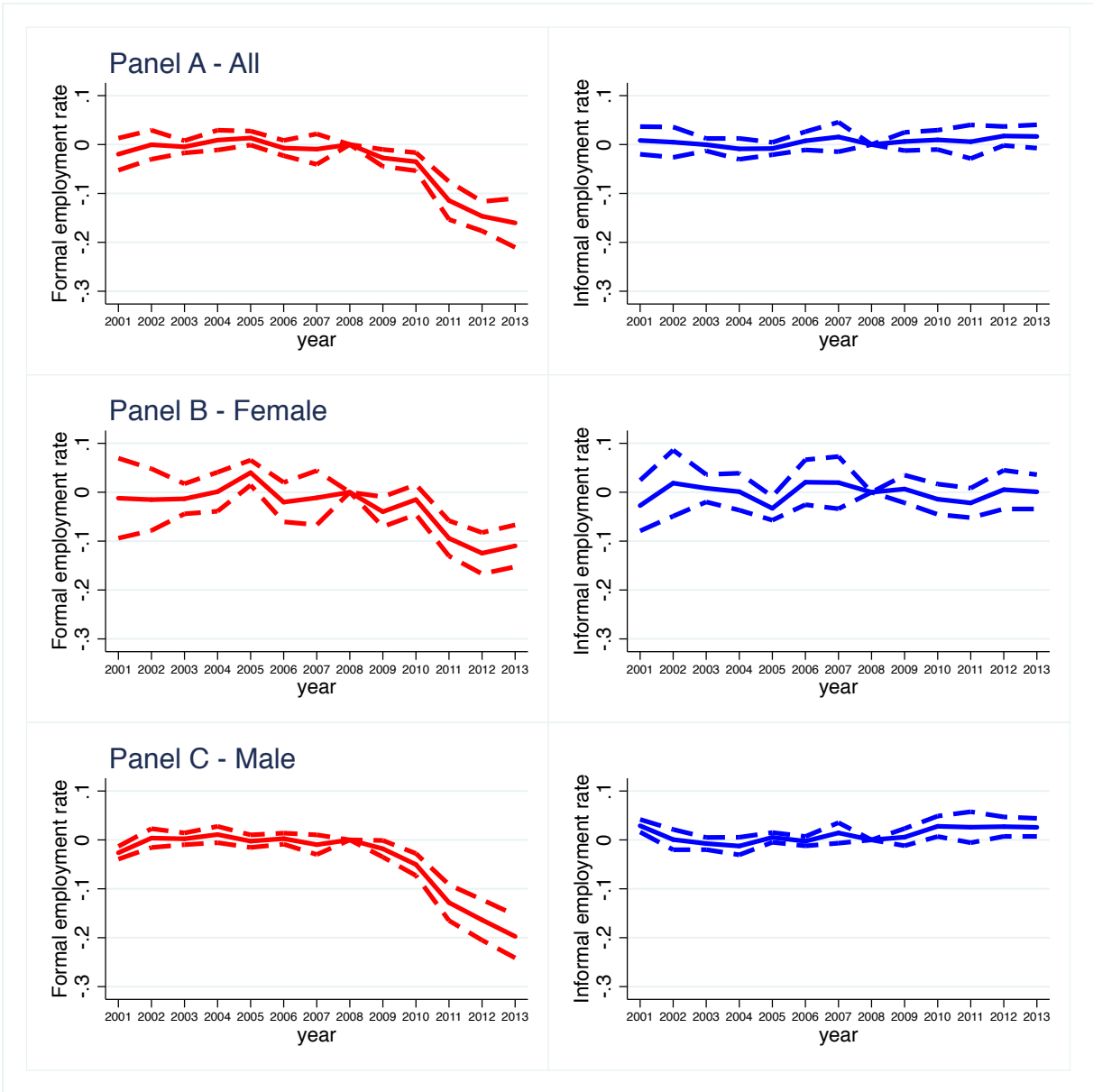
Employment rate (relative to 2008) controlling for gender (in panel A), age, education, country of origin, family characteristics, occupation dummies, provinces of residence dummies.
Left-hand side: formal sector. Right-hand side: informal sector. Dashed lines: 95% confidence interval.
Source: ISMU survey, authors' calculations, see Tables A10, A11, and A12 in the Appendix.

Table 1: Timing the start of the crisis, verifying the validity of the difference-in-differences strategy and checking the absence of an "Ashenfelter's dip". Placebo tests.

	(1) 2001-2007 Placebo=2007	(2) 2001-2007 Placebo⩾ 2006	(3) 2001-2008 Placebo=2008	(4) 2001-2008 Placebo⩾ 2007	(5) 2001-2008 Placebo⩾ 2006
Placebo X Informal	0.006	-0.017	-0.013	-0.002	-0.015
	(0.043)	(0.037)	(0.033)	(0.034)	(0.032)
Informal	-0.155***	-0.149***	-0.152***	-0.154***	-0.148***
	(0.016)	(0.015)	(0.019)	(0.016)	(0.014)
Female	-0.169***	-0.169***	-0.173***	-0.173***	-0.173***
	(0.016)	(0.017)	(0.011)	(0.015)	(0.016)
Age	1.319***	1.321***	1.478***	1.476***	1.479***
	(0.410)	(0.345)	(0.406)	(0.337)	(0.267)
Age squared	-1.523***	-1.524***	-1.711***	-1.707***	-1.711***
	(0.479)	(0.384)	(0.445)	(0.392)	(0.292)
Years in Italy	0.011***	0.011***	0.010***	0.010***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Compulsory school	0.015*	0.015	0.016**	0.016**	0.016*
	(0.008)	(0.011)	(0.006)	(0.007)	(0.009)
High school	0.025*	0.025**	0.024***	0.024**	0.024***
	(0.012)	(0.009)	(0.009)	(0.011)	(0.008)
Tertiary education	0.067***	0.066***	0.068***	0.068***	0.068***
	(0.014)	(0.011)	(0.009)	(0.012)	(0.010)
Married	0.013*	0.013*	0.011	0.011*	0.011*
	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Children abroad	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Children in Italy	0.002	0.002	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	28,912	28,912	33,857	33,857	33,857
R-squared	0.304	0.304	0.322	0.322	0.322

