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ABSTRACT

Labor Market Regulation and Firm Adjustments in Skill Demand*

We study how changes in labor market regulation may trigger firm adjustments in skill demand. Leveraging rich administrative data from Italy, we investigate the effects of a reform that reduced firing costs for permanent employees and tightened temporary contracts' regulation to increase job stability. By using a difference-in-differences design, we document that the reform had unintended effects, inducing firms to increase layoffs of unskilled permanent employees and reducing hirings of unskilled workers on temporary contracts, but had no effect on skilled workers or permanent hirings. A theoretical search and matching model with heterogeneous skills and contract durations rationalizes our main findings.

JEL Classification: J42, J63, J65, M53

Keywords: labor market regulation, employment protection, temporary work, skill demand, worker flows

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1 Introduction

Two of the most significant shocks that have hit advanced economies in recent decades, namely the rise of computers (e.g. Autor et al. 1998), and globalization (e.g. Autor et al. 2014), have produced differential impacts by workers' skill levels, with losers primarily among low-skilled workers. However, labor market regulation and reforms aimed at tackling the dualistic labor markets that emerged in Europe after the so-called flexibilization "at the margin" of the '80s and the '90s (Boeri 2011), were not explicitly designed for workers with heterogeneous skill levels; instead, they usually targeted individuals employed with different types of contracts, i.e. temporary or permanent. Some examples are reforms changing the level of employment protection legislation (EPL) — i.e. firing costs — for permanent contracts (Dolado et al. 2016, Boeri and Garibaldi 2019) or those increasing the costs of using temporary contracts (Cahuc et al. 2022). Although scholars have extensively studied the effect of such policies on firm performance and total employment (e.g., Cahuc et al. 2020; 2022), little is known about how firms react to adjust their skill demand in response to a change in labor market regulation.

In this paper, we show that labor market reforms may have unintended effects on the firms' demand for skills, paradoxically harming the workers which they are primarily designed for (i.e. less resilient workers, such as the low-skilled ones). Using rich administrative data, we document that a reform aimed at reducing the gap in EPL between temporary and permanent workers had as its main effect an increase in separations and a reduction of hirings of low-skilled workers. In addition to contributing to this scant empirical literature, we propose a theoretical model to rationalize our main findings, i.e., a differential effect of the reform according to workers' skill levels and types of contracts, by building upon the search and matching model of Cahuc et al. (2016), where temporary and permanent jobs coexist in the economy.[1]

We study empirically the effects of the the so-called "Fornero Reform" that was part of a new wave of reforms in various EU countries that has sought to address duality by discouraging the use of fixed-term contracts (Cahuc et al. 2020) and, more broadly, to reduce the gap in EPL between fixed-term and open-ended jobs over the last decade. Italy is an interesting case to analyze, in light of the strong dualistic features of its labor market, with fixed-term contracts that account for a large share of new jobs. The Fornero Reform had two main pillars, namely a reduction in EPL for permanent workers and a tightening of the regulation for the use of fixed-term contracts. Indeed, before the Fornero Law, workers in firms with more than 15 employees had the right, in the case of a dismissal declared unfair by a court of law, to ask for reinstatement (and receive all foregone wages plus health and social security contributions) or receive monetary compensation. By way of contrast, for smaller firms, it was (and still is) up to the employer to decide whether to reinstate the

[1] Their framework is extended by allowing for the presence of skilled and unskilled workers characterized by different productivity levels. Moreover, in our setting, firms may decide not to destroy a job even if it is no longer productive. This occurs if the opportunity cost of keeping the firm-worker match is lower than the firing costs.

worker (without paying foregone wages) or pay a smaller monetary compensation. The Fornero Law limited the possibility for workers of firms with more than 15 employees to opt between reinstatement and monetary compensation to a set of well-defined cases (see the following Section); moreover, it reduced the amount of the monetary compensation and eased the uncertainty surrounding the duration and costs of litigation, which used to be non-negligible, especially in certain areas of the country (Gianfreda and Vallanti 2017).

A second aspect of the reform concerned the restrictions on the use of temporary contracts (e.g., longer intervals between two successive temporary contracts for the same worker-firm match) and the increase in social security contributions for fixed-term workers. The aim of the reform was thus to encourage firms to open permanent positions by both reducing EPL for permanent workers and increasing the costs of fixed-term contracts, thereby reducing the EPL gap between permanent and temporary contracts (Dolado et al. 2016).

In this study, we analyze the effects of a comprehensive labor market reform on hirings and separations (layoffs and quits) by both skill (high versus low) and type of contract (permanent versus temporary). Our analysis is based on Italian administrative data from the National Social Security Institute (INPS) that provides detailed information on hirings and separations by skill level and type of contract for workers of all Italian firms. We focus on the period 2010-2014, since by extending the time horizon the effects of the 2012 Fornero Law would be confounded with those of another major labor market reform introduced in 2015, the so-called "Jobs Act" (Boeri and Garibaldi 2019). In the econometric analysis, we identify the impact of the reform using the 15-employee threshold in a difference-in-differences (DID) research design. As noted above, the reduction in EPL for permanent workers occurred only for firms above this threshold, which therefore constitute the treatment group. Moreover, before the Fornero Reform firms above the 15 employee-threshold tended to employ a larger share of workers on fixed-term contracts, compared to smaller firms, in order to escape the more stringent regulation on permanent contracts (see, for instance, Hijzen et al. 2017, and Section 5 of this paper). For this reason, larger firms were also more exposed to the part of the reform which increased the costs of employing temporary workers. This in turn allows us to use DID to identify the overall impact of the reform on firms' hirings and separations.

Our empirical analysis shows that the Fornero Reform did not have any effect on either hirings or separations in the case of high-skilled workers.[2] By contrast, for low-skilled workers, the reform led firms to reduce hirings of fixed-term workers, while it did not increase hirings of permanent workers. In the case of low-skilled workers, we also document an increase in separations above the 15-employee cutoff, which is mostly driven by layoffs and not by voluntary quits or contract terminations. These results are robust to a large battery of robustness checks, including changes in the estimation sample and alternative definitions of the firm "legal size" that is relevant for the application of EPL.

[2] We refer to "skilled" or "high-skilled" ("unskilled" or "low-skilled") workers as those that spent more time in the educational system to acquire job-related skills, typically university graduates. We refer to Section 4 for details.

Additional analyses reinforce the interpretation that the estimated impacts were induced by the reform. For instance, the aforementioned effects are stronger in those areas of the country where labor trials used to take longer. Indeed, longer trials were inducing firms exposed to higher firing costs for permanent workers to use more fixed-term contracts before the reform. Thus, lowering dismissal costs removed these incentives. Consistently, we also find that the impact of the reform on hirings was larger in those firms above the 15-employee threshold that used to employ, before the reform, a larger share of temporary workers.

In a nutshell, we add to the empirical literature by showing that comprehensive labor market reforms aimed at narrowing the gap between regulation of open-ended and fixed-term contracts (i.e., lowering firing costs and tightening regulation of fixed-term positions) may backfire on low-skilled workers. Our findings are consistent with Bassanini and Cingano (2019) who showed, for a sample of OECD countries, that episodes of liberalization of permanent contracts are followed by a reduction in employment and that such negative impact is larger and longer lasting during downturns.

On the theoretical side, our model extends previous work by Cahuc et al. (2016) and offers two main insights that are broadly consistent with our empirical findings. First, an increase in the costs of opening a fixed-term position lowers the probability of signing temporary contracts and such effect is larger in the case of unskilled workers. This result comes from the fact that firms deciding to hire high-skilled workers are less influenced by this policy change because their expected profits are reduced by a relatively lower percentage amount. Second, a reduction in firing costs leads to an increase in layoffs, especially among low-skilled workers. This is because, in our model, lower firing costs increase the incentives to destroy unproductive jobs.[3] In turn, unproductive matches are more frequent among low-skilled workers, as the opportunity cost of saving an unproductive job is lower for less productive matches. So the resulting increase in layoffs is larger for low-skilled workers.

The paper proceeds as follows. Section 2 discusses the connections of this paper with the past literature. In Section 3 we illustrate the reform and the institutional background, while in Section 4 we describe the data. Our DID strategy is explained in Section 5. In Section 6, we comment on the main empirical findings, provide evidence on the parallel trend assumption and effect dynamics, and report triple-difference estimates leveraging variation in firms' use of temporary contracts (before the reform) and courts' efficiency — affecting the incidence of temporary contracts' costs and firing costs, respectively. This section also includes some robustness checks. In Section 7, we present a theoretical model that rationalizes some of our key empirical results. Finally, Section 8 draws conclusions.

[3] See Cacciatore and Fiori (2016) for a similar result within a real business cycles model with search frictions that reducing firing costs sharply increases layoffs because firms tend to instantaneously destroy unproductive matches.

2 Related literature

Our paper speaks to two main strands of literature, one empirical, and the other theoretical. First, it refers to the large body of empirical work on the effects of EPL on various economic outcomes.[4] In particular, our work is strictly related to recent papers investigating the effect of labor market reforms changing temporary contracts' regulations on worker flows. Recently, some scholars have investigated the effects of reforms that made the use of temporary contracts more costly or difficult in France and Portugal, and demonstrated that dual labor market reforms may backfire, and reduce firm performance and employment (Cahuc et al. 2020; 2022).[5] A study for Italy provides evidence on a reform going in the opposite direction, which made temporary contracts easier to use by eliminating the requirement to specify a reason for their use (causal clause). Di Porto and Tealdi (2022) focuses on workers' careers and finds that this reform decreased the likelihood of contracts becoming permanent by about 12.5 percentage points in the initial months after the reform and by 5.1 percentage points over a year. As a result, two years following the reform, the wages of the affected workers dropped by 25%.

Our paper is also related to studies on the effect of reforms reducing EPL and, in particular, firing costs. Evidence from an Italian reform that was implemented in 2015 (the "Jobs Act"), which also affected firms above the 15-employee cutoff, shows that some negative effects of dual labor market reforms can be avoided when the reduction of EPL is coupled with firm subsidies to transform temporary contracts into permanent ones. Indeed, both Sestito and Viviano (2018) and Boeri and Garibaldi (2019) document an increase of hirings with open-ended contracts after the "Jobs Act."[6] Ardito et al. (2022) is one of the few studies investigating the effect of EPL reforms by workers' skill levels. The authors find a positive effect of the "Jobs Act" on net changes in worker flows in the Piedmont region, especially of low-educated, low-skilled workers or workers performing basic manual tasks; an increase in new open-ended contracts, mainly through conversion of temporary contracts (benefiting

[4] The literature is too rich to be surveyed here. We could mention, among the many others, Schivardi and Torrini (2008) on a firm's propensity to grow; Bjuggren (2018) on productivity; Bratti et al. (2021) on firm-provided training; Ciminelli et al. (2022) on labor shares; Cingano et al. (2016) on business investment; Leonardi and Pica (2013) on wages; Martins (2009) on workers' effort; Oyer and Schaefer (2002) on workers' returns to experience; Bottasso et al. (2017) on firm dynamics; Griffith and Macartney (2014) and Aghion et al. (2021) on innovation; Hijzen et al. (2017) on worker turnover; Kugler and Pica (2008) and Bassanini and Garnero (2013) on worker flows.

[5] Similar findings that temporary contracts are an important tool available to firms for reducing labor costs are provided by Daruich et al. (2022). Leveraging an Italian reform that lifted constraints on the employment of temporary contracts, the authors show that after the introduction of incentives for using temporary work, firms increased the use of temporary contracts and experienced lower labor costs and higher profitability. Other papers investigated the effect of changing temporary contract regulation. Grasso and Tatsiramos (2022) study the effect of the 2018 reform that tightened the regulation of temporary contracts in Italy, using data on online vacancies and find a reduction (increase) in the relative hiring of temporary (permanent) workers as well as a shift towards more skilled workers. See also Centeno and Novo (2012) — who find that a tightening of EPL for permanent workers caused an increase in excess worker turnover and an increase in the share of temporary workers in Portugal — and Cappellari et al. (2012) on apprenticeship and temporary contracts.

[6] Pigini and Staffolani (2021) find that the "Jobs Act" did not negatively affect job survival probability and that treated firms changed their recruitment strategy in favor of potentially more productive workers. Leveraging an earlier reform (in 1990) that tightened firing costs for firms below the 15-employee threshold in Italy, Kugler and Pica (2008) find that higher EPL reduced job and worker flows with a negative effect on firm entry.

from social contribution rebates), again mainly targeting low-skilled workers. These effects are interpreted as firms using "defensive strategies," i.e., competing by reducing costs, rather than investing in innovation. From an empirical point of view, compared to their study, we focus on overall Italy and on a different reform, which while reducing firing costs also provided much lower tax rebates for temporary to permanent contracts' conversions.

We are not the first to investigate the effects of the Fornero Reform on worker flows. O'Higgins and Pica (2020), for instance, using *aggregated* firm data on hirings,[7] show that the Fornero Reform increased permanent hirings, particularly amongst the youngest workers. Important for these findings are the complementarities between EPL reduction and Active Labor Market Policies targeted at young workers (i.e., the Youth Guarantee). We add to this paper by using firm-level data and focusing on firms' demand for skills.[8]

Adding the skill dimension is also our main contribution to a second strand of (theoretical) literature that adopts a search and matching framework to analyze labor market reforms aimed at tackling duality. For instance, Cahuc et al. (2016) show how EPL entails a large job reallocation that favors temporary contracts with negligible effects on total employment, whereas Cahuc et al. (2020) focus on the impact of taxation of temporary contracts on the duration of jobs. Charlot and Malherbet (2013) also use a matching model *à la* Pissarides (2000) to study how firing costs and other policies that reduce labor turnover may have a positive effect on human capital accumulation. A different view on the role played by temporary jobs in the labor market is taken by Pries and Rogerson (2005) and Faccini (2014) that, by assuming workers as both inspections and experience goods, look at the benign effects of unrestricted job turnover. In particular, short-term contracts can be seen as a screening device that allows firms to terminate unfitting matches at no cost. Unlike these papers, our model emphasizes the differential effect of labor market reforms on worker flows (hirings and firings) by workers' skill level and type of contract.

3 Institutional context and the Fornero Reform

Prior to the Fornero Reform, individual dismissals in Italy were regulated by law 604/1966 and law 300/1970 (also called "Statuto degli Lavoratori," Workers' Statute). According to these laws, workers' dismissals were legitimate in cases of "just cause" or "justified reasons." The just cause is represented by transgressions or misconducts on the part of employees, which undermine the relationship of trust established with their employers; in other words, it arises when the employee engages in disciplinary conduct that is so serious as not to allow even a provisional continuation of the employment relationship. The justified reason can

[7] Cells are defined as the intersection between firm size, province, 2-digit industry sector, contract type, age, and gender.

[8] Our paper is indirectly related to Berton et al. (2017) investigating the effect of the Fornero Reform on the quality of job matches, namely the probability that a worker is well matched to her job in terms of educational requirements (i.e. median level of education). Using individual-level data from the Italian Labor Force Survey, the authors document an increase in the probability of a "good" match of 9.5%, and an increase in firm productivity. Compared to Berton et al. we do not look at the worker side but investigate the firm side, in particular how firms adjusted their demand for skilled and unskilled workers after the reform.

be subjective, almost always linked to a breach by the employee of her contractual duties, or objective, for reasons inherent in the production activity, its proper functioning, and the organization of work, such that no reasonable alternatives exist.