Notes: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data are from the ISMU survey. 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. We use data before the crisis (2001-2007). The Placebo variable is equal to 1 for the year 2007 in column 1 and for the years 2006 and 2007 in column 2. The Placebo variable is equal to 1 for the year 2008 in column 3, for the years 2007 and 2008 in column 4, and for the years 2006, 2007 and 2008 in column 5.

Table 2: Wage differential between formal (regulated) and informal (unregulated) sector. Difference-in-differences estimations.

	(1) Crisis$\geqslant$ 2009	(2) Crisis$\geqslant$ 2009	(3) Crisis$\geqslant$ 2009	(4) Crisis$\geqslant$ 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
	(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-squared	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 (2001-2013). 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.

Table 3: Wage differential between formal (regulated) and informal (unregulated) sector. Two-stage difference-in-differences estimation.

	Individual data		Province-occupation cells	
	Unweighted	Weighted	Unweighted	Weighted
	(1)	(2)	(3)	(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 CrisisXInformal 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 (2001-2013). We restrict the sample to immigrants residing in Italy for at most 30 years. The sample includes full-time workers only.

Table 4: 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	-0.106**	-0.109***	-0.097***	-0.125***	-0.103***	-0.117***
	(0.049)	(0.031)	(0.028)	(0.036)	(0.035)	(0.039)
Informal	-0.171***	-0.134***	-0.180***	-0.151***	-0.145***	-0.160***
	(0.027)	(0.013)	(0.021)	(0.020)	(0.016)	(0.018)
Crisis X Informal X X High avg./min.wage			-0.014			
			(0.043)			
Crisis X High avg./min.wage			-0.054***			
			(0.016)			
Informal X High avg./min.wage			0.048**			
			(0.023)			
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	Low avg./min.wage	High avg./min.wage	Full sample	Below med. informal	Above med. informal	Full sample
Observations	26,755	22,438	49,193	25,713	23,480	49,193
R-squared	0.300	0.374	0.335	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)
Sample	Simple	Complex	Full sample	Unskilled	Skilled	Full sample
Observations	28,356	20,837	49,193	22,244	26,949	52,579
R-squared	0.311	0.317	0.333	0.347	0.333	0.326
			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-squared	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 (2001-2013). 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.

Table 5: 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)	(7)	(8)	(9)
Crisis X Informal	-0.076*	-0.113**	-0.127***	-0.211*	-0.112***	-0.103***	-0.135***	-0.119***	-0.173***
	(0.043)	(0.048)	(0.032)	(0.120)	(0.036)	(0.026)	(0.026)	(0.035)	(0.022)
Informal	-0.077***	-0.212***	-0.230***	-0.287***	-0.135***	-0.154***	-0.195***	-0.145***	-0.134***
	(0.020)	(0.034)	(0.022)	(0.038)	(0.018)	(0.012)	(0.023)	(0.017)	(0.018)
Crisis X Informal X Illegal			0.080**						
			(0.036)						
Crisis X Illegal			-0.057***						
			(0.011)						
Informal X Illegal			0.080***						
			(0.024)						
Crisis X Informal X Self-emp						-0.149**			
						(0.068)			
Crisis X Self-emp						0.145***			
						(0.027)			
Informal X Self-emp						-0.229***			
						(0.063)			
Crisis X Informal X Part-time									0.306***
									(0.033)
Crisis X Part-time									-0.370***
									(0.011)
Informal X Part-time									-0.323***
									(0.018)
Sample	Illegal migrants	Legal migrants	Full sample	Self-employed	Wage workers	Full sample	Part time	Full time	Full sample
Observations	6,265	42,700	52,327	2,407	46,786	52,579	10,245	49,193	63,354
R-squared	0.280	0.330	0.328	0.407	0.335	0.335	0.224	0.333	0.388

Notes: Robust standard errors in parentheses, clustered by province in subsamples, by province times occupation in columns 3, 6 and 9. 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 (2001-2013). We restrict the sample to immigrants residing in Italy for at most 30 years. The sample includes full-time workers only (unless otherwise specified in columns 7 and 9). The dependent variable is the logarithm of after-tax wage.

Table 6: 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 (2001-2013). 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 β_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 β_f is the coefficient at the interaction term in column 6, i.e. from the estimation that includes the full set of covariates. Whenever covariates are included, we also include their interaction with the "Crisis" dummy.

Table 7: 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 $\leqslant$25	(3) Years in Italy $\leqslant$20	(4) Years in Italy $\leqslant$15	(5) 2001-2013 except 2002	(6) 2001-2013 except 2005	(7) 2006-2013
Crisis X Informal	-0.115***	-0.116***	-0.113***	-0.105***	-0.115***	-0.118***	-0.113***
	(0.034)	(0.035)	(0.036)	(0.037)	(0.035)	(0.035)	(0.039)
Informal	-0.164***	-0.144***	-0.143***	-0.139***	-0.147***	-0.144***	-0.139***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.019)	(0.017)	(0.024)
Observations	49,285	48,918	47,838	44,129	45,098	45,452	29,977
R-squared	0.323	0.332	0.328	0.324	0.332	0.335	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 (2001-2013). 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 dependent variable is the logarithm of after-tax wage.

Appendix A: Additional figures and tables

Figure A1: Wages in Lombardy, ISMU and SHIW data.
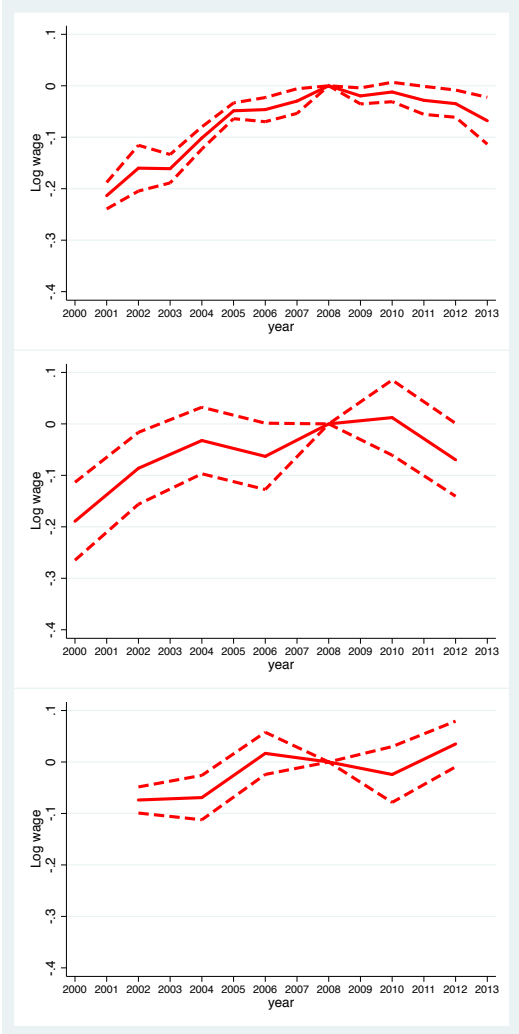
Vertical axis: logarithm of wages (relative to 2008) controlling for available individual characteristics, such as age, gender, education, and occupation, and family characteristics. The ISMU estimates also condition on province dummies, which are not available in the SHIW dataset for confidentiality reasons. The first graph includes immigrants only, while the second graph includes both natives and immigrants. The first graph is based on the ISMU survey (annual, 2001-2013). The second graph is based on the SHIW survey (biannual, 2000-2012). The third graph presents the difference between the residuals of the previous two figures for the years 2002, 2004, 2006, 2008, 2010, and 2012 when both ISMU and SHIW data are available. Dashed lines: 95% confidence interval.

Figure A2: Informal employment and permanence in the host country: Density of years in Italy by formal (0) and informal (1) workers.

Graphs by Informal sector
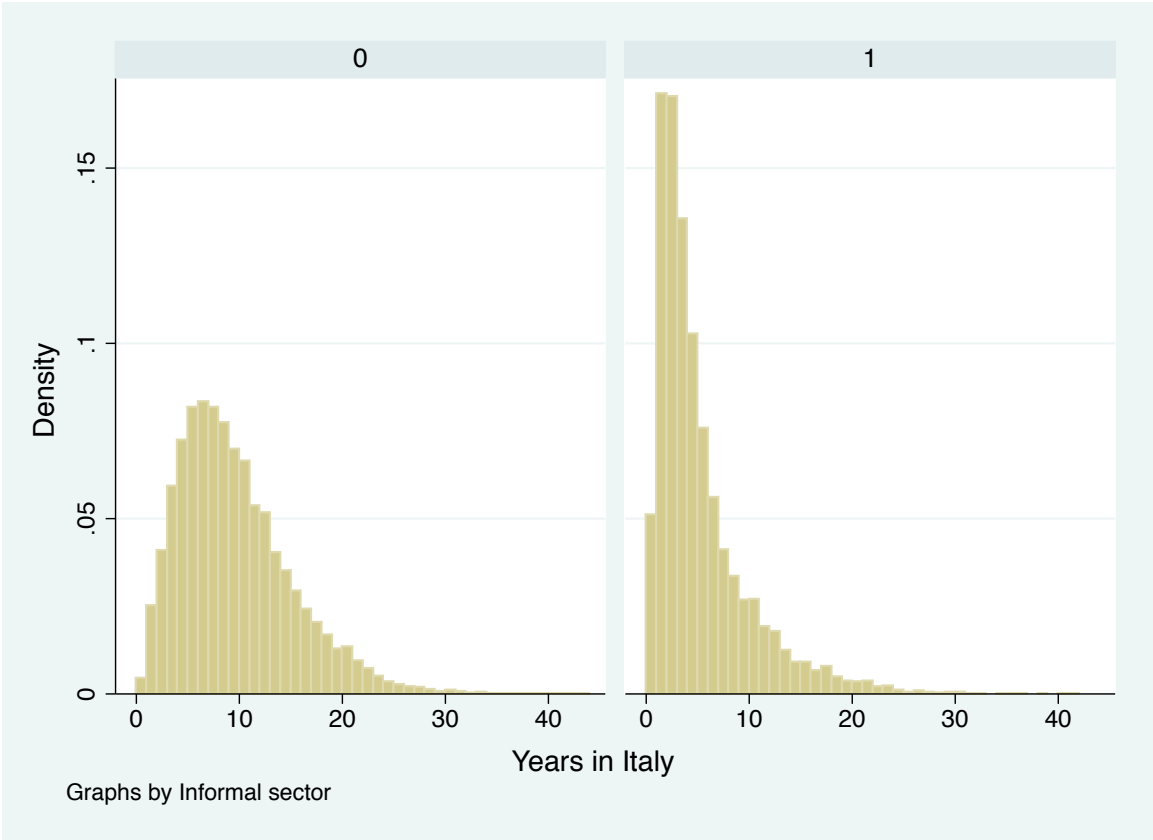
Source: ISMU survey (2001-2013)