The level of protection enjoyed by unfairly terminated workers prior to the 2012 legislative revisions was arguably stronger in the case of employees working in enterprises with more than 15 employees. In fact, an employee who was wrongfully fired from a company with more than 15 employees could request reinstatement and receive lost wages as well as health and social security contributions (for a minimum of 5 months) related to the time between the dismissal and the sentence if a judge deemed the dismissal to be unfair. Although reinstatement was the most likely outcome in practice, the wrongfully terminated worker still had the option of receiving a severance payment equal to 15 months' worth of pay. Contrarily, in businesses with fewer than 15 employees, it was up to the employer to decide whether to reinstate the wrongfully terminated employee (without paying any forgone income) or to make a severance payment, which varied from 2.5 to 14 months for extremely senior employees (Hijzen et al. 2017). When taking into account the *de facto* expenses connected with the extremely long average duration of labor trials in Italy, the greater *de jure* costs for employers in the case of enterprises with more than 15 employees were further increased: over the years 2007 to 2010, Gianfreda and Vallanti (2017) indicate that labor trial decisions took an average of about 850 days, with significant regional variance.

Law 92/2012, also known as "Fornero Reform," came into force on July 18th, 2012. Such reform was based on two main pillars, namely, a reduction in EPL for permanent workers and a tightening of the regulation for the use of fixed-term contracts. As for the first aspect, the Fornero Law limited the possibility for workers of firms with more than 15 employees to opt between reinstatement and monetary compensation to a set of well-defined cases. In particular, the reform made a first, important change to the regulation of dismissals, providing for different levels of protection based on the type of illegitimacy of the dismissal: full real protection, limited real protection, strong compensation protection, and weak compensation protection.

In the event of a discriminatory dismissal — but also for null and/or oral dismissals — regardless of the size of the company, the worker has the right to *full real protection*: the judge declares the dismissal void and orders the employer to reinstate the employee and pay him an indemnity calculated on the basis of the last salary accrued from the day of dismissal to that of reinstatement. However, this amount must not be less than 5 months' salary and the employer is also required to pay contributions. The same type of protection is granted to working mothers dismissed during pregnancy or maternal leave.

In the most serious cases of unjustified dismissal, workers are protected by *limited real protection*. These are situations in which the judge, having analyzed the case, realizes that a justified subjective reason or just cause does not actually exist or that the behavior of the worker that caused the dismissal could be punished with a different sanction (with a conservative sanction, on the basis of the reference collective agreement or disciplinary codes). In these situations, the dismissal is canceled and the employer is forced to reinstate the em-

ployee, pay her an indemnity calculated on the basis of the last salary from the day of the dismissal to that of the reinstatement (a sum which, in any case, must not exceed the 12 months) and pay the contributions.

Dismissal for an illegitimate justified objective reason occurs, for example, when the worker is fired for economic reasons or because the employer declares her physically and/or psychologically unfit to continue the activity: in both cases, if the judge considers these reasons to be non-existent, *limited real protection* is applied.

The last two forms of protection envisaged by the Fornero Reform, on the other hand, concern the possibility of receiving only compensation, thus excluding reintegration into the company. Depending on the case, the reform entails *strong compensation protection* for those situations in which the dismissal is unjustified in a less serious way (for the judge, the extremes of just cause or justified reason do not apply). The employment relationship is declared concluded from the day of the dismissal, but the employer must in any case compensate the worker with an indemnity ranging from a minimum of 12 to a maximum of 14 months. The *weak compensation protection* is applied for formal or procedural violations (for example the employer did not report the reasons for the dismissal in the written document or did not comply with the procedure to the letter); also in this case the relationship is declared terminated and the employer must pay the employee a sum which cannot be less than 6 months or more than 12.

The worker unjustly dismissed by a company with fewer than 15 employees had the right to *mandatory protection*: in the absence of just cause or justified reason, the judge cancels the dismissal and obliges the employer either to rehire the worker within 3 days or to compensate her with an indemnity from a minimum of 2.5 to a maximum of 6 months. If the dismissal is discriminatory, void, or oral, *full real protection* also applies in the case of small businesses.

The second pillar of the reform concerns changes in the regulation of temporary contracts. Two main novelties contribute to increasing the cost of temporary contracts. The first is a rise by 1.4% in social contributions paid by firms for temporary workers, used to finance the Social Insurance for Employment (ASPI, "Assicurazione Sociale per l'Impiego"). Such contributions are partially refunded when contracts are converted to permanent. The second is the lengthening of the time interval between successive temporary contracts. In the case of a temporary contract stipulated with the same worker, at least 90 days (20 before the reform) or 60 days (10 before the reform) must pass in the case of a contract lasting more than or equal to 6 months. The main novelties introduced by the reform, and the expected effects on labor costs, are summarized in Table 1.

Finally, another component of the Fornero Law concerns incentives introduced for apprenticeship contracts. This part of the reform mostly relates to younger workers.[9] For this group of workers, the reform entails at least six months of training, with a maximum duration of 36 months. In particular, the Fornero reform changes the apprentices to employees ratio

[9] More precisely, for individuals aged between 15 and 25 the reform concerned vocational education and training, while for the 18–29 age the reform affected vocational apprenticeship, higher education and research apprenticeship.

Table 1: Main novelties introduced by the Fornero (labor market) Reform

Permanent contracts		*Temporary contracts*	
Changes introduced by Fornero Law	Effect on labor costs (sign)	Changes introduced by Fornero Law	Effect on labor costs (sign)
EPL: Reintegration limited to specific cases, less court's discretionality (reform of Article 18)*	(-)	No "causal close" for first contract below 12 months	(-)
		Longer interval after expiration before automatic conversion into permanent	(-)
Validation of worker resignations (to fight blank resignations)	(+)		
		Longer interval between temporary contracts	(+)
		Higher social security contributions (partly rebated in case of conversion into permanent contracts)	(+)
		Stricter regulation of other atypical work	(+)
		Validation of worker resignations (to fight blank resignations)	(+)

Note. The table reports the main novelties introduced by the Fornero Reform in the regulation of permanent and temporary contracts. *Only firms above 15 employees.

that increases from 1 to 1 to 3 to 2 for firms above 10 employees and it remains 1 to 1 for smaller firms. Moreover, it introduces a cap on hiring apprentices in the absence of (or less than 3) workers in the same occupation. Maida and Sonedda (2021) document that thanks to the reform, workers hired with an apprenticeship contract had a one-percent point increase in the probability of entering an open-ended contract.[10]

An even more radical reform of EPL came into force in 2015, through the "Jobs Act" (Law 183/2014, passed in December 2014). By introducing a new type of permanent contract with "graded security" that allowed employment protection to rise with worker tenure and limited the possibility of reinstatement of workers to discriminatory dismissals, excluding this possibility for dismissals for economic reasons, the law reduced workers' *real protection*. Additionally, a sizable hiring subsidy for new hires with open-ended contracts was introduced by the 2015 Budget Law. Basically, firms were exempted from paying social security contributions up to an annual ceiling of 8,060 Euros and for three years after the recruitment of a worker (see Boeri and Garibaldi 2019, Sestito and Viviano 2018, for further details on the "Jobs Act").

4 Data

Data used in this paper are made available by INPS through the VisitINPS Scholars program B. We use data from different sources at the worker and firm level, that are subsequently merged using anonymized fiscal codes (for both workers and firms). In what follows, we describe each source of data and discuss sample selection. In Appendix A, we provide details on the procedure carried out in order to create the final dataset for the analysis.

We obtain data on hirings and separations from the "UniLav" module (*Unificato Lavoro*, also called UniLav-ISCO). The latter is filled by the employer and comprises information on different types of events at the firm level: hirings, renewals, transformations, and separations.[11] For both hirings and separations we have information on the exact date of the event,

[10] In order to avoid confounding effects related to this part of the reform, our sample selection excludes firms with less than 10 employees. See next Section for details.

[11] As we explain in detail below, we also obtained additional data on transformations of temporary contracts into permanent ones. However, these data were made available to us at the very end of the project when the

the level of education of the worker (reported by the employer), and details on her specific occupation for each single employment episode. UniLav uses the Italian National Statistical Institute (ISTAT) classification of occupations (*Classificazione delle professioni 2011*) and information is available at the 5-digit level.[12] The classification of schooling levels is standard: no education, primary, secondary, tertiary and above. From this source of data, we are able to calculate the number of hirings and separations at the firm level for each year and level of skill.

We also use hiring episodes from the UniLav-ISCO dataset in order to derive the skill content of jobs either by leveraging information on the education level of workers hired in those occupations or classifying as skilled certain occupations that require tertiary education. To do this, as mentioned above, we initially aggregate education into three main levels, corresponding to primary (or no education), secondary, and tertiary. As far as occupation is concerned, we aggregate data at the 3-digit level, resulting in 145 occupations. In line with the over-education literature, we use occupation cell-level data to address some potential measurement errors in workers' education, especially because it is reported by employers. The cell methodology allows us to achieve two goals: 1) it addresses potential measurement errors or missing data due to employers' (non-)reporting;[13] 2) it is more in line with the definition of skilled/unskilled jobs (in terms of the level of education they require) compared to that of high-educated/low-educated workers, as workers in certain jobs may be over-educated or under-educated. We present nonetheless results using the original education variable reported by employers.

We alternatively employ the following criteria to classify workers as high-skilled vs. low-skilled using information on hirings. We consider as high skilled those workers who report tertiary education (usually indicated in what follows as "Education"). In a second definition, workers are defined as high skilled if the 3-digit occupation corresponds to intellectual, scientific, and highly specialized occupations (indicated using the label "Occupation"). Alternative criteria for defining the skill content of jobs are based on education statistics computed at the occupation level. The "Mean" indicator classifies jobs as high skilled when, at the 3-digit occupation, the average level of tertiary educated individuals is higher than the mean across all occupations (corresponding to about 30% of observations); "Median" refers to jobs as high skilled when, at the 3-digit occupation, the workers' median level of education is tertiary (corresponding to about 6% of observations); finally, according to the "Mode" indicator workers are high skilled when, at the 3-digit occupation, the modal level

main dataset was created, hence information on transformations was merged ex-post to the final dataset. In principle, information on transformations was also available in the UniLav data, but it was not possible to recover the type of transformation (e.g. from temporary to permanent contracts). See more details below.

[12] This classification is based on the ISCO classification (International Standard Classification of Occupations). See https://www.istat.it/en/archivio/18421 for additional details.

[13] For around 21% of observations in the raw data the employer reported no level of education for the worker. Using the "Education" measure (see below) we consider these episodes as concerning unskilled workers. The reason is that given the relatively small size (between 10 and 20 employees, see below) of firms included in the estimation sample and the low number of university graduates employed by these firms, employers are likely to report more precisely tertiary education compared to lower education. Measures based on occupational cells are not affected by this imputation.

of education is tertiary (corresponding to about 8% of observations).

As mentioned above, this procedure has some similarities with that used to classify over-educated or under-educated workers, in which individual education is put in relation with the educational level prevailing in a given occupation. An example is the use of deviations from the median educational level in a given occupation, as a proxy of being under- or over-educated vs. matched with a given occupation, in terms of education. Similarly, we define as skilled-jobs those in which workers with a tertiary degree are prevalent, according to the criteria above.[14] In Table B8 in the Appendix we report, separately for hirings and separations, correlations between different measures of skills as calculated above. The correlations are generally high, especially within the same skill level (high skilled, low skilled).

In order to recover additional information on each hiring episode, using the individual worker identifier, we merge the UniLav-Isco data with data on *Rapporti di lavoro annuali* (Uniemens, Annual Labor Relationships). This second source of data comprises information on the universe of employment episodes each year for private sector workers (excluding agriculture), hence it includes information on both stocks (workers already employed in ongoing jobs) and flows (hirings and separations).[15] This allows us to recover information on the type of contract (permanent versus fixed term), and working arrangements (full-time versus part-time) of hirings and separations. Finally, the Uniemens data enable us to identify the types of separations, i.e., layoffs, quits, and contract terminations.

INPS also provides information on firm-level data (*INPS aziende annuali*, INPS Annual Firms). In particular, the dataset comprises information on different establishments for each firm, the sector of activity, the age of the firm (entry and exit dates), the location (region and province level), and a large set of employment-related information. In particular, information on the number of employees on the payroll is available also by type of contract (permanent versus temporary), and working time arrangement (full versus part-time).

Finally, additional information at the firm level (on incorporated businesses) is provided by the CERVED dataset. The data reports information on balance sheets and income statements but no information on firm size. The sample is slightly unbalanced towards large firms, with small firms somewhat less represented. In particular, from these data, we use the information on (per worker) sales and (per worker) labor costs as measures of firm performance.

In Appendix A, we provide details about the merge procedure for the above datasets. In the end, we obtain a firm-level dataset for the years 2010-2014 that comprises about 4 million observations for the population of firms in the range 2-100 employees, with about 790,000 observations per year.[16] This is the starting firm population to which we apply further selection criteria.

[14] In order to compute the "Occupation", "Mean", "Median" and "Mode" indicators we used the universe of hiring episodes in 2010-2014. Since for each worker-firm match there are multiple observations for each year, we proceeded to drop multiple observations for the same worker-firm pair.

[15] We excluded workers in regulated professions (*casse professionali*), in agriculture, domestic workers, and collaborators. We also dropped seasonal workers. This is related to the legal definition of firm size.

[16] As mentioned, we exclude years from 2015 onward as a second important reform took place in Italy, the "Jobs Act."

In our analysis, we use a balanced 5-year panel that considers only non-agriculture and single establishment firms. This is done mainly because it makes it easier to identify the firm size relevant for the application of EPL. Moreover, we focus on firms with 10 to 20 employees in the main empirical estimation. The lower bound of 10 employees is due to changes in certain rules about apprenticeship introduced by the Fornero Reform for firms above 10 employees (see Section 3). Although not strictly required by our DID strategy, we impose an upper bound of 20 employees when selecting firms to be included in the sample in order to avoid using too large firms, compared to the 15-employee cutoff relevant for the EPL rules. We also focus on a balanced panel in order to ensure that our results are not driven by changes in the sample composition after the reform; however, we also run some robustness checks using the unbalanced panel. These selection criteria result in a balanced panel of 55,134 firms followed for 5 years, i.e., from 2010 to 2014.[17]

As for firm size, following Boeri and Garibaldi (2019), we use the variable *forza aziendale* (readily available in the firm data, i.e., *Aziende annuali*), and we keep fixed the firm size at the beginning of the estimation period (namely, at January 2010). This is made mainly for two reasons. First, to make the "treatment" of interest predetermined with respect to the outcome variables. Indeed, hirings and separations affect the *current* firm size, which in turn determines the "treatment" variable (being above/below the 15-employee cutoff). Second, the Fornero reform is likely to affect current firm size, making the "treatment" variable potentially endogenous. However, trying to avoid an endogeneity issue we might run into a measurement error one, which could affect the magnitude and precision of our estimates.[18] Indeed, some firms below/above the 15-employee cutoff in January 2010 might have changed size and switched above/below the threshold in the pre-reform period; in that case, the "treatment" variable would be measured with error. Of the 55,134 unique firms appearing in our main estimation sample, 81.7% of firms below 15 employees in January 2010 remain below the cutoff in the whole pre-reform period (2010 and 2011), and 77.2% of firms above the cutoff remains above for the whole pre-reform period. Overall, in the pre-reform period 80.6% of firms are "stayers" in terms of their position with respect to the 15-employee threshold. In order to assess the influence of this measurement error, we also estimate models only focusing on the sample of size "stayers."

In Tables 2, 3 and 4 we report descriptive statistics based on the samples used in our "baseline estimates" for hirings, separations and conversions of temporary into permanent contracts.

[17] The balanced panel is comprised of firms that appeared in all years from 2010 to 2014. During the estimation procedure two observations are automatically dropped.

[18] Simply speaking, in an Instrumental Variables (IV) setting, we could think of our model as the reduced form model in which firm size at January 2010 is an instrument for current firm size. In this case, our estimates should be rescaled by the first stage coefficient of currently being above 15 on being above 15 employees in January 2010.

Table 2: Descriptive statistics: Hirings

Variables	N.	mean	sd
low skilled (Occupation)	275,668	1.120	4.435
high skilled (Occupation)	275,668	0.033	0.073
low skilled (Mean)	275,668	0.905	4.041
high skilled (Mean)	275,668	0.142	1.323
low skilled (Median)	275,668	1.139	4.465
high skilled (Median)	275,668	0.022	0.651
low skilled (Mode)	275,668	1.117	4.426
high skilled (Mode)	275,668	0.032	0.718
low skilled (Education)	275,668	1.079	4.344
high skilled (Education)	275,668	0.037	0.708
permanent low skilled (Occupation)	275,668	0.254	1.653
permanent high skilled (Occupation)	275,668	0.008	0.328
temporary low skilled (Occupation)	275,668	0.621	3.392
temporary high skilled (Occupation)	275,668	0.019	0.531
permanent low skilled (Mean)	275,668	0.195	1.484
permanent high skilled (Mean)	275,668	0.042	0.548
temporary low skilled (Mean)	275,668	0.525	3.136
temporary high skilled (Mean)	275,668	0.073	0.990
permanent low skilled (Median)	275,668	0.258	1.666
permanent high skilled (Median)	275,668	0.006	0.290
temporary low skilled (Median)	275,668	0.633	3.415
temporary high skilled (Median)	275,668	0.013	0.471
permanent low skilled (Mode)	275,668	0.252	1.648
permanent high skilled (Mode)	275,668	0.009	0.330
temporary low skilled (Mode)	275,668	0.622	3.389
temporary high skilled (Mode)	275,668	0.017	0.512
permanent low skilled (Education)	275,668	0.244	1.623
permanent high skilled (Education)	275,668	0.011	0.325
temporary low skilled (Education)	275,668	0.600	3.319
temporary high skilled (Education)	275,668	0.021	0.526

Note. See Section 4 for details concerning the different measures of skills. "sd" stands for standard deviation.

Table 3: Descriptive statistics: Separations

Variables	N.	mean	sd
low skilled (Occupation)	275,668	0.642	2.664
high skilled (Occupation)	275,668	0.015	0.438
low skilled (Mean)	275,668	0.495	2.374
high skilled (Mean)	275,668	0.090	0.828
low skilled (Median)	275,668	0.651	2.680
high skilled (Median)	275,668	0.011	0.408
low skilled (Mode)	275,668	0.641	2.662
high skilled (Mode)	275,668	0.015	0.434
low skilled (Education)	275,668	0.623	2.614
high skilled (Education)	275,668	0.018	0.425
permanent low skilled (Occupation)	275,668	0.381	1.793
permanent high skilled (Occupation)	275,668	0.009	0.326
temporary low skilled (Occupation)	275,668	0.140	1.395
temporary high skilled (Occupation)	275,668	0.004	0.216
permanent low skilled (Mean)	275,668	0.282	1.556
permanent high skilled (Mean)	275,668	0.061	0.601
temporary low skilled (Mean)	275,668	0.119	1.281
temporary high skilled (Mean)	275,668	0.017	0.418
permanent low skilled (Median)	275,668	0.386	1.806
permanent high skilled (Median)	275,668	0.006	0.307
temporary low skilled (Median)	275,668	0.142	1.400
temporary high skilled (Median)	275,668	0.003	0.198
permanent low skilled (Mode)	275,668	0.379	1.792
permanent high skilled (Mode)	275,668	0.009	0.326
temporary low skilled (Mode)	275,668	0.141	1.395
temporary high skilled (Mode)	275,668	0.004	0.205
permanent low skilled (Education)	275,668	0.370	1.767
permanent high skilled (Education)	275,668	0.011	0.320
temporary low skilled (Education)	275,668	0.136	1.357
temporary high skilled (Education)	275,668	0.004	0.207

Note. See Section 4 for details concerning the different measures of skills. "sd" stands for standard deviation.

Table 4: Descriptive statistics: Conversions from temporary to permanent contracts

Variables	N.	mean	sd
total	275,668	1.201	3.227
High skilled			
high skilled (Education)	275,668	0.071	0.718
high skilled (Occupation)	275,668	0.052	0.686
high skilled (Mean)	275,668	0.287	1.534
high skilled (Median)	275,668	0.039	1.123
high skilled (Mode)	275,668	0.062	1.122
Low skilled			
low skilled (Education)	275,668	1.064	2.630
low skilled (Occupation)	275,668	1.114	3.090
low skilled (Mean)	275,668	0.803	2.766
low skilled (Median)	275,668	1.138	2.964
lwo skilled (Mode)	275,668	1.102	2.929

Note. See Section 4 for details concerning the different measures of skills. "sd" stands for standard deviation.

5 Empirical strategy

In order to identify the effect of the Fornero Reform on hirings and separations (y_{it}), we use a DID design implemented through Two-way Fixed Effects (TWFE). Indeed, as all firms were treated *in the same period,*, that is the year of the introduction of the reform (2012), TWFE enables us to estimate the average treatment effect on the treated (ATT). The estimated equation reads as follows

$$y_{it} = \gamma_0 + \gamma_1 above_{i0} + \gamma_2\ post_t + \gamma_3(above_{i0} \times post_t) + u_{st} + v_{rt} + \varepsilon_{it}, \tag{1}$$

where $above_{i0}$ is an indicator for (legal) firm size (*forza aziendale*) being above 15 employees, with size fixed at time 0 (January 2010) to make it predetermined with respect to the reform (Boeri and Garibaldi 2019);[19] $post_t$ is a post-2011 indicator; $(above_{i0} \times post_t)$ is the DID variable of interest, whose associated coefficient γ_3 measures, under the usual DID assumptions, the average treatment effect on the treated of the reform. Finally, u_{st} and v_{rt} capture sector-by-year and province-by-year fixed effects that account for possible different propensities to hire and fire workers in different sectors, but also local differences in labor market conditions, which have been found to affect the propensity of courts of law to adjudicate in favor of firms or workers, on issues related to Art 18 alleged violations (Ichino et al. 2003). Equation (1) has been estimated with OLS and cluster-robust standard errors have

[19] In the paper, we sometimes refer to firms above 15 employees as "large", and those below the cutoff as "small" firms.

been considered, where the cluster dimension is firm code. Because we set firm size at January 2010, equation (1) above estimated by OLS may be seen as estimating an Intention to Treat (ITT): indeed, firms that belong to the control group may overcome the 15-employees threshold and vice versa, possibly creating measurement error. Even if, as noted in the data section, most firms do not change "treatment status" over time, as a robustness check we also consider an IV-DID identification strategy, similar to those in Leonardi and Pica (2013) and Bjuggren (2018). In particular, we consider as treated those firms that, in 2011, just before the reform, were above the 15 employees threshold and we instrument the DID term with the interaction between the $post_t$ dummy and a treatment status that is based on firm legal size as of January 2010. In this case, the validity of the IV-DID identification strategy requires the usual DID assumptions (no anticipation and parallel trends, see below), but also additional ones like independence, exclusion restriction, the existence of a first stage, and the monotonicity of the instrument.

The analysis of the effects of labor market reforms "treating" firms above the 15-employee cutoff has also been addressed by means of the regression discontinuity design (RDD) approach. The main reasons why we prefer to adopt a DID identification strategy are mainly two. First, the definition of firm size given by Article 18 of the Workers' Statute, which also defines treated firms according to the Fornero Reform, is quite complex, so that it is difficult to precisely identify a firm's legal size. Indeed, identification fails in RDDs when the forcing variable is measured with error (Davezies and Le Barbanchon 2017). By way of contrast, DID is generally more robust to measurement error as identification is less local (i.e. in our case it is not at a potentially misclassified cutoff). Second, it may sound a bit odd to look for employment effects of the Fornero reform (that changed EPL) but at the same time claim no manipulation of the running variable before the reform, namely firm size, which would entail that EPL was not actually affecting firm hiring and firing behavior (near the threshold in an RDD) before the reform.

Firms above 15 and larger use of temporary contracts

In our analysis, we consider firms above the 15-employee cutoff as more exposed not only to the part of the reform decreasing firing costs but also of the part that increased the cost of temporary contracts, mainly because firms above the cutoff are more likely to use temporary contracts.

Although, as already noted, the previous literature suggests that firms above the 15-employee threshold used temporary contracts relatively more in order to escape the steep increase in firing costs of permanent employees, we show in Table 5 that, this is also true in our estimation sample. Before the Fornero Reform (i.e. for the years 2010 and 2011), larger firms had on average a larger stock of workers on temporary contracts.[20] The estimates in

[20] Unlike in the DID specifications using panel data, in which the inclusion of the time-invariant firm size (in January 2010) is redundant (Wooldridge 2022), here we include firm size to investigate whether there is a discontinuity in the use of temporary contracts at 15 employees. If firm size is excluded, the estimated coefficients on the variable *above* in columns (1)-(4) are 0.275 (s.e.=0.033), 0.275 (s.e.=0.083), 1.334 (s.e.=0.059) and 1.228 (s.e.=1.228), respectively.

Table 5: Temporary contracts around the threshold before the Fornero Reform

Variables	(1) # hirings temporary	(2) % hirings temporary on employee stocks	(3) # stock temporary	(4) % temporary on employee stocks
above	0.048	0.180	0.461***	1.385***
	(0.054)	(0.143)	(0.094)	(0.285)
normalized firm size	0.050***	0.021	0.190***	-0.034
	(0.009)	(0.026)	(0.016)	(0.052)
Observations	110,267	110,267	110,267	110,267
R-squared	0.068	0.070	0.154	0.150
Mean dep.	0.627	2.468	2.877	14.43
% effect	7.640	7.303	16.03	9.599

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. Estimated on the 2010-2011 period (i.e. before the reform). Above is a dummy equal to one for employment above 15 employees. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on above variable by the mean of the dependent variable and multiplying the result by 100. Before the reform, greater EPL (Article 18 of Workers' Statute) produced a larger incentive for large firms of using temporary contracts.

column (4) demonstrate an about 10% increase in the percentage of temporary workers at the cutoff. This implies that those firms were more exposed to both pillars of the Fornero Reform, namely the reduction in firing costs for permanent employees and the increased labor costs associated with the temporary contracts.

6 Results

6.1 Main results

Tables 6 and 7 show our baseline results for both hirings and separations on the balanced panel of firms with a predetermined firm size in the range of 10-20 employees. In both tables, we report results for different types of contracts (permanent and temporary) and by skill (high-skilled and low-skilled workers). As far as skill measurement is concerned, we focus on the "Education" and "Median" definitions of skills that have been described in Section 4:[21] in short, "Education" refers to the reported level of educational qualification possessed, while "Median" is an indicator variable equal to one for workers in jobs where, at the 3-digit occupation level, the median level of education is tertiary.

Focusing on hirings in Table 6, estimates suggest a statistically significant reduction in the number of hirings of low-skilled workers. Our estimates in both panels suggest that the Fornero Reform entailed a reduction of about 0.16 hirings of low-skilled workers: in the case of treated firms, this is equivalent to an about 10 percent fall in the average number of low-skilled hirings with respect to the period before the reform. Results suggest that this finding is mainly driven by firms' lower propensity to hire low-skilled workers with a temporary contract; indeed, we find, after the reform, a reduction of about 0.1 unskilled workers who are hired with a temporary contract, which corresponds to an average reduction of about 11 percent. By way of contrast, we do not find any statistically significant effect of the reform on the hiring of highly skilled workers. Moreover, results do not depend at all on the way we define workers' skill levels.

Turning to separations in Table 7, our estimates suggest that the reform caused an increase in the number of separations of low-educated workers with a permanent position, independently of the way we define skills. In particular, the estimates (column 3) show that the reform generated an increase of about 0.05 separations of permanent low-educated employees,[22] that is equivalent to an about 11 percent increase in the average number of separations for this category of workers for treated firms compared to the pre-reform period. Moreover, also in the case of separations, we do not find any significant impact on highly educated (or skilled) workers.

In order to better understand the nature of such results, we have run regressions for different types of separations, namely layoffs, quits, and terminations. Estimates reported in Table 8 suggest that, in the case of low-skilled workers on a permanent contract, the increase in separations induced by the reform is entirely due to an increase in layoffs: in particular, when considering Education, the DID coefficient amounts to an increase in the number of layoffs in firms above the 15-employee threshold of about 65 percent compared to the pre-reform period.

[21] As a robustness check, we also report results obtained by replicating the analysis using all other skill definitions discussed in Section 4: see Tables B1 and B2 in Appendix B.

[22] In what follows, we often use low-educated and low-skilled interchangeably.

Table 6: Baseline Results: Hirings

Variables	(1) unskilled	(2) skilled	(3) unskilled permanent	(4) skilled permanent	(5) unskilled temporary	(6) skilled temporary
			Panel A: skill measure is Education			
above	0.433***	0.014**	0.054***	0.004	0.268***	0.007*
	(0.042)	(0.006)	(0.015)	(0.003)	(0.032)	(0.004)
post×above	-0.159***	0.002	-0.011	-0.001	-0.098***	0.003
	(0.038)	(0.007)	(0.015)	(0.004)	(0.029)	(0.006)
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.080	0.033	0.028	0.012	0.064	0.026
Mean dep. variable	1.564	0.0452	0.323	0.0138	0.878	0.0243
% effect	-10.15	3.953	-3.379	-3.789	-11.16	11.55
			Panel B: skill measure is Median			
above	0.464***	0.004	0.060***	0.001	0.285***	0.002
	(0.044)	(0.005)	(0.016)	(0.003)	(0.033)	(0.004)
post×above	-0.170***	0.001	-0.015	0.001	-0.102***	0.002
	(0.039)	(0.006)	(0.016)	(0.004)	(0.030)	(0.004)
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.080	0.035	0.027	0.010	0.064	0.027
Mean dep. variable	1.658	0.0237	0.342	0.00782	0.932	0.0120
% effect	-10.26	5.841	-4.382	6.540	-10.96	13.08

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of hirings by skill and type of contract. In Panel A Skill is defined on the basis of reported Education, in Panel B Skill is measured as median level of skill at the cell level, see Section 4 for details. Above is a dummy equal to one for firm employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100.