Table A1: Irregular workers by legal status and gender

	Legal migrants	Illegal migrants	Male	Female
Regular workers	40,185	2,404	30,325	12,412
Irregular workers	2,515	3,861	3,184	3,272
Total	42,700	6,265	33,509	15,684

Table A2: Summary statistics.

	Mean	Std. Dev.
Log earnings	6.94	0.36
Informal	0.15	0.36
Illegal	0.07	0.25
Female	0.35	0.48
Age	0.35	0.09
Years in Italy	8.34	5.28
Married	0.57	0.49
Children abroad	0.46	1.40
Children in Italy	0.76	1.97
Compulsory school	0.35	0.48
High school	0.44	0.50
Tertiary education	0.14	0.35

Notes: Log(earnings) are the net monthly wages as provided directly by the interviewed. Illegal is a dummy being 1 if the migrant reports having no residence permit. Data source: ISMU survey data, 2001-2013.

Table A3: **Number of workers by occupation and monthly wages**

	Regular workers		Irregular workers		Total		Minimum wage	Average wage Regular	Irregular	Total
Unskilled workers	11,412	24.2%	565	1.2%	11,977	25.4%	958	1,106	875	1,095
Skilled workers	2,112	4.5%	128	0.3%	2,240	4.8%	1,218	1,201	937	1,186
Building workers	4,425	9.4%	784	1.7%	5,209	11.0%	1,129	1,297	1,094	1,267
Farm workers	3,185	6.8%	486	1.0%	3,671	7.8%	948	1,227	1,035	1,201
Cleaners	1,678	3.6%	308	0.7%	1,986	4.2%	1,088	1,029	740	985
Warehouse and custody workers	1,634	3.5%	155	0.3%	1,789	3.8%	1,022	1,087	840	1,065
Clerical workers	900	1.9%	38	0.1%	938	2.0%	1,020	1,164	807	1,150
Sales workers	1,215	2.6%	259	0.5%	1,474	3.1%	983	1,062	713	1,000
Food and beverage workers	4,005	8.5%	574	1.2%	4,579	9.7%	1,056	1,091	827	1,058
Craftsmen	3,199	6.8%	521	1.1%	3,720	7.9%	916	1,183	939	1,149
Truck workers	1,682	3.6%	111	0.2%	1,793	3.8%	1,095	1,496	1,142	1,474
House helpers	1,431	3.0%	643	1.4%	2,074	4.4%	590	887	718	834
Home-based caregivers	1,959	4.2%	788	1.7%	2,747	5.8%	590	894	799	867
Baby sitters	414	0.9%	147	0.3%	561	1.2%	590	971	692	898
Social assistance operators	900	1.9%	30	0.1%	930	2.0%	1,043	1,190	917	1,181
Medical and paramedical	797	1.7%	45	0.1%	842	1.8%	1,296	1,510	1,014	1,484
Intellectual professions	553	1.2%	72	0.2%	625	1.3%	1,081	1,412	1,375	1,407
Total	41,501	88.0%	5,654	12.0%	47,155	100.0%				

Notes: Wages are in euros per months, calculated only for the full-time workers. Data source: ISMU survey data, 2001-2013.

Table A4: Average monthly net wage from SHIW data

	Monthly net wage
Farm workers	1113
Manufacturing & Mining	1432
Building workers	1296
Sales workers	1217
Truck workers	1487
Finance	1856
Other services	1400
House helpers	1044
Public administration	1560
International organizations	2124

Data source: Survey on Household Income and Wealth (SHIW) by Bank of Italy, 2000-2012. Information refers to both native and foreign workforce.

Table A5: Skill types and variables from O*NET

Type of skill	Skill sub-type	O*NET variables
Manual	Limb, hand and finger dexterity	Arm-hand steadiness
		Manual dexterity
		Finger dexterity
		Control precision
		Multilimb coordination
		Response orientation
		Rate control
		Reaction time
		Wrist-finger speed
		Speed of limb movement
		Extent flexibility
	Body coordination and flexibility	Extent flexibility
		Dynamic flexibility
		Gross body coordination
		Gross body equilibrium
		Explosive strenght
		Dynamic strength
		Trunk strenght
		Stamina
Communication	Oral	Oral comprehension
		Oral expression
	Written	Written comprehension
		Written expression