Table 7: Baseline Results: Separations

Variables	(1) unskilled	(2) skilled	(3) unskilled permanent	(4) skilled permanent	(5) unskilled temporary	(6) skilled temporary
			Panel A: skill measure is Education			
above	0.165***	0.010*	0.050***	0.007	0.067***	0.002
	(0.024)	(0.005)	(0.014)	(0.005)	(0.014)	(0.002)
post×above	0.013	-0.003	0.041**	-0.003	-0.018	-0.000
	(0.024)	(0.004)	(0.016)	(0.003)	(0.013)	(0.002)
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.041	0.017	0.033	0.011	0.017	0.010
Mean dep. variable	0.753	0.0240	0.366	0.0155	0.218	0.00580
% effect	1.785	-12.14	11.18	-16.74	-8.187	-0.111
			Panel B: skill measure is Median			
above	0.178***	0.007	0.054***	0.007	0.071***	0.001
	(0.025)	(0.004)	(0.014)	(0.005)	(0.015)	(0.001)
post×above	0.009	-0.003	0.042**	-0.004	-0.020	0.001
	(0.025)	(0.004)	(0.017)	(0.003)	(0.014)	(0.002)
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.040	0.017	0.033	0.011	0.017	0.009
Mean dep. variable	0.795	0.0147	0.385	0.0109	0.230	0.00254
% effect	1.079	-22.28	10.81	-34.26	-8.749	25

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of separations by skill and type of contract. In Panel A Skill is defined on the basis of reported Education, in Panel B Skill is measured as median level of skill at the cell level, see Section 4 for details. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100.

Table 8: Baseline Results: Different types of Separations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	layoffs				quits			
Variables	unsk. perm.	sk. perm.	unsk. temp.	sk. temp.	unsk. perm.	sk. perm.	unsk. temp.	sk. temp.
				Panel A: skill measure is Education				
above	-0.007	0.001	0.000	0.000*	0.024***	0.000	0.008***	0.001*
	(0.006)	(0.000)	(0.002)	(0.000)	(0.006)	(0.001)	(0.003)	(0.000)
post×above	0.048***	-0.000	-0.000	-0.000	0.004	0.002	0.003	-0.001**
	(0.009)	(0.001)	(0.002)	(0.000)	(0.008)	(0.001)	(0.004)	(0.000)
Observations	275,668	275,668	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.029	0.006	0.006	0.006	0.011	0.008	0.006	0.005
Mean dep. variable	0.0729	0.00150	0.00868	3.74e-05	0.131	0.00486	0.0325	0.00146
% effect	65.47	-33.26	-0.111	-52.46	2.901	39.74	-10.51	-67.62
				Panel B: skill measure is Median				
above	0.035***	0.001	0.065***	0.004*	0.024***	0.001	0.009**	0.000
	(0.013)	(0.002)	(0.015)	(0.002)	(0.007)	(0.001)	(0.003)	(0.000)
post×above	0.064***	0.004	-0.006	-0.003**	0.005	0.001	0.003	-0.000
	(0.017)	(0.003)	(0.004)	(0.002)	(0.008)	(0.001)	(0.004)	(0.000)
Observations	275,668	275,668	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.033	0.010	0.017	0.010	0.011	0.008	0.006	0.006
Mean dep. variable	0.356	0.000565	0.230	0.00539	0.138	0.00284	0.0341	0.000524
% effect	17.94	67.94	-2.482	-64.00	3.532	39.01	8.649	-86.91

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of separations by skill and type of contract. In Panel A Skill is defined on the basis of reported Education, in Panel B Skill is measured as median level of skill at the cell level, see Section 4 for details. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100.

In Table 9 we analyze the effect on contract transformations. Our estimates suggest a strong and statistically significant reduction in the number of transformations of unskilled workers from temporary to permanent in the case of treated firms. This result may seem surprising; indeed, one might expect that, given the increasing costs of new fixed-term positions and the contemporary reduction in EPL for permanent ones, firms should have increased transformations. Moreover, to further push transformations, the Reform had also foreseen (as discussed in Section 3) that employers had the right to be paid back (for a maximum period of six months) the additional social security contribution of 1.4% for temporary contracts in the case of transformations into permanent ones. However, the relatively mild additional contribution, combined with the six-month cap, made the generosity of the rebate very small, unlike in the case of the "Jobs Act" which indeed caused a large increase in the number of transformations (Boeri and Garibaldi 2019). A possible explanation for the fall in the number of transformations is that the reduction of hirings of temporary workers also impacted negatively on later transformations. Another rationalization could be that following the increase in costs associated with new fixed-term positions, firms may expect new hires on temporary positions to be more productive than in the past and therefore more likely to be stabilized with permanent contracts in the future. This intuition is further explored in the second part of the paper (see Section 7) in which we introduce a theoretical model to analyze some implications of increasing the costs associated with temporary contracts (and of reducing firing costs).

6.2 Common trend assumption, anticipation effects, and dynamic effects

In this Section, we briefly discuss the common trend assumption in the pre-reform period to underpin the validity of our research design. In order to analyze this issue, we conduct an event-study DID which allows us to estimate year-specific coefficients for the $above_{i0} \times year_t$ interactions, where $year_t$ are year indicators (and we omit the first year before the reform, 2011).

Reassuringly, graphs reported in Figure 1 show that the coefficients of the treatment interaction with the 2010 year indicator are not statistically different from those with the 2011 year indicator (omitted from the graph because it represents the baseline). This evidence is consistent with a common trend in the pre-reform period.[23]

The reader might wonder whether firms were perceiving the novelties introduced by the Fornero Reform as very temporary, in which case we would have observed a very small adjustment in the demand for skills in the post-reform period. We tend to exclude this possibility. The reform of Article 18 by the Fornero Law did not come out of the blue, it was

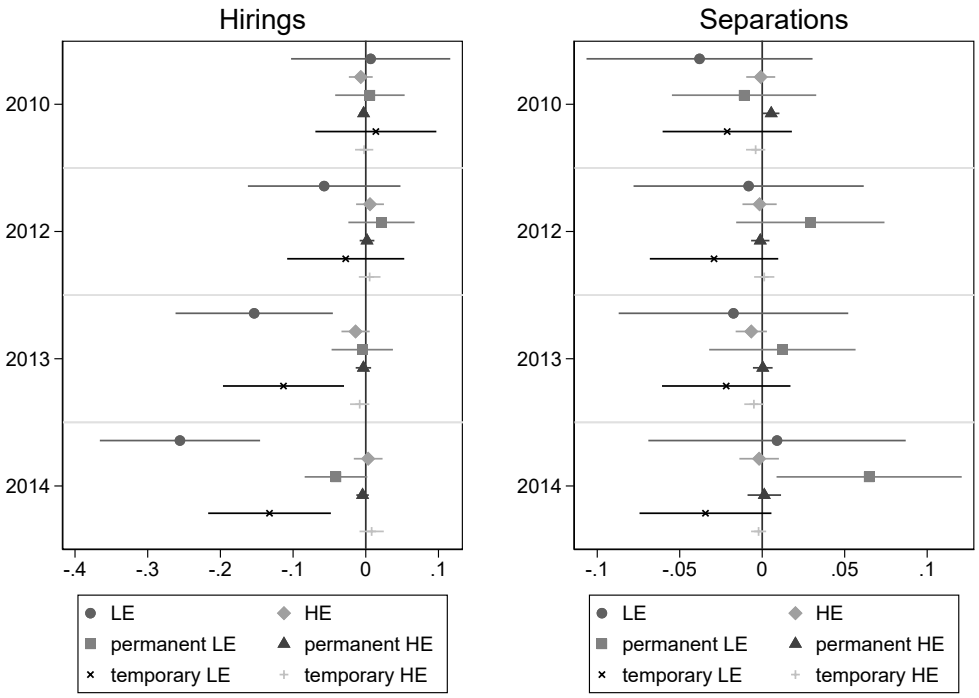
[23] The event-study estimates also provide information on a "fake-treatment placebo," a falsification test that is sometimes done by anticipating the time of the treatment. Indeed, the 2010 and 2011 coefficients are not statistically different, and therefore the *fake-treatment* falsification, in which 2010 is used as the base year would produce the same estimates.

Table 9: Transformations from temporary to permanent contracts

Variables	(1) total	(2) skilled (Education)	(3) skilled (Median)	(4) unskilled (Education)	(5) unskilled (Median)
above	0.493***	0.031***	0.027**	0.425***	0.451***
	(0.033)	(0.007)	(0.011)	(0.029)	(0.030)
post×above	-0.119***	0.000	0.012	-0.115***	-0.129***
	(0.027)	(0.004)	(0.013)	(0.023)	(0.023)
Observations	275,668	275,668	275,668	275,668	275,668
R-squared	0.051	0.051	0.014	0.060	0.053
Mean dep. variable	1.753	0.0966	0.0557	1.554	1.661
% effect	-6.777	0.266	21.53	-7.404	-7.755

Note. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the number of transformations from temporary to permanent by skill. In columns 2 and 4 Skill is defined on the basis of reported Education, in columns 3 and 5 Skill is measured as median level of skill at the cell level, see text for detail. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A firm-size bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100.

Figure 1: Event study, Hirings and Separations (skill measure: Education)



Note. The figure presents the event-study DID estimates of the effect of the reform on hirings and separations. 2011 is the year immediately preceding the introduction of the 2012 Fornero Reform and is omitted from the graph. Bars represent 95% confidence intervals and symbols point estimates. LE and HE stand for low educated and high educated, respectively.

the result of other attempts to reform it, such as a bill proposed by Senator Pietro Ichino in 2008 to drop the workers' real protection for firings for economic reasons. So, we think that both firms and unions were considering the reform as permanent and "transversal" to governments' political orientation. Indeed, the following labor market reform, the "Jobs Act," was introduced by a left-wing government and kept the main pillars of Fornero's, introduced by a "technical" government.

On a different note, since the Fornero Law was the result of a long discussion about "Article 18" that started many years before, and various attempts at reforming it, a concern could be that the Reform might have been anticipated by firms. In this case, we would have expected an anticipation of the hirings of temporary workers, whose costs were expected to increase in the future, immediately before the reform. The same holds for permanent workers if the reason for the low permanent hires were the high firing costs. However, in both cases we do not see in Figure 1 any difference between the base (omitted) year 2011 and 2010. So, we do not find any evidence of anticipatory effects in the data.

A last remark concerns the time pattern of the effects. A possible concern with our analysis is that in the short time span observed after the reform, some effects may not have had enough time to manifest. As to temporary contracts, a possible objection is that the

negative effect on hirings may be observed only when the existing contracts come to an end and temporary workers are not replaced. However, Figure 1 suggests that the reduction of hirings of low-skilled workers in temporary contracts appears quite early, from the first year after the reform, and is of comparable magnitude in 2013 and 2014. So we expect our estimates not to capture very short-term effects but also medium-term effects. We do not see any positive trend in the effects on the hirings with permanent contracts, actually, if any, there is a slight reduction over time. This is inconsistent with firms requiring a longer time — compared to what we observe — to hire workers with permanent contracts, in which case we should find an increasingly positive effect over time.

Finally, Figure 1 highlights a positive effect on separations of low-skilled permanent workers, which is however limited to the last year we observe and we cannot exclude that the effect would be larger considering a longer time span (however, doing it, the effect would be confounded with the "Jobs Act"). Thus, taken for its face value, the event study DiD suggests that our estimate on separations could be a *lower bound*.

6.3 Triple-difference results

To sharpen our interpretation that the estimated effects are due to the Fornero Reform, we estimate a triple-difference version of equation (1).

Larger use of temporary contracts before the reform

Results reported in Table 5 show that, before the Fornero Reform, firms above the 15-employee threshold had a larger share of temporary workers, so those firms should have been more exposed to the reform component that tightened the regulation of temporary contracts. The reduction in the hiring of temporary workers observed in our DID estimates should be particularly salient for firms above the threshold that, before the reform, used to employ a relatively larger share of temporary workers. In order to better identify the impact of the Fornero Reform we, therefore, estimate the following triple difference model:

$$\begin{aligned} y_{it} =& \gamma_0 + \gamma_1 above_{i0} + \gamma_2\ post_t + \gamma_3 (above_{i0} \times post_t) + \gamma_4\ sharetemp_{i0} + \\ & \gamma_5\ (sharetemp_{i0} \times post_t) + \gamma_6\ (sharetemp_{i0} \times above_{i0}) + \gamma_7\ (sharetemp_{i0} \times above_{i0} \\ & \times post_t) + u_{st} + v_{rt} + \varepsilon_{it}, \end{aligned} \tag{2}$$

where the variable "*sharetemp*" refers to the percentage of temporary workers as measured in January 2010, normalized in order to have zero mean and unit standard deviation. The triple interaction term is the triple difference coefficient of interest. Estimates of equation (2) in the case of hirings are reported in Table 10 and suggest that the coefficient of interest has the expected sign, being negative and statistically significant. In other words, the empirical results confirm that the Fornero Reform caused a reduction in the number of hirings of unskilled workers, entirely driven by hirings of unskilled workers with a temporary contract. The effect was clearly larger in firms above the 15-employee threshold that, before the

reform, used to rely more on temporary workers.[24] Table 10 points to an additional negative effect of the reform on hirings of temporary low-skilled workers of 23% (=0.202/0.878*100) for a one-standard deviation increase in the percentage of temporary workers at the baseline.

[24] Additional results for an alternative measure of skills are reported in Appendix B (see the following Section).

Table 10: Heterogeneity: Hirings. % of temporary contracts (skill measure: Education)

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. tem.p	(6) sk. temp.
above	0.307***	0.011**	0.055***	0.004	0.163***	0.004
	(0.037)	(0.005)	(0.015)	(0.003)	(0.027)	(0.004)
above × % temp 2010	0.549***	0.011	0.008	0.004	0.400***	0.004
	(0.098)	(0.015)	(0.019)	(0.003)	(0.085)	(0.014)
post × above	-0.107***	0.002	-0.013	-0.000	-0.055**	0.003
	(0.035)	(0.007)	(0.015)	(0.004)	(0.026)	(0.005)
post × above × % temp 2010	-0.288***	0.002	-0.008	-0.006	-0.202***	0.009
	(0.084)	(0.019)	(0.019)	(0.004)	(0.075)	(0.018)
post × % temp 2010	-0.426***	-0.000	0.036***	0.004**	-0.382***	-0.006
	(0.037)	(0.005)	(0.010)	(0.002)	(0.034)	(0.005)
% temp 2010	1.172***	0.030***	-0.027***	-0.005***	1.014***	0.033***
	(0.044)	(0.007)	(0.008)	(0.002)	(0.042)	(0.007)
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.133	0.035	0.028	0.012	0.128	0.029
Mean dep. variable	1.564	0.0452	0.323	0.0138	0.878	0.0243

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of hirings by skill and type of contract. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. The share of temporary workers is measured in January 2010 and it is standardized. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period.

Table 11: Heterogeneity: Separations. % of temporary contracts (skill measure: Education)

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
above	0.131***	0.009*	0.055***	0.007	0.039***	0.001
	(0.022)	(0.005)	(0.014)	(0.005)	(0.012)	(0.001)
above × % temp 2010	0.152***	-0.001	0.005	-0.005*	0.100***	0.002
	(0.053)	(0.006)	(0.018)	(0.003)	(0.039)	(0.005)
post × above	0.026	-0.003	0.036**	-0.003	-0.005	-0.000
	(0.023)	(0.003)	(0.016)	(0.003)	(0.012)	(0.001)
post × above × % temp 2010	-0.050	-0.000	0.008	0.000	-0.025	0.001
	(0.049)	(0.007)	(0.019)	(0.002)	(0.037)	(0.005)
post× % temp 2010	-0.123***	0.004	0.055***	0.003***	-0.142***	-0.000
	(0.021)	(0.002)	(0.008)	(0.001)	(0.017)	(0.002)
% temp 2010	0.319***	0.005*	-0.061***	-0.003**	0.280***	0.007***
	(0.022)	(0.003)	(0.006)	(0.001)	(0.018)	(0.002)
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.052	0.018	0.034	0.011	0.043	0.011
Mean dep. variable	0.753	0.0240	0.366	0.0155	0.218	0.00580

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of separations by skill and type of contract. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. The share of temporary workers is measured in January 2010 and it is standardized. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period.

In turn, in the case of separations (see Table 11), the triple difference coefficient is small and not statistically significant from zero. Given that we have already seen above that the effect on separations was entirely driven by layoffs, we can interpret this result by noting that all firms above the 15-employee threshold, independently of their initial stock of temporary workers, reacted to the reduction in firing costs of permanent employees by increasing firings.

Efficiency of courts

In Table 12 we report the results of a similar exercise but mainly related to the size of firing costs. Previous literature (Garibaldi and Violante 2005) has shown that firing costs above the 15-employee threshold may depend on the efficiency of local labor courts. This is because if a firing was declared unjustified by the court, not only a firm above the 15 employees threshold had the duty to reinstate the unfairly dismissed worker, but it had also to pay all foregone wages, health, and social security contributions. This amount may be substantial if the court's decision is taken with long delays; moreover, because in Italy the duration of trials is highly heterogeneous, also the ex-post firing costs (i.e. those that take into consideration formal firing costs and those due to the foregone wages) are likely to be very different at local level. For instance, (Gianfreda and Vallanti 2017) have computed that ex-post firing costs used to be equivalent (over the period 2007-2010) to about 36 months of wages in Trento (North of Italy) versus 160 months in Salerno (South of Italy) for a blue-collar worker with 8 years of tenure in a firm above the 15-employee threshold. In Table 12, we report regressions for both hirings and separations after splitting the sample into two subsamples, i.e. between those firms operating in areas where local courts are above (Panel A and C) and below (Panel B and D) the median efficiency level.[25] As far as hirings are concerned, results in panels A and B show that the reduction in hirings of unskilled workers, and in particular of low-skilled workers with a temporary contract, has been much stronger in the areas of the country where courts' delays used to be longer, as should be expected in the light of the empirical evidence discussed above. Similarly, separations of permanent unskilled workers increased only in the areas of the country that used to be characterized by inefficient courts of law.

Taken together, these results seem to offer robust evidence that the reform may have induced a reduction in hirings and an increase in separations, thus determining a small reduction in the size of affected firms; moreover, because the impact of the reform is limited to the case of low-skilled workers, the reform may have generated also a small change in the composition of the workforce towards more skilled labor.

[25] The level of efficiency of the courts is measured for the years 2013-2014 in terms of the average duration of proceedings in the case of labor trials. See Cerruti et al. (2022) for details.

Table 12: Heterogeneity: Hirings and Separations. Efficiency of courts (skill measure: Education)

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
			Panel A: Hirings high-efficiency courts			
post×above	-0.144***	0.010	-0.019	-0.000	-0.060*	0.010
	(0.044)	(0.009)	(0.018)	(0.003)	(0.032)	(0.007)
Observations	179,026	179,026	179,026	179,026	179,026	179,026
			Panel B: Hirings low-efficiency courts			
post×above	-0.185***	-0.014	0.003	-0.001	-0.167***	-0.010
	(0.071)	(0.013)	(0.029)	(0.010)	(0.057)	(0.009)
Observations	96,637	96,637	96,637	96,637	96,637	96,637
			Panel C: Separations high-efficiency courts			
post×above	-0.008	0.001	0.016	0.001	-0.014	-0.000
	(0.029)	(0.004)	(0.019)	(0.002)	(0.015)	(0.002)
Observations	179,026	179,026	179,026	179,026	179,026	179,026
			Panel D: Separations low-efficiency courts			
post×above	0.049	-0.010	0.084***	-0.009	-0.026	0.000
	(0.045)	(0.008)	(0.030)	(0.007)	(0.024)	(0.002)
Observations	96,637	96,637	96,637	96,637	96,637	96,637

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of hirings by skill and type of contract. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The level of efficiency of the courts is measured in terms of the average duration of proceedings, see Cerruti et al. (2022) for details. Low (high)-efficiency courts are those below (above) the national median.

6.4 Robustness checks

In this section, we report the results of a set of robustness checks. First, we probe the robustness of our main results to the additional alternative definitions of workers' skills described in Section 4. In particular, we replicate the analysis after defining skills using three alternative measures, namely "Mean", "Mode" and "Occupation". The "Mean" indicator is a dummy equal to 1 for jobs at the 3-digit occupation level that are characterized by an average level of tertiary education higher than the overall occupations' mean; "Mode", is a dummy equal to 1 for jobs, at the 3-digit occupation, where the modal level of education is tertiary; finally,

"Occupation" in turn is a dummy equal to 1 for jobs whose 3-digit occupation refers to intellectual, scientific, and highly specialized occupations. The estimates reported in Table B1 and B2 suggest that the main results are broadly stable across alternative ways of measuring the skill content of jobs since the DID coefficients have similar magnitudes and statistical significance as those reported in our baseline estimates.

We further probe the robustness of our main results by adopting an alternative definition of firm size; in particular, instead of defining size with the full-time equivalent number of employees provided by INPS ("*forza aziendale*"), we measure firm size with a simpler proxy sometimes used in the previous literature, namely counting a full-time employee as one and part-time as 0.5. Empirical results displayed in Panel A of Tables B3 and B4 broadly confirm our previous results, i.e. we find a statistically significant reduction in hirings of unskilled workers with a temporary contract and a statistically significant increase in the separations of unskilled workers with a permanent position.

In Panel B of the same table we carry out an additional robustness check. So far we have focused on a balanced panel of firms in order to address potential compositional changes of the sample over time that may represent a threat to DID. Indeed, we cannot know the reasons underlying the exit of the firms from the panel, so that exit may indicate a closure of the firm or a merger. Therefore our results can identify the effects of the reform only for the sample of "continuing" firms that we can observe for the whole sample period. However, we now move to explore the effect of the reform on the whole unbalanced sample, i.e. we also keep in the panel those firms that we do not observe for the whole sample period. However, in this case, we also include firms' fixed effects.[26] Reassuringly, the empirical estimates suggest that, also in the case of the whole unbalanced panel, the reform has led to a fall in the hiring of unskilled workers with a temporary contract and an increase in the number of separations of workers with a permanent position, with a magnitude that is broadly comparable to that we observe for our main results.

Last but not least, we carried out some robustness checks associated with the timing in which the firm size, relevant for the application of the firing rules and the novelties introduced by the Fornero Reform, is measured. As we noted in Section 5, by measuring firm size in January 2010 we are ensuring that the treatment variable (i.e. a firm being above the 15 employee-threshold) is predetermined in our DID identification strategy. One may claim that a firm's decision to remain above vs. below the 15-employee cutoff might be partly driven by considerations related to firings costs as envisaged by Article 18 of the Workers' Statute, but we can be quite confident that firm size in January 2010 is unlikely to have been affected by expectations related to a reduction of the costs of dismissals that would have been introduced more than two years later by the Fornero Law. Looking, for instance, at searches for "riforma Fornero" the trend retrieved from Google Trends seems to be quite flat at zero before 2012

[26] It is important to note that in the case of a balanced panel, a DID model like that in equation (1), but augmented with a full set of firms fixed effect, would yield the same DID coefficient and standard errors as shown by Wooldridge (2022). This result does not carry through to the unbalanced panel case, where including firm fixed effects might be important to control for time-invariant firm unobserved characteristics that can explain the attrition in the panel.

(see Figure B3). Thus, we expect our estimates not to be affected by anticipation effects on firms' skill adjustments. We also discussed the absence of anticipatory effects in subsection 6.2. However, our estimate of what essentially is an ITT effect may be an underestimate of the effect of the reform, due to measurement error in firm size in the case of firms that were switching above/below the size cutoff (15 employees) between January 2010 and when the Fornero Law came into force. To address this possible concern: 1) we estimate the model on the sample of size "stayers" only. i.e. those firms that are always below or above the 15 employee-threshold over the observation period; 2) we estimate an IV-DID model in which a firm's size just before the implementation of the reform (average firm size in 2011) is instrumented with firm size in January 2010.

Table B5 reports the results of our baseline specification estimated over the sub-sample of "stayers" only. Results suggest the existence of a statistically significant decline in the number of hirings not only in the case of temporary but also for permanent unskilled workers (the latter is about half of the former's coefficient); moreover, estimates confirm the increase in the number of separations in the case of unskilled workers, but a decline in the separations of unskilled temporary workers. It is worth stressing that these estimates, although informative, are potentially plagued by sample-selectivity issues, as being a "stayer" (i.e. remaining on the same side of the cutoff) is presumably not exogenous with respect to the reform.

Finally, Table B6 shows the IV-DID estimates, where treatment status (above 15-employees) as of 2011 is instrumented with treatment status as of January 2010. We noted in Section 5 that our baseline OLS estimates are roughly the reduced form estimates of these IV-DID regressions. The first-stage results show that the above (above$\times$post) indicator measured in January 2010, that is just before the reform, is a good predictor of the corresponding indicator measured in 2010, and that there is no sign of weak identification. All in all, the empirical results confirm the OLS ones, although, in line with an ITT interpretation, the magnitude of the estimated coefficients is larger in the IV-DID case.

6.5 Additional results on firm performance

Taken together, our results imply that the Fornero Reform may have induced a small reduction in the size of affected firms since it has caused an increase in separations of permanent unskilled workers and a reduction in the hiring of temporary low-skilled ones. These differential effects on hirings and separations have also driven a reduction in the net flows of workers: indeed, in results not shown but available upon request, we find that, after the reform, there was a statistically significant decline in the net flow of both temporary and permanent workers. Moreover, because the impact of the reform is limited to the case of low-skilled workers, the reform may have generated a change in the composition of the workforce towards more skilled labor.[27] Indeed, this interpretation of our results is consistent with additional analyses that we have carried out on firm-level outcomes, such as revenues and labor costs. Interestingly, the empirical results reported in Table B7 show that, above the

[27] We remind the reader that skill levels are only available for relatively recent worker flows and not for workers hired before 2010.

15-employee threshold, after the reform both revenues and labor costs remained unchanged; by way of contrast, when we consider revenues per worker (a proxy of labor productivity) and labor costs per worker, we observe a statistically significant increase of about 1 percent. These findings are consistent with a decline in the size of the affected firms which, in a period of recession (GDP growth rates were negative during the 2012-2014 period in Italy), reduced hirings of temporary low-skilled workers (which had become more expensive) and increased layoffs of permanent low-skilled employees (which had been made easier by the reform). The restructuring process that ensued in the affected firms entailed both an increase in labor costs per employee (through an increase in the relative importance of high-skilled employees in the workforce and/or through an increase of extra working time, which tends to cost more) but also of sales per employee, which can be explained by the fact that firms exploited the reform to fire some permanent low-skilled workers for which the surplus from the firm-worker match had become negative, an intuition that is further developed by the theoretical model proposed in the next section.

7 Theoretical model

In this Section, we propose a theoretical model to explore the potential effects of dual labor market reforms such as the Fornero's, on hirings, firings, and contract transformations in a setting with two types of contracts (temporary, permanent) and two skill levels (low, high), consistently with the approach followed in the empirical section of the paper. Our framework builds upon the model of Cahuc et al. (2016) in which temporary and permanent jobs coexist in the same labor market. It is a partial equilibrium setting: we focus on the choices firms and workers have to make after they are brought together via a random search process, but we do not model such a process, thereby abstracting from vacancy creation and labor supply decisions. We add two distinctive features to Cahuc et al.'s setting. First, we assume that the labor force is composed of high-skilled and low-skilled workers. Second, we consider the possibility that, in some circumstances, for firms and workers, it is optimal not to cut a job even if it is no longer productive.

The remainder of this Section unfolds as follows. After explaining the general setting of the model, in subsections 7.1 and 7.2, we characterize permanent and temporary contracts, respectively. In subsection 7.3, we describe the equilibrium with permanent and temporary contracts. The following Sections present some comparative statics results. In subsection 7.4.1, we analyze the case of reforms increasing (Cahuc et al. 2020) or reducing (Daruich et al. 2022), the costs of temporary workers, that were introduced, for instance, in France and Italy, respectively. Subsection 7.4.2 presents comparative statics for reforms reducing (or increasing) firing costs for permanent workers, such as the Italian "Jobs Act", studied in Sestito and Viviano (2018) and Boeri and Garibaldi (2019). Finally, subsection 7.5 summarizes the main results and discusses the effect of reforms such as the Fornero Law, which both increased temporary contracts' costs and reduced firing costs for permanent workers. As

we will discuss below, our model, albeit highlighting some interesting mechanisms, mainly gives predictions in terms of the probability of workers being hired with different types of contracts or being fired, according to their skill levels, while effects on worker flows are difficult to derive analytically and remain an empirical matter. In a sense, the first part of this paper is not a test of the model, but our theoretical model is a first attempt at highlighting the processes potentially underlying the empirical evidence.

Consider an economy populated by a continuum of infinitely lived and risk-neutral workers that differ in two crucial aspects: skill levels and the value of unemployment. Workers are either high-skilled or low-skilled, the former being more productive. Let us denote with L_h (L_l) the measure of the high-skilled (low-skilled) labor force in the economy.

Each worker also has a different value of unemployment U. In our framework, U can be interpreted as the opportunity cost of being employed and consists of all the foregone value of non-working time in units of consumption. Of course, the value of the non-working period comprehends both leisure and the utility of searching for a job. The value of U is distributed along the interval $\left[\underline{U}, \overline{U}\right]$. We denote with $H_i(.)$ and $h_i(.)$ respectively the cumulative and the density functions for the value of unemployment of type i workers, with $i \in \{h, l\}$.[28] For the moment, we do not make any specific assumption on the differences between $H_h(.)$ and $H_l(.)$, though it is quite sensible to consider a greater value for U for the high-skilled workers (as unemployed, they expect to receive more remunerated job offers so the utility of searching is higher).