Table A6: Intentions to return to the origin country

	(1) No restriction years in Italy	(2) Years in Italy $\leqslant 30$	(3) Years in Italy $\leqslant 25$	(4) Years in Italy $\leqslant 20$	(5) Years in Italy $\leqslant 15$
Informal	0.019	0.020	0.020	0.018	0.018
	(0.020)	(0.020)	(0.020)	(0.021)	(0.023)
Female	0.013*	0.013*	0.013*	0.015*	0.018**
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Age	-0.080	-0.100	-0.118	-0.151	-0.182
	(0.280)	(0.281)	(0.285)	(0.308)	(0.345)
Age squared	0.217	0.243	0.268	0.322	0.388
	(0.359)	(0.359)	(0.365)	(0.396)	(0.449)
Years in Italy	-0.001	-0.001	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Married	-0.003	-0.003	-0.002	-0.002	-0.002
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Children abroad	0.009**	0.009**	0.009**	0.008**	0.006
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Children in Italy	-0.006	-0.007	-0.007	-0.008	-0.010**
	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)
Compulsory school	-0.045***	-0.045**	-0.045***	-0.037**	-0.039**
	(0.016)	(0.016)	(0.016)	(0.014)	(0.017)
High school	-0.046***	-0.046***	-0.047***	-0.039**	-0.042**
	(0.016)	(0.016)	(0.016)	(0.016)	(0.019)
Tertiary education	-0.053**	-0.053**	-0.053**	-0.048**	-0.051**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.020)
Year dummies	yes	yes	yes	yes	yes
Occupation dummies	yes	yes	yes	yes	yes
Province dummies	yes	yes	yes	yes	yes
Country of origin dummies	yes	yes	yes	yes	yes
Observations	10,474	10,432	10,329	9,726	8,584
R-squared	0.048	0.048	0.048	0.048	0.051

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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Estimation sample of column 1: no restriction on immigrant's permanence in Italy. Column 2: we restrict the sample to immigrants with permanence in Italy equal to or less than 30 years. Column 3: permanence in Italy equal to or less than 25 years. Column 4: permanence in Italy equal to or less than 20 years. Column 5: permanence in Italy equal to or less than 15 years. Data are from the ISMU survey. The information on the intentions to return to the origin country is available for the years 2010-2013.

Table A7: Year dummies in regressions for subsamples

	(1) Female	(2) Male	(3) Unskilled	(4) Skilled	(5) Young	(6) Old
Informal	-0.180***	-0.089***	-0.183***	-0.125***	-0.137***	-0.178***
	(0.019)	(0.020)	(0.044)	(0.022)	(0.027)	(0.027)
Informal X Year2001	0.009	-0.036	0.096**	-0.065	-0.010	0.036
	(0.033)	(0.050)	(0.038)	(0.054)	(0.031)	(0.058)
Informal X Year2002	0.072*	-0.019	0.064	0.012	0.019	0.055
	(0.037)	(0.034)	(0.047)	(0.043)	(0.033)	(0.074)
Informal X Year2003	0.017	-0.037	0.060	-0.042	0.012	-0.078
	(0.032)	(0.032)	(0.057)	(0.027)	(0.035)	(0.052)
Informal X Year2004	0.056	-0.089**	-0.011	-0.032	-0.051	0.046
	(0.043)	(0.034)	(0.049)	(0.040)	(0.036)	(0.040)
Informal X Year2005	0.004	-0.002	0.033*	-0.017	0.013	-0.016
	(0.034)	(0.027)	(0.018)	(0.031)	(0.018)	(0.040)
Informal X Year2006	-0.036	-0.015	0.004	-0.033	-0.029	0.005
	(0.039)	(0.024)	(0.041)	(0.027)	(0.031)	(0.034)
Informal X Year2007	0.007	0.018	0.007	0.017	-0.010	0.056
	(0.038)	(0.027)	(0.035)	(0.038)	(0.034)	(0.041)
Informal X Year2009	-0.019	-0.102***	-0.022	-0.091*	-0.057*	-0.070
	(0.049)	(0.030)	(0.044)	(0.047)	(0.031)	(0.053)
Informal X Year2010	-0.070	-0.168***	-0.116**	-0.111***	-0.140***	-0.057
	(0.067)	(0.054)	(0.053)	(0.033)	(0.034)	(0.049)
Informal X Year2011	-0.119*	-0.177**	-0.120	-0.153***	-0.189**	-0.077
	(0.063)	(0.081)	(0.118)	(0.046)	(0.081)	(0.059)
Informal X Year2012	-0.100**	-0.207***	-0.144**	-0.157***	-0.165***	-0.124***
	(0.044)	(0.034)	(0.061)	(0.032)	(0.038)	(0.043)
Informal X Year2013	-0.160***	-0.184***	-0.140*	-0.202***	-0.132***	-0.194***
	(0.039)	(0.064)	(0.077)	(0.037)	(0.045)	(0.052)
Female			-0.164***	-0.169***	-0.141***	-0.199***
			(0.012)	(0.008)	(0.010)	(0.009)
Age	1.538***	1.643***	1.369***	1.858***	2.656***	2.561***
	(0.417)	(0.283)	(0.342)	(0.351)	(0.467)	(0.549)
Age squared	-1.736***	-2.049***	-1.575***	-2.193***	-3.910***	-2.865***
	(0.513)	(0.329)	(0.419)	(0.405)	(0.815)	(0.578)
Years in Italy	0.003***	0.013***	0.011***	0.010***	0.011***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Compulsory school	0.017	0.023**	0.022***		0.013	0.033***
	(0.013)	(0.009)	(0.006)		(0.014)	(0.011)
High school	0.021	0.040***		-0.042***	0.026*	0.042***
	(0.013)	(0.010)		(0.008)	(0.015)	(0.010)
Tertiary education	0.071***	0.071***			0.051***	0.094***
	(0.012)	(0.009)			(0.014)	(0.012)
Married	-0.041***	0.053***	0.018**	0.016	0.024***	-0.002
	(0.005)	(0.007)	(0.008)	(0.010)	(0.008)	(0.011)
Children abroad	0.002	-0.003	-0.003	0.000	-0.002	0.001
	(0.004)	(0.005)	(0.003)	(0.002)	(0.004)	(0.003)
Children in Italy	-0.002	0.008***	0.009***	0.003	0.000	0.010***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
Observations	15,684	33,509	22,244	26,949	25,995	23,198
R-squared	0.256	0.301	0.348	0.333	0.321	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 (2001-2013). 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.