Time is continuous and the common discount rate is $r > 0$. There is a continuum of firms in the economy. To produce the unique consumption good (the numeraire), each firm needs to hire one worker. This is the standard one firm-one job assumption of search and matching models (see Pissarides, 2000, chapter 1). A high (low) skilled worker-firm pair produces y_h (y_l) units of the consumption good per unit of time, with $y_h > y_l$. In our partial equilibrium setting, we ignore vacancy creation conditions. Still, we can think of two perfectly segmented labor markets, one for the high-skilled and the other one for the low-skilled.

When a worker and a firm meet, a type λ is randomly selected from the interval $[\lambda_{min}, +\infty)$. The value of λ follows a cumulative distribution $G(.)$ and a density function $g(.)$.[29] Parame-

[28] We also assume that for both types of workers, the distribution has no mass point and a positive density over all its support.

[29] We also assume that such a distribution has no mass point and positive density over all its support.

ter λ stands for the constant Poisson rate at which the job becomes unproductive, so that the firm-worker pair produces 0 instead of y_i, with $i \in \{l, h\}$. Knowing λ, the firm-worker pair decides whether it is profitable to start a new labor relationship and, in case, which kind of contract to sign.[30]

Labor contracts may be of two types: open-ended or temporary. The latter have a fixed duration Δ. The crucial difference is that in case a match covered by a permanent contract becomes unproductive, the job can be destroyed with employers incurring firing costs F. F is the same across skill levels as it stands for red-tape costs and not severance payments, whose amount depends on the worker's wage. It is indeed well known that in models with risk-neutral agents and flexible wages (like the present one), severance pays do not influence labor market outcomes (Lazear 1990) as their impact can be offset by an efficient contract.

If the job is temporary, it cannot be terminated before the end of the contract. However, after the Δ period has elapsed, the firm-worker pair can decide to prolong their match, this time by signing an open-ended contract. So it is not possible in our model to have one temporary contract after another for the same job. It is a way to model the restrictions foreseen in many legislations to avoid the abuse of temporary contracts (e.g. 36 months according to the Fornero Law).

Finally, hiring a new worker involves fixed (red tape) initial costs c_n with $n \in \{p, t\}$, subscript p (t) standing for permanent (temporary). We assume that $c_p \approx c_t$: the costs a firm incurs to create a permanent job are not identical to those needed for a temporary one and, to remain as general as possible, we do not want to impose any specific different order of magnitude between them. Still, we assume that the differences are not as large as to be the main driver of the temporary vs. permanent jobs firm's choice.

[30] It is important to stress here that, in our framework, all the decisions are made by the firm and the employee together. So it is not the employer alone that decides the type of labor contract that must be signed or if it is profitable to destroy a job. What really matters is the maximization of the joint surplus, not just firms' profits (or workers' utility). This may appear odd, but it allows us to focus on the efficient scenario, the one of a social planner that wants to maximize the surplus of the economy with no distributive issues. Moreover, it simplifies the model, as the way the surplus of the match is split (i.e. the wages), does not play a role in the decisions.

7.1 Permanent jobs

Let denote with $S_{c,i,j}(\lambda)$ the surplus of continuing a permanent job of type $i \in \{l,h\}$ with a worker j and a shock arrival rate λ. It can be written as follows:

$$S_{c,i,j}(\lambda) = J_{c,i,j}(\lambda) + W_{c,i,j}(\lambda) + F - U_j.$$

The term $J_{c,i,j}$ stands for the discounted value for the firm, while $W_{c,i,j}$ is worker j's discounted utility. If the match is broken, the firm gets no profits and has to pay firing costs F while the worker j enjoys a utility in unemployment U_j.

If the job becomes unproductive, the firm-worker pair has to decide whether to destroy it or not. Of course, the match is not broken if its surplus $S_{c,i,j}$ when nothing is produced is greater than 0, otherwise, it is terminated. Keeping an unproductive job implies that the employer still pays a certain salary $w_{i,j}$ to the worker.[31] This means $rJ_{c,i,j} = -w_{i,j}$ and $rW_{c,i,j} = w_{i,j}$. So, the decision to break the match or not ultimately depends on the sign of $F - U_j$. When $F < U_j$ it is better to destroy an unproductive job because continuing it would entail a surplus $S_{c,i,j} < 0$. On the contrary, when $F > U_j$, it is more profitable to continue the unproductive match (that is paying the worker $w_{i,j}$ and not producing anything), as its value is greater than 0. Intuitively, this is likely to happen if firing costs are high and/or the opportunity cost of maintaining the job is low.

Let denote with j^* the marginal worker whose U_{j^*} is identical to F. For every firm-worker pair, it should be the same to destroy or to keep an unproductive match with worker j^*. For convenience, we assume that unproductive workers with utility in unemployment U_{j^*} are never laid off.

Now we turn the attention to the case in which the firm and the worker meet the first time. Here there are no firing costs to pay if no agreement is reached. So the surplus of starting a new match of type $i \in \{l,h\}$ with a worker j and shock arrival rate λ is

$$S_{p,i,j}(\lambda) = J_{p,i,j}(\lambda) + W_{p,i,j}(\lambda) - U_j$$

[31] As Cahuc et al. (2016) we assume that permanent workers earn a wage that can be renegotiated only by mutual agreement.

in which $J_{p,i,j}$ is the employers' discounted value of starting a new job. The term $W_{p,i,j}$ is the worker's discounted utility in employment. To study the behavior of $S_{p,i,j}(\lambda)$ we must analyze two separate cases, one in which the worker has utility in unemployment U_j lower than U_{j^*}, and the other one where $U_j > U_{j^*}$. The former would apply to a fraction $H_i(F) \cdot L_i$ of the labor force L_i, with $i \in \{l, h\}$, the latter to the remaining part $[1 - H_i(F)] \cdot L_i$.
The term $J_{p,i,j}(\lambda)$ verifies the following equation:

$$rJ_{p,i,j}(\lambda) = \begin{cases} y_i - w_{p,i,j} - \lambda \left(F + J_{p,i,j}\right) - (r+\lambda)\, c_p & \text{if } U_j > U_{j^*} \\ y_i - w_{p,i,j} - \lambda \left(\dfrac{w_{p,i,j}}{r} + J_{p,i,j}\right) - (r+\lambda)\, c_p & \text{if } U_j \leq U_{j^*}. \end{cases} \tag{3}$$

This type of equation is standard in search and matching models. Keeping a job of type $i \in \{l, h\}$ filled is like holding an asset, that ensures a flow of revenues $y_i - w_{p,i,j}$, the amount of production net of the wage costs, per unit of time. At a rate $\lambda \sim g[\lambda_{min}, +\infty)$, the job gets unproductive, implying a capital loss. If the worker has a utility in unemployment $U_j > U_{j*}$ (the first case on the right-had side of (3)), the job is destroyed. The capital loss is then given by firing costs $F + J_{p,i,j}$. If, on the contrary, $U_j \leq U_{j*}$ (the second case on the right-hand-side of (3)), firing costs are higher than the opportunity cost of the match and it is not profitable to destroy the job when, at a rate λ, it becomes unproductive. The firm will continue to pay the worker j a salary $w_{p,i,j}$ forever (this corresponds to a total value of $w_{p,i,j}/r$). The last term stands for the initial hiring costs c_p the firm has to bear when the open-ended labor relationship begins. On the other side of the market, workers' expected utilities from a permanent position verify the following equations:

$$rW_{p,i,j}(\lambda) = \begin{cases} w_{p,i,j} + \lambda \left(U_j - W_{p,i,j}\right) & \text{if } U_j > U_{j^*} \\ w_{p,i,j} & \text{if } U_j \leq U_{j^*} \end{cases} \tag{4}$$

with $i \in \{l, h\}$. An employee with a utility in unemployment $U_j > U_{j^*}$ earns a wage $w_{p,i,j}$ and faces the risk of losing her job at a rate λ. Her capital loss is then equal to $U_j - W_{p,i,j}$. On the contrary, a worker j with a utility $U_j \leq U_{j*}$ knows that she will get a wage $w_{p,i,j}$ even if the job gets unproductive.

We can use equations (3) and (4) to express the surplus $S_{p,i,j}(\lambda)$ as follows:

$$S_{p,i,j}(\lambda) = \begin{cases} \dfrac{y_i - rU_j - \lambda F}{r+\lambda} - c_p & \text{if } U_j > U_{j^*} \\ \dfrac{y_i}{r+\lambda} - U_j - c_p & \text{if } U_j \leq U_{j^*} \end{cases} \tag{5}$$

with $i \in \{l, h\}$. It is easy to see that, in both cases, $S_{p,i,j}(\lambda)$ is decreasing in λ. When $\lambda \to 0$, the expression on the right-hand side (RHS, hereafter) in (5) is positive.[32] As $\lambda \to +\infty$, the expressions on the RHS in (5) are negative.[33] So we can identify a unique threshold value denoted by $\lambda_{p,i,j}$, that verifies $S_{p,i,j}(\lambda_{p,i,j}) = 0$ and $S_{p,i,j} < 0$ for any $\lambda > \lambda_{p,i,j}$:

$$\lambda_{p,i,j} = \begin{cases} \dfrac{y_i - r\left(U_j + c_p\right)}{F + c_p} & \text{if } U_j > U_{j^*} \\ \dfrac{y_i}{U_j + c_p} - r & \text{if } U_j \leq U_{j^*} \end{cases} \tag{6}$$

with $i \in \{l, h\}$.

7.2 Temporary Jobs

Now let us focus on the surplus of a temporary job. Since we are assuming that it is not possible to break a temporary match before its date of termination, we do not have to consider two scenarios depending on the value of U_j. The surplus of starting a new temporary job of type $i \in \{l, h\}$ with a worker j and shock arrival rate λ is

$$S_{t,i,j}(\lambda) = J_{t,i,j}(\lambda) + W_{t,i,j}(\lambda) - U_j$$

in which $J_{t,i,j}$ is the employers' discounted value of starting a new temporary job. The term $W_{t,i,j}$ is the worker's discounted utility in temporary employment.

[32] It is equal to $\frac{y_i}{r} - U_j, -c_p > 0$ for any value of U_j.
[33] It is equal to $-F - c_p < 0$ if $U_j > U_{j^*}$ and equal to $-U - c_p < 0$ if $U_j \leq U_{j^*}$.

The former can be written as follows:

$$J_{t,i,j}(\lambda) = \int_0^{\Delta} \left[y_i \cdot e^{-(\lambda+r)\tau} - w_{t,i,j} \cdot e^{-r\tau} \right] d\tau + \max \left[J_{p,i,j}(\lambda), 0 \right] \cdot e^{-(\lambda+r)\Delta} - c_t \quad (7)$$

with $i \in \{l, h\}$. The first term on the RHS stands for the discounted sum of profits firms obtain for a temporary job with duration Δ. Notice that the amount of production y_i per unit of time is multiplied by $e^{-(\lambda+r)\tau}$ because we have to take into account both the time discount factor r and the fact that at a rate λ the job becomes unproductive ($e^{-\lambda\tau}$ is the survival function of the process). Conversely, the wage for temporary workers $w_{t,i,j}$ remains constant for the entire duration of the job so the discount factor is just $e^{-r\tau}$. Once the contract expires, the job may be transformed into a permanent one, if its value is greater than 0. Of course, such an option must be discounted by $e^{-(\lambda+r)\Delta}$. Finally, the last term on the RHS is the hiring cost paid at the beginning of the contract.

Similarly, the value of beginning a temporary contract with a shock arrival rate λ for a worker j of type $i \in \{l, h\}$ is:

$$W_{t,i,j}(\lambda) = \int_0^{\Delta} \left[w_{t,i,j} - rU_j \right] \cdot e^{-r\tau} d\tau + \max \left[W_{p,i,j}(\lambda), U_j \right] \cdot e^{-(\lambda+r)\Delta} + U \left(1 - e^{-(\lambda+r)\Delta} \right) \quad (8)$$

with $i \in \{l, h\}$.

The integral term on the RHS of (8) is the discounted value of being temporarily employed for a period of time Δ. These gains are obtained by subtracting the opportunity cost of employment rU_j from the wage $w_{t,i,j}$. Once the contract expires, if the job is still productive, the worker may become a permanent employee if her expected value $W_{p,i,j}$ is greater than the utility in unemployment U_j. The third term on the RHS is just the worker's outside option once the temporary contract ends.

Using the definition of the surplus $S_{t,i,j}$ and the equations (7) and (8), we get:

$$S_{t,i,j}(\lambda) = \int_0^{\Delta} \left[y_i e^{-\lambda\tau} - rU_j \right] \cdot e^{-r\tau} d\tau + \max \left[S_{p,i,j}(\lambda), 0 \right] \cdot e^{-(\lambda+r)\Delta} - c_t \quad (9)$$

with $i \in \{l, h\}$. Solving the integral, we obtain:

$$S_{t,i,j}(\lambda) = \frac{y_i}{r+\lambda}\left(1 - e^{-(r+\Delta)\lambda}\right) - U_j\left(1 - e^{-r\Delta}\right) + \max\left[S_{p,i,j}(\lambda), 0\right] \cdot e^{-(\lambda+r)\Delta} - c_t \quad (10)$$

with $i \in \{l, h\}$. The expression on the RHS of (10) is positive if $\lambda \to 0$, negative if $\lambda \to +\infty$, and decreasing in λ (computations are in Appendix C). So there exists a unique threshold $\lambda_{t,i,j}$ that verifies $S_{t,i,j}(\lambda_{t,i,j}) = 0$.

7.3 Equilibrium with permanent and temporary jobs

Once a firm meets a worker of type $i \in \{l, h\}$ and utility in unemployment U_j, they observe the value λ of their match and then jointly decide whether to sign an open-ended contract, a temporary one, or to separate and find other job opportunities.

We focus first on the labor market equilibrium for workers with $U_j > F$. Let us denote as $\lambda_{s,i,j}$ the value of λ such that $S_{t,i,j} = S_{p,i,j}$. The following Proposition summarizes our results:

Proposition 1. *Consider the labor market $i \in \{l, h\}$ for workers j with $U_j \in \left(F, \overline{U}\right]$. If:*

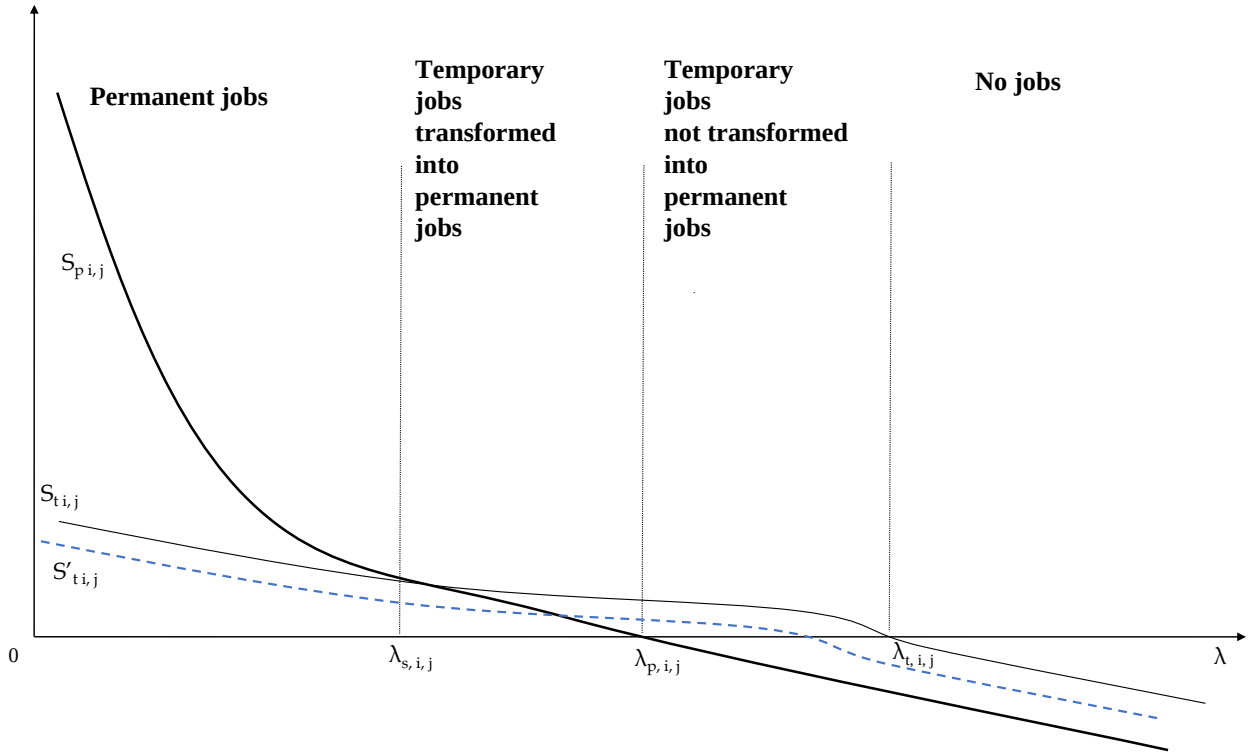
$$\frac{U_j + c_t}{y_i - r\left(U_j + c_t\right)} \cdot \log\left(\frac{y_i}{rU_j}\right) \;<\; \Delta \;<\; \frac{1}{r} \cdot \log\left(\frac{U_j}{U_j - F}\right)$$

then there exists a unique equilibrium with both permanent and temporary jobs.
In particular, for $\lambda < \lambda_{s,i,j}$, the firm-worker pair chooses an open-ended contract; for $\lambda_{s,i,j} < \lambda < \lambda_{t,i,j}$ a temporary job is created; for $\lambda > \lambda_{t,i,j}$ no contract is signed.

The formal proof is in Appendix C. Here we simply provide the intuitions for the results and a graphical representation of both cases. Note that, for any skill type $i \in \{l, h\}$, the amount and the composition of jobs (temporary or permanent) is different for any value of $U_j \in \left(F, \overline{U}\right]$.

Figure 2 illustrates the equilibrium. When $\lambda < \lambda_{s,i,j}$, starting a permanent job offers a higher surplus so firms and workers decide to sign an open-ended contract. That this occurs for low values of λ is understandable, as this means a higher expected duration of

Figure 2: Equilibrium with permanent and temporary jobs



Note. An increase in c_t shifts $S_{t,i,j}$ downwards.

a productive match. So the firm-worker pair prefers to start a long-term relationship and avoid paying both c_t and then c_p after a Δ period. Conversely, if λ is too high (precisely, $\lambda > \lambda_{t,i,j}$) the firm-worker pair mutually decides it is not profitable to start a new job, as the probability that it will become unproductive is too high. In the middle ground, we have the case for temporary jobs. When $\lambda_{s,i,j} < \lambda < \lambda_{t,i,j}$, the employer and the employee jointly decide it is better to sign a temporary contract. This happens when the risk that the job becomes unproductive is not sufficiently low. It is more convenient to wait, knowing that this could entail paying hiring costs twice (first c_t and then c_p) rather than taking the risk and incurring firing costs F. Note from Figure 2 that, within the interval $\lambda_{s,i,j} < \lambda < \lambda_{t,i,j}$, we can distinguish two different scenarios. When $\lambda_{s,i,j} < \lambda < \lambda_{p,i,j}$, then $S_{t,i,j} > S_{p,i,j}$

but $S_{p,i,j} > 0$. The firm-worker pair opts for a temporary job but with the idea of signing a permanent contract after Δ periods. Conversely, with $\lambda_{p,i,j} < \lambda < \lambda_{t,i,j}$, we have $S_{p,i,j} < 0$ and employers and employees choose a temporary contract having in mind that, at its expiration date, they will separate.

A final remark concerns the condition imposed in Proposition 1. The duration of the temporary contract must not be either too long or too short. The interpretation for this condition goes as follows. If Δ were too large, a temporary contract would be like a permanent one, but without the possibility of breaking the match in case it becomes unproductive. So nobody would choose this kind of agreement for any value of the shock arrival rate λ. Without a genuine trade-off between temporary and open-ended contracts, there would exist only permanent jobs in the economy.

Notice that the upper bound of Proposition 1 is increasing in F. So the condition in Proposition 1 is more likely to be satisfied if firing costs are large. Firms would be willing to sign a temporary contract with a longer duration Δ if breaking a permanent one is more expensive.

At the same time if the length of the temporary contract were too short, firms would pay hiring costs c_t for a job that would ensure just a tiny amount of profits. No employer would opt for such a solution and, again, only permanent contracts would be present in the economy. That also explains why the condition in Proposition 1 is less likely to be satisfied when c_t is large or the amount of production per unit of time y_i is low.[34]

We can turn the attention to the remaining part of the labor force, the workers whose utility in unemployment U_j is lower than F. Proposition 2 summarizes the results.

[34] The lower bound in the condition is increasing in c_t and decreasing in y_i.

Proposition 2. *Consider the labor market $i \in \{l, h\}$ for workers j with $U_j \in [\underline{U}, F]$. Then*

$$\Delta > \frac{U_j + c_t}{y_i - r\left(U_j + c_t\right)} \cdot \log\left(\frac{U_j + c_t}{U_j}\right)$$

is the necessary and sufficient condition for a unique equilibrium in which temporary and permanent contracts coexist in the market. In particular, for $\lambda < \lambda_{s,i,j}$, the firm-worker match chooses an open-ended contract; for $\lambda_{s,i,j} < \lambda < \lambda_{t,i,j}$ a temporary job is created; for $\lambda > \lambda_{t,i,j}$ no contract is signed.

The proof is in Appendix C. Proposition 2 is similar to Proposition 1. We still need a condition on Δ to ensure an equilibrium with both kinds of jobs. Unlike Proposition 1, however, in this case we just need a lower bound on the length of the temporary jobs. So, at the equilibrium, it is possible that workers with $U_j \leq F$ are employed under temporary contracts with an extremely large duration, something it is not admissible for employees with a higher reservation utility (i.e. $U_j > F$).[35] The reason for that is the following. We have seen that, if $U_j \leq F$, it is not optimal to destroy a job when it gets unproductive. The fraction of the labor force considered in Proposition 2 will never get fired but will continue to receive a certain wage while producing nothing. So in this scenario, a trade-off between temporary and permanent contracts exists even with a very large Δ: either to hire a worker knowing she will never be laid off or to sign a contract with a fixed and (possibly) large duration, after which, paying supplementary hiring costs, the agreement may become permanent.

For low values of λ (precisely $\lambda < \lambda_{s,i,j}$), the risk the job becomes unproductive is small. So it is better to sign a permanent contract and create a job for life rather than incur additional hiring costs once the temporary contract expires. Conversely, with a larger λ (that is $\lambda_{s,i,j} < \lambda < \lambda_{p,i,j}$), the occurrence of an adverse shock on the productivity of the match is higher. It is better to opt for a temporary contract and maybe transform it later into a permanent one by paying additional hiring costs. If $\lambda_{p,i,j} < \lambda < \lambda_{t,i,j}$ the best option is to open a temporary contract without the possibility of transforming it into a permanent one. With $\lambda > \lambda_{t,i,j}$ the risk the job becomes unproductive is too high and no contract is signed. Figure 2 illustrates these results.

[35] If $U_j \leq F$, then at the limit $\Delta \longrightarrow +\infty$ we have $S_{p,i,j} = S_{t,i,j}$, with $i \in \{l, h\}$ and for any value of λ. This can be easily seen by inspecting equations (5) and (10). Only in this extreme case, the firm-worker pairs are indifferent between temporary and permanent contracts and the results of Proposition 2 do not hold.

Finally, notice that the reason we need a lower bound for the results in Proposition 2 to hold is the same presented discussing Proposition 1. Too low a value for Δ implies a very small surplus for the resulting temporary job: nobody would find it convenient to sign this contract, paying a fixed cost c_t to produce the consumption good for such a small amount of time. Only permanent jobs would exist in the economy for any value of λ.

7.4 Comparative statics on the effect of the Fornero Reform

7.4.1 An increase in hiring costs for temporary jobs

In this section, we study the effects of an increase in hiring costs for the creation of temporary jobs, c_t. From equation (10), a variation in c_t affects the surplus $S_{t,i,j}$ for any skill type $i \in \{l, h\}$ and utility $U_j \in \left[\underline{U}, \overline{U}\right]$. In turn, as Figure 2 makes it clear, a shift of the $S_{t,i,j}$ curve influences both $\lambda_{s,i,j}$ and $\lambda_{t,i,j}$. Since each firm-worker pair opts for a temporary contract only if they get a value for $\lambda \in \left(\lambda_{s,i,j}, \lambda_{t,i,j}\right)$, any variation of such an interval affects the availability of temporary contracts in the labor market.

Proposition 3 illustrates the effects of c_t on both $\lambda_{t,h,j}$ and $\lambda_{s,h,j}$.

Proposition 3. *Suppose a marginal increase in hiring costs c_t for temporary high-skilled and low-skilled jobs. Then, for any given value of $U_j \in \left[\underline{U}, \overline{U}\right]$:*

$$0 > \frac{d\lambda_{t,h,j}}{d\,c_t}\frac{c_t}{\lambda_{t,h,j}} > \frac{d\lambda_{t,l,j}}{d\,c_t}\frac{c_t}{\lambda_{t,l,j}} \quad \textit{and} \quad \frac{d\lambda_{s,h,j}}{d\,c_t}\frac{c_t}{\lambda_{s,h,j}} = \frac{d\lambda_{s,l,j}}{d\,c_t}\frac{c_t}{\lambda_{s,l,j}} > 0.$$

This implies:

$$0 > \frac{d\left(\lambda_{t,h,j} - \lambda_{s,h,j}\right)}{d\,c_t} \cdot \frac{c_t}{\lambda_{t,h,j} - \lambda_{s,h,j}} > \frac{d\left(\lambda_{t,l,j} - \lambda_{s,l,j}\right)}{d\,c_t} \cdot \frac{c_t}{\lambda_{t,l,j} - \lambda_{s,l,j}}.$$

The proof is in Appendix D. Here, we first consider the sign of the above elasticities and then we focus on their different order of magnitude.

The first result in Proposition 3 is that a marginal increase in hiring costs for temporary contracts reduces $\lambda_{t,i,j}$, the value of λ above which it is no longer profitable to sign a temporary contract (with no transformation into a permanent one). This is obvious, as a higher

c_t means a lower surplus $S_{t,i,j}$ for any skill type $i \in \{l,h\}$ and utility $U_j \in \left[\underline{U}, \overline{U}\right]$. So, firms and workers decide to create temporary jobs only with higher expected productivity (i.e. a lower λ). Proposition 3 also states that an increase in c_t shifts $\lambda_{s,i,j}$ to the right. This implies that the marginal value of λ that ensures the same amount of surplus for both temporary and permanent contracts is now higher. This is also understandable. A policy that raises hiring costs for temporary contracts c_t while keeping the costs for permanent ones unchanged would push workers and firms to prefer the latter. In the end, as conveyed in Figure 2, an increase in c_t shifts $S_{t,i,j}$ downwards, reducing the interval $\left[\lambda_{s,i,j}, \lambda_{t,i,j}\right]$.

Let us turn our attention to the extent of the change in $\lambda_{t,i,j}$ and $\lambda_{s,i,j}$. For a given percentage increase in c_t, the reduction in $\lambda_{t,i,j}$ is smaller for the high-skilled workers. The reason is the following. First recall that $S_{t,i,j}\left(\lambda_{t,i,j}\right) = 0$. We are therefore considering the marginal temporary jobs, whose expected productivity is just equal to all the costs needed to open them. So in a labor market with more expensive hiring costs c_t the expected productivity of these marginal jobs must be higher. It is easy to see from equation (10) that a percentage increase in c_t dents surpluses $S_{t,h,j}$ and $S_{t,l,j}$ by exactly the same amount, because hiring costs are single off payments unrelated to the level of skills of the worker employed. On the contrary, the expected productivity differs across skills. High-skilled jobs produce more units of the consumption good per unit of time ($y_h > y_l$). But this means that to make up for an equal percentage loss in surplus caused by a higher c_t, in the high-skilled labor market it is sufficient to raise the expected duration of a productive job by a shorter percentage amount. This is tantamount to saying that there is a lower percentage decrease in $\lambda_{t,h,j}$ than in $\lambda_{t,l,j}$.

This logic does not hold once we consider the effect of c_t on $\lambda_{s,i,j}$. Indeed, the elasticity of $\lambda_{s,i,j}$ with respect to c_t is identical for high-skilled and low-skilled labor contracts. To understand why, notice that we are now focusing on the lower bound of the interval $\left[\lambda_{s,i,j}, \lambda_{t,i,j}\right]$, in which firms and workers have to choose between a permanent job or a temporary one that will be transformed into a permanent one after a period Δ. In making such a decision, the expected productivity of the match does not matter. This is because it will be exactly the same whatever the type of contract signed. For any given value of λ, starting a job with a permanent contract or beginning with a temporary contract followed by a perma-

nent one secures the same expected productivity.[36] What really influences this choice are the opportunity cost of the match in the two different agreements, the risk of incurring in firing costs, and the values of c_p and c_t. Since, for any level of U_j, high-skilled and low-skilled jobs differ only in terms of y_i, the fact that productivity does not play a role in the choice between these two different arrangements implies that $\lambda_{s,h,j} = \lambda_{s,l,j} = \lambda_{s,j}$. Of course, its derivative with respect to c_t will be the same across skill levels.

Simple computations allow us to get the last inequality in Proposition 3: a given increase in hiring costs leads to a percentage reduction in the interval of opportunities for temporary contracts $\left[\lambda_{s,i,j}, \lambda_{t,i,j}\right]$ that is more accentuated in the low-skilled labor market.