Table A8: Regressions without occupation dummies

	(1) Crisis⩾ 2009	(2) Crisis⩾ 2009	(3) Crisis⩾ 2009	(4) Crisis⩾ 2008
Informal X Crisis	-0.131***		-0.082**	-0.101***
	(0.035)		(0.031)	(0.023)
Informal	-0.156***	-0.173***	-0.156***	-0.154***
	(0.022)	(0.030)	(0.022)	(0.021)
Informal X Year2001		0.021		
		(0.027)		
Informal X Year2002		0.055		
		(0.041)		
Informal X Year2003		0.015		
		(0.036)		
Informal X Year2004		-0.022		
		(0.035)		
Informal X Year2005		0.012		
		(0.019)		
Informal X Year2006		-0.009		
		(0.025)		
Informal X Year2007		0.027		
		(0.035)		
Informal X Year2009		-0.054		
		(0.038)		
Informal X Year2010		-0.123***		
		(0.038)		
Informal X Year2011		-0.134*		
		(0.073)		
Informal X Year2012		-0.160***		
		(0.038)		
Informal X Year2013		-0.184***		
		(0.058)		
Informal X $\max\{Year - 2009, 0\}$			-0.033***	
			(0.009)	
Female	-0.229***	-0.228***	-0.229***	-0.228***
	(0.012)	(0.012)	(0.012)	(0.012)
Age	1.686***	1.677***	1.681***	1.686***
	(0.316)	(0.316)	(0.315)	(0.320)
Age squared	-2.052***	-2.040***	-2.044***	-2.054***
	(0.360)	(0.359)	(0.359)	(0.365)
Years in Italy	0.012***	0.012***	0.012***	0.012***
	(0.001)	(0.001)	(0.001)	(0.001)
Compulsory school	0.024***	0.024***	0.024***	0.023***
	(0.008)	(0.008)	(0.008)	(0.008)
High school	0.037***	0.037***	0.037***	0.037***
	(0.007)	(0.007)	(0.007)	(0.007)
Tertiary education	0.093***	0.093***	0.093***	0.093***
	(0.010)	(0.010)	(0.010)	(0.010)
Married	0.019**	0.020**	0.019**	0.019**
	(0.007)	(0.007)	(0.007)	(0.007)
Children abroad	-0.002	-0.002	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Children in Italy	0.004**	0.004**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	49,193	49,193	49,193	49,193
R-squared	0.294	0.295	0.295	0.293

Notes: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy. All regressions include year dummies, dummies for country of origin, province dummies. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data are from the ISMU survey (2001-2013). 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.

Table A9: Employment in the formal/regulated and informal/unregulated sectors, full sample

	(1) Employment in formal sector	(2) Employment in formal sector	(3) Employment in informal sector	(4) Employment in informal sector	(5) Employment in informal sector
Year$\geq$ 2009	-0.085***	-0.069***	0.006	0.009	0.015
	(0.011)	(0.012)	(0.009)	(0.009)	(0.009)
Female	-0.044***	-0.044***	0.037***	0.038***	0.039***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age	2.400***	1.278***	-0.792***	-0.969***	-1.029***
	(0.405)	(0.237)	(0.222)	(0.240)	(0.245)
Age squared	-2.812***	-1.582***	0.961***	1.161***	1.243***
	(0.452)	(0.282)	(0.277)	(0.294)	(0.298)
Years in Italy	0.003***	0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Married	-0.001	-0.007	0.003	0.003	0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Children abroad	-0.003***	-0.003**	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Children in Italy	-0.003**	-0.003*	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Compulsory school	0.022***	0.022***	-0.026***	-0.026***	-0.026***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
High school	0.022***	0.030***	-0.033***	-0.032***	-0.032***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Tertiary education	0.034***	0.046***	-0.053***	-0.052***	-0.053***
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Occupation dummies	yes	yes	yes	yes	yes
Province dummies	yes	yes	yes	yes	yes
Country of origin dummies	yes	yes	yes	yes	yes
Observations	57,061	56,208	57,061	56,208	54,945
R-squared	0.092	0.081	0.082	0.084	0.087

Notes: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Sample is limited to documented migrants. Estimates in columns 2 and 4 are conditional on labor force participation. The specification in column 5 is conditional on employment.

Table A10: Employment in the formal/regulated and informal/unregulated sectors with year dummies, full sample.

	(1) Employment in formal sector	(2) Employment in formal sector	(3) Employment in informal sector	(4) Employment in informal sector	(5) Employment in informal sector
Year2001	-0.020	-0.010	0.008	0.011	0.011
	(0.017)	(0.014)	(0.014)	(0.015)	(0.015)
Year2002	-0.000	-0.001	0.005	0.005	0.005
	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)
Year2003	-0.005	0.001	-0.000	0.001	0.000
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Year2004	0.009	0.008	-0.009	-0.009	-0.009
	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
Year2005	0.013*	0.010	-0.008	-0.009	-0.009
	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
Year2006	-0.007	-0.007	0.008	0.008	0.008
	(0.008)	(0.009)	(0.010)	(0.009)	(0.009)
Year2007	-0.009	-0.015	0.015	0.015	0.015
	(0.016)	(0.015)	(0.015)	(0.016)	(0.015)
Year2009	-0.027***	-0.009	0.006	0.008	0.009
	(0.009)	(0.010)	(0.010)	(0.009)	(0.009)
Year2010	-0.035***	-0.015	0.010	0.012	0.013
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
Year2011	-0.115***	-0.098***	0.006	0.008	0.018
	(0.020)	(0.021)	(0.018)	(0.018)	(0.019)
Year2012	-0.147***	-0.136***	0.017*	0.019*	0.033***
	(0.015)	(0.015)	(0.010)	(0.010)	(0.011)
Year2013	-0.160***	-0.149***	0.016	0.019	0.032**
	(0.026)	(0.026)	(0.012)	(0.012)	(0.015)
Female	-0.043***	-0.044***	0.038***	0.039***	0.040***
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Age	2.383***	1.246***	-0.790***	-0.966***	-1.024***
	(0.403)	(0.236)	(0.223)	(0.241)	(0.245)
Age squared	-2.774***	-1.526***	0.958***	1.157***	1.235***
	(0.444)	(0.278)	(0.276)	(0.293)	(0.296)
Years in Italy	0.003***	0.005***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Married	-0.003	-0.009	0.003	0.003	0.004
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Children abroad	-0.003***	-0.002**	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Children in Italy	-0.003**	-0.003*	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Compulsory school	0.027***	0.027***	-0.027***	-0.027***	-0.027***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
High school	0.028***	0.036***	-0.033***	-0.032***	-0.033***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Tertiary education	0.038***	0.051***	-0.054***	-0.052***	-0.053***
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Year dummies	yes	yes	yes	yes	yes
Occupation dummies	yes	yes	yes	yes	yes
Province dummies	yes	yes	yes	yes	yes
Country of origin dummies	yes	yes	yes	yes	yes
Observations	57,061	56,208	57,061	56,208	54,945
R-squared	0.103	0.094	0.083	0.085	0.088

Notes: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Sample is limited to documented migrants. Estimates in columns 2 and 4 are conditional on labor force participation. The specification in column 5 is conditional on employment.

Table A11: Employment in the formal/regulated and informal/unregulated sectors with year dummies, female.

	(1) Employment in formal sector	(2) Employment in formal sector	(3) Employment in informal sector	(4) Employment in informal sector	(5) Employment in informal sector
Year2001	-0.012	0.020	-0.027	-0.019	-0.019
	(0.042)	(0.030)	(0.026)	(0.029)	(0.029)
Year2002	-0.015	-0.015	0.019	0.019	0.018
	(0.032)	(0.033)	(0.034)	(0.034)	(0.034)
Year2003	-0.013	-0.007	0.008	0.009	0.009
	(0.016)	(0.015)	(0.014)	(0.014)	(0.014)
Year2004	0.001	-0.004	0.001	-0.000	-0.000
	(0.020)	(0.020)	(0.019)	(0.019)	(0.019)
Year2005	0.040***	0.035***	-0.033**	-0.034***	-0.034***
	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)
Year2006	-0.020	-0.020	0.020	0.020	0.020
	(0.021)	(0.023)	(0.023)	(0.023)	(0.023)
Year2007	-0.011	-0.019	0.020	0.019	0.019
	(0.028)	(0.027)	(0.027)	(0.027)	(0.027)
Year2009	-0.040**	-0.011	0.007	0.010	0.010
	(0.016)	(0.015)	(0.014)	(0.014)	(0.014)
Year2010	-0.015	0.008	-0.014	-0.011	-0.010
	(0.016)	(0.015)	(0.016)	(0.016)	(0.016)
Year2011	-0.094***	-0.076***	-0.022	-0.019	-0.007
	(0.018)	(0.018)	(0.015)	(0.016)	(0.016)
Year2012	-0.125***	-0.114***	0.005	0.008	0.023
	(0.022)	(0.021)	(0.020)	(0.021)	(0.022)
Year2013	-0.110***	-0.103***	0.001	0.002	0.014
	(0.022)	(0.020)	(0.018)	(0.018)	(0.019)
Age	2.846***	1.649***	-1.163***	-1.403***	-1.449***
	(0.410)	(0.251)	(0.288)	(0.289)	(0.293)
Age squared	-3.137***	-1.848***	1.263***	1.529***	1.585***
	(0.456)	(0.311)	(0.368)	(0.365)	(0.370)
Years in Italy	0.002	0.003***	-0.003***	-0.003**	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Married	-0.027**	-0.040***	0.031***	0.030***	0.031***
	(0.010)	(0.011)	(0.009)	(0.009)	(0.009)
Children abroad	-0.003	-0.002	0.002	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Children in Italy	-0.009***	-0.009***	0.008***	0.008***	0.008***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Compulsory school	0.036**	0.036**	-0.035*	-0.034*	-0.035*
	(0.018)	(0.017)	(0.018)	(0.018)	(0.019)
High school	0.040**	0.047**	-0.044**	-0.042**	-0.044**
	(0.019)	(0.019)	(0.019)	(0.020)	(0.020)
Tertiary education	0.057***	0.074***	-0.079***	-0.077***	-0.078***
	(0.021)	(0.018)	(0.018)	(0.019)	(0.019)
Year dummies	yes	yes	yes	yes	yes
Occupation dummies	yes	yes	yes	yes	yes
Province dummies	yes	yes	yes	yes	yes
Country of origin dummies	yes	yes	yes	yes	yes
Observations	20,854	20,405	20,854	20,405	19,933
R-squared	0.117	0.117	0.120	0.122	0.125

Notes: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Sample is limited to documented migrants. Estimates in columns 2 and 4 are conditional on labor force participation. The specification in column 5 is conditional on employment.