We want to point out one final caveat on the results of Proposition 3. Our findings concern the interval of temporary jobs opportunities $\left[\lambda_{s,i,j}, \lambda_{t,i,j}\right]$ and not the measure of workers that will be effectively employed under such a contract. If $L_i h_i(U_j)$ is the labor force of type $i \in \{l,h\}$ and utility in unemployment $U_j \in \left[\underline{U}, \overline{U}\right]$, and we denote with $E_{i,j}$ the fraction of it that is employed, then we have that $\int_{\underline{U}}^{\overline{U}} \left(L_i h_i(U_j) - E_{i,j}\right) \cdot \left[G\left(\lambda_{t,i,j}\right) - G\left(\lambda_{s,i,j}\right)\right] dU_j$ stands for the number of workers of type $i \in \{l,h\}$ that will sign a temporary contract.[37] Unfortunately, we are not able to compare the magnitudes of these variables in the two different labor market segments without making an assumption on the functional form of the distributions $G(.)$, $H_h(.)$ and $H_l(.)$. We can show however that the elasticity of the integrand with respect to c_t is negative and larger for the low-skilled workers, if we assume an exponential cumulative function $G(\lambda) = 1 - e^{-\lambda}$. This means that a percentage decrease in c_t reduces by a larger percentage amount the measure of low-skilled unemployed workers *for any value of utility* $U_j \in \left[\underline{U}, \overline{U}\right]$. What happens to the entire measure of unemployed workers for each skill type $i \in \{l,h\}$ depends on the differences between $H_h(.)$ and $H_l(.)$. Of course, by imposing $H_h(.) = H_l(.)$, the results we get for any value of U_j would trivially translate into the aggregate level. But it would be a very restrictive assumption to maintain that the distribution of the opportunity cost of employment is identical across skill levels.

[36] In other terms, as long as $S_{p,i,j} > 0$, $S_{p,i,j} - S_{t,i,j}$ is independent of y_i, for $i \in \{l,h\}$ and $U_j \in \left[\underline{U}, \overline{U}\right]$.

[37] We are assuming no job offers for the employed workers.

7.4.2 A reduction in firing costs

In this section, we focus on the effects of a decrease in firing costs F. Proposition 4 presents the results.

Proposition 4. *A marginal reduction in firing costs F for both high-skilled and low-skilled jobs raises layoffs. If $L_l \cdot h_l(F) > L_h \cdot h_h(F)$, this increase is greater among the low-skilled workers.*

The proof is in Appendix D. A decrease in F reduces the threshold under which permanent workers that become unproductive remain employed. This means that in the economy the fraction of the total labor force that will be fired in case an adverse negative shock hits a match is now higher. Let us consider in particular all permanent workers with utility in unemployment $U_{j^*} = F$. Before the change in F, in the case their job had been hit by a negative shock, the firm-worker pair would have been indifferent in the choice between breaking the match or not.[38] Once F is reduced, the same event would lead to the layoffs of these workers. This explains the increase in firings.

The intuition for the inequality in Proposition 4 is also easy to nail down. The variable $L_l \cdot h_l(F)$ stands for the measure of low-skilled labor force with $U_{j^*} = F$. If in the economy there are more workers of this type compared to high-skilled ones having the same utility in unemployment, then the amount of unproductive permanent employees will be greater in the low-skilled labor market. We should expect a lower amount of firings in the high-skilled sector.

Is the condition $L_l \cdot h_l(F) > L_h \cdot h_h(F)$ a reasonable assumption? Notice that it holds in a labor market that presents two specific characteristics. First, firing costs are not so large and most unproductive workers get fired. In other terms, F is not much greater than $\underline{U}$. Second, low opportunity costs of employment are more frequent among the low-skilled workers, so that $L_l \cdot h_l(U_j) > L_h \cdot h_h(U_j)$ for low values of U_j. These two features clearly imply the inequality in Proposition 4. We also believe that they are both quite realistic. It is not uncommon in heavily regulated labor markets that firms prefer not to destroy unprofitable jobs. But it is hard to believe that such a scenario is standard. As far as it concerns the

[38] Actually, we are assuming throughout the paper that unproductive workers with utility in unemployment $U_{j^*} = F$ are never fired. In this case, the increase in firings is even stronger.

opportunity cost of employment, it is reasonable to think it increases with skill levels. Even assuming the value of leisure is the same across the entire labor force, searching for a high-skilled job delivers larger expected gains.[39]

A reduction in F does not simply affect the marginal workers with utility U_{j^*}. Workers with $U_j \in [\underline{U}, F)$ are untouched by the policy, as their unproductive jobs will continue to be protected. But for workers with $U_j \in \left(F, \overline{U}\right]$, we can show that a lower F raises the thresholds $\lambda_{s,j}$ and $\lambda_{p,i,j}$.[40] From Figure 2, the increase in the former means that the rate at which unemployed workers may get a permanent position is now higher. A higher value for the latter reduces the difference $G\left(\lambda_{t,i,j}\right) - G\left(\lambda_{p,i,j}\right)$ so that the chance of signing a temporary contract with no transformation is lower.[41] It is likely that these effects translate into larger inflows into permanent employment. In turn, this would entail also more firings: if firms are less choosy in signing open-ended contracts (a larger $\lambda_{s,j}$ means that the average permanent job has lower expected productivity), more matches will be destroyed in the future. Unfortunately, we are not able to gauge at the analytical level if these effects are stronger for the low-skilled segment of the labor force compared to the high-skilled one.

In the light of the empirical results of our paper, we can interpret the surge in lay-offs for marginal workers with utility U_{j^*} as the sudden, direct, consequence of a reduction in firing costs, whereas the creation of more permanent jobs and their subsequent positive impact on firings as an effect that takes more time to kick in. So, focusing on a relatively short interval of time after the policy has been implemented (and on a recessionary period), the first effect is more likely to emerge.

7.5 A summary of the comparative statics results

The Fornero reform consisted both of an increase in the cost of hiring with temporary contracts and a reduction of firing costs. Table 13 summarizes our comparative statics results and

[39] The strong procyclicality of the opportunity cost of employment analyzed by Chodorow-Reich and Karabarbounis (2016) goes in a sense in the same direction.

[40] As expected $\lambda_{t,i,j}$ is unaffected by F: in the choice between signing temporary contracts without transformation into permanent ones and not signing any contract firing costs do not play any role.

[41] The effect on the interval $G(\lambda_{p,i,j}) - G(\lambda_{s,j})$ is ambiguous, so we cannot ascertain the impact of F on temporary contracts that could be transformed into permanent ones. Yet, results in Table 9 suggest that the combined effect on transformations of increasing the cost of temporary contracts (c_t) and reducing firing costs (F) was negative.

highlights when the two policies have a potentially countervailing impact on the variables of interest and when, on the contrary, the effects go in the same direction.

It is important to emphasize again that the results of our theoretical model generally concern the probabilities that a contract is signed (permanent, temporary, and temporary with the possibility of transformation into a permanent one) and not the actual worker flows in and out of the different employment and unemployment states. This is due to the complexity of the computations even under specific functional forms for the distributions $G(.)$, $H_h(.)$, and $H_l(.)$. However, the theoretical model delivers unambiguous predictions on the flows of layoffs for high and low-skilled workers, presented in Proposition 4.

Raising the cost of opening a temporary job (i.e. a higher c_t) and, at the same time, making layoffs less costly (a lower F) unambiguously raise the threshold $\lambda_{s,j}$. This implies a higher probability of signing a permanent contract for any worker, irrespective of her value in unemployment and skill level.

An unambiguous prediction is also obtained if we look at the probability of creating a temporary job, which is lower after the increase in c_t and the reduction in F: the interval $\left[\lambda_{s,j},\, \lambda_{t,j}\right]$ gets narrower because $\lambda_{s,j}$ is higher but also because of the negative effect of c_t on $\lambda_{t,j}$. Unfortunately, for both probabilities, we are unable to establish at the analytical level if the magnitude of these changes is greater for high-skilled or low-skilled workers. As Proposition 3 makes it clear, the increase in c_t has a greater percentage impact in the low-skilled labor market segment, but we cannot claim the same for the reduction in F.

The effects of a larger c_t and lower F on the probability of opening temporary contracts with transformation deserve a separate discussion. Increasing the cost of opening a temporary job reduces such a probability: firms prefer to resort to a permanent contract for all those workers with sufficiently high expected productivity that, before the policy change, would have been hired with a temporary contract with transformation. The interval $\left[\lambda_{s,j},\, \lambda_{p,j}\right]$ shrinks. So, for all workers with a low opportunity cost of employment $U_j \in [\underline{U},\, F)$ — who are unaffected by a change in firing costs — it is less likely to get a temporary job with the possibility of transformation. Since we have seen that $\lambda_{s,j}$ is identical for $i \in \{l, h\}$, we also conclude that such a reduction is identical for low-skilled and high–skilled workers.

Different is the case for all workers with a high value of unemployment, $U_j \in \left(F, \overline{U}\right]$. For them, a reduction of F produces uncertain results on the interval $\left[\lambda_{s,j},\, \lambda_{p,j}\right]$, as it raises

Table 13: Summary of comparative statistics results

Type of reform	c_t increases	F_t decreases	*Fornero Reform:* c_t increases and F_t decreases
Probability of			
Hiring permanent low skilled	+	+	+
Hiring permanent high skilled	+	+	+
Hiring temporary high skilled	−	−	−
Hiring temporary low skilled	−−	−	−
Conversion high skilled with $U_j \in (\underline{U}, F)$	−	0	−
Conversion low skilled with $U_j \in (\underline{U}, F)$	−	0	−
Conversion high skilled with $U_j \in (F, \overline{U})$	−	?	?
Conversion low skilled with $U_j \in (F, \overline{U})$	−	?	?
Firing high skilled with $U_j \in (\underline{U}, F)$	0	0	0
Firing low skilled $U_j \in (\underline{U}, F)$	0	0	0
Firing high skilled with $U_j \in (F, \overline{U})$	+	+	+
Firing low skill with $U_j \in (F, \overline{U})$	+	+	+
Measure of			
Firings high skilled with $U_j = F$	0	+	+
Firings low skilled with $U_j = F$	0	++	++

Note. +, −, 0, and "?" stand for positive, negative, zero, and ambiguous effects, respectively. Finally, ++ stands for a larger positive effect in absolute value than +; −− stands for a larger negative effect in absolute value than −. The latter effect sizes must be compared by column and for the same outcome (e.g. probability of permanent hirings) but across skill types.

both $\lambda_{s,j}$ and $\lambda_{p,j}$. Workers with relatively low expected productivity (as they have a value of λ close to $\lambda_{p,j}$), and that would have been hired with a temporary contract with no chance of being permanently employed after period Δ, experience a higher chance of signing a contract with transformation after the decrease in F. Permanent positions are relatively less expensive for firms. In the end, lower F and higher c_t have ambiguous effects on transformations for workers with $U_j \in \left(F, \overline{U}\right]$.

The effects of raising c_t and reducing F on the probability of layoffs come directly from the previous results on permanent positions. The obvious side effect of a greater chance of signing a permanent contract is that the probability of being laid off will also be higher. Of course this holds only for workers with $U_j \in \left(F, \overline{U}\right]$. The other firm-worker matches are never destroyed even in case they become unproductive.

Finally, the last line of Table 13 simply reproduces the results presented in Proposition 4.

8 Concluding remarks

Reforms aiming at reducing dualism in the labor market ("dual labor market reforms") and the diffusion of fixed-term contracts have been recently introduced in several countries. Yet, little is known about the effects of such policy interventions on firms' demand for highly (educated) skilled and low (educated) skilled workers.

In this paper, we assess the labor market consequences of a comprehensive dual labor market reform (Fornero Law) introduced in Italy in 2012. The reform reduced firing costs for permanent workers in the case of firms above 15 employees and increased regulation of temporary contracts across the board.

In order to estimate the effect of the reform, we use a difference-in-differences strategy, where firms above the threshold of 15 employees constitute the "treatment group", i.e. those affected by EPL reduction, and those below 15 act as the "control group." Moreover, given that, prior to the reform, firms with more than 15 employees used to employ a larger share of temporary workers to avoid the higher costs associated with firing permanent employees, they are also likely to have been more exposed to the second pillar of the reform concerning the stricter regulation of temporary contracts.

Limiting the discussion to the most robust results among the different estimated specifi-

cations, in the first three years after its introduction, the reform has generated a statistically significant increase in separations (largely driven by layoffs) in the case of permanent workers, as predicted by economic theory. In particular, firms above the threshold appear to have increased layoffs of low-skilled permanent workers. A robust effect that emerges is the reduction in hirings of low-skilled workers, driven by a lower propensity to hire fixed-term workers. This result is consistent with those changes in the Fornero Law that made it more costly and difficult to hire on fixed-term contracts; conversely, there is no evidence that the reduction in firing costs incentivized firms to hire more permanent workers. Taken together, our findings suggest that the reduction in firing costs for permanent employees has not been enough to offset the effects of a stricter regulation in the use of temporary contracts.

The estimated effects are generally stronger in the case of firms above the 15-employee threshold that were presumably more affected by the reform, namely those employing a larger share of temporary workers before the reform and those operating in areas of the country with more inefficient courts of law. It is worth noting that our results suggest a significant reduction in net worker flows: this is consistent with a reduction in employment by treated firms. Moreover, we find that after the reform both sales and labor costs remained unchanged, while both revenues and labor costs per worker increased in treated firms: this may be due either to a composition effect, associated with a decrease in low-skilled workers (paid less and less productive), or to a more intensive use of overtime (more expensive), with an increase in hours worked per worker.

Our main empirical results are rationalized by a search and matching model that extends Cahuc et al. (2016) by featuring skilled and unskilled labor. The model offers two key insights in line with the empirical evidence reported in the paper. The likelihood of signing temporary contracts is reduced by an increase in the cost of creating a fixed-term job and this effect is worse for unskilled individuals. This outcome is the result of the fact that firms choosing to hire highly skilled workers are less affected by this policy change, because their expected profits are decreased by a relatively smaller percentage. Second, a decrease in the cost of firing employees results in more layoffs, particularly of low-skilled workers. In the model, lower firing costs raise firms' incentives to destroy unproductive jobs. The latter are more frequently held down by low-skilled workers, as the opportunity cost of saving unproductive jobs is lower. As a consequence, the rise in layoffs is greater for low-skilled

workers.

Therefore, the result of a differential impact on hirings (zero) and on layoffs (positive) generated by the reduction in firing costs of permanent workers could be explained by noting that firms might have used the increased flexibility to fire marginally unproductive workers, while it may take time for hiring to positively respond to the lower firing costs of permanent workers, as found in the theoretical model of (Cacciatore et al. 2016). Such evidence is consistent with previous cross-country empirical work suggesting that flexibility-enhancing reforms of permanent contracts tend to reduce employment in the short run, particularly during downturns (Bassanini and Cingano 2019, Cacciatore et al. 2016). In the future, it would be interesting to evaluate the effects of dual labor market reforms implemented during economic expansions or to assess their medium- and long-term effects, something that could not be done in the current paper because another major reform (the "Jobs Act") was implemented only three years after the one which we focus on.

References

Aghion, P., A. Bergeaud, and J. Van Reenen (2021). The impact of regulation on innovation. Technical report, National Bureau of Economic Research.

Ardito, C., F. Berton, L. Pacelli, and F. Passerini (2022). Employment protection, workforce mix and firm performance. *The B.E. Journal of Economic Analysis and Policy forthcoming*.

Autor, D. H., D. Dorn, G. H. Hanson, and J. Song (2014). Trade adjustment: Worker-level evidence. *The Quarterly Journal of Economics 129*(4), 1799–1860.

Autor, D. H., L. F. Katz, and A. B. Krueger (1998). Computing