Table A12: Employment in the formal/regulated and informal/unregulated sectors with year dummies, male.

	(1) Employment in formal sector	(2) Employment in formal sector	(3) Employment in informal sector	(4) Employment in informal sector	(5) Employment in informal sector
Year2001	-0.026***	-0.030***	0.029***	0.029***	0.029***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)
Year2002	0.004	0.002	0.001	0.001	0.001
	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
Year2003	0.002	0.008	-0.007	-0.007	-0.007
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Year2004	0.011	0.011	-0.012	-0.012	-0.012
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
Year2005	-0.003	-0.004	0.005	0.005	0.005
	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)
Year2006	0.003	0.002	-0.003	-0.003	-0.002
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Year2007	-0.010	-0.014	0.014	0.014	0.014
	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
Year2009	-0.018**	-0.007	0.006	0.007	0.007
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Year2010	-0.050***	-0.032***	0.028**	0.030***	0.031***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Year2011	-0.128***	-0.114***	0.026	0.028*	0.036*
	(0.019)	(0.021)	(0.016)	(0.016)	(0.019)
Year2012	-0.164***	-0.153***	0.027**	0.029***	0.041***
	(0.021)	(0.020)	(0.010)	(0.010)	(0.014)
Year2013	-0.197***	-0.181***	0.026***	0.028***	0.042***
	(0.022)	(0.025)	(0.009)	(0.009)	(0.012)
Age	2.069***	0.955***	-0.531**	-0.676***	-0.736***
	(0.388)	(0.218)	(0.200)	(0.216)	(0.219)
Age squared	-2.647***	-1.402***	0.841***	1.009***	1.097***
	(0.461)	(0.283)	(0.255)	(0.275)	(0.279)
Years in Italy	0.004***	0.005***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Married	0.032***	0.030***	-0.031***	-0.031***	-0.032***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Children abroad	-0.005**	-0.004**	0.003***	0.003***	0.004***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Children in Italy	0.001	0.001	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Compulsory school	0.024***	0.024***	-0.023***	-0.023***	-0.024***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
High school	0.025***	0.033***	-0.030***	-0.029***	-0.030***
	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)
Tertiary education	0.027***	0.037***	-0.034***	-0.034***	-0.035***
	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)
Year dummies	yes	yes	yes	yes	yes
Occupation dummies	yes	yes	yes	yes	yes
Province dummies	yes	yes	yes	yes	yes
Country of origin dummies	yes	yes	yes	yes	yes
Observations	36,207	35,803	36,207	35,803	35,012
R-squared	0.103	0.088	0.055	0.057	0.060

Notes: Robust standard errors in parentheses, clustered by province times simple occupations dummy times before/after crisis dummy.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Sample is limited to documented migrants. Estimates in columns 2 and 4 are conditional on labor force participation. The specification in column 5 is conditional on employment.

Appendix B: Microfoundations of the model in Section 6

In this Appendix we provide microfoundations for the labor demand and labor supply. We assume that in each sector $s = F, I$ there is a competitive industry in which firms have Cobb-Douglas production function $Y = A^s L^\beta$, where A^F, A^I are the productivity pararameters in the formal and informal sectors, respectively. We assume that $A^F > A^I$. Then profit-maximizing firms choose the number of jobs by equalizing wages with the marginal labor productivity $w = \beta A^s / L^{1-\beta}$. Therefore the elasticity of labor demand in each sector is $1/(1-\beta)$.

Let us now discuss labor supply. Workers differ across two dimensions: disutility of labor v and mobility across sectors. We assume that these parameters are independently distributed across workers. The cumulative distribution function of disutility of labor in each sector is $G^s(\cdot)$. In the initial equilibrium, α^F percent of workers employed in the formal sector are mobile across sectors (i.e. can move to the informal sector) while $1 - \alpha^F$ can only work in the formal sector. As for the workers initially employed in the informal sector, none of them can move to the formal sector. This assumption is natural as wages in the formal sector are higher in equilibrium.

The elasticity of labor supply in each sector is therefore the elasticity of the cumulative distribution function of disutility of labor $e_S^F = w^F G^{F\prime}(w^F)/G^F(w^F)$ and $e_S^I = w^I G^{I\prime}(w^I)/G^I(w^I)$.

When the recession starts, both sectors experience a proportional productivity shock (both A^F and A^I decline by x percent). Since wages in the formal sector are not flexible, $\Delta L^F/L^F$ percent of formal workers are fired. We assume that the rationing of jobs in the formal sector is random so among the workers who are fired, $G^F(w^I)/G^F(w^F)$ percent are interested in working for the wage w^I. The share α^F can move to the informal sector. Therefore, the total proportion of workers previously employed in the formal sector looking for informal jobs is $\alpha = \alpha^F G^F(w^I)/G^F(w^F)$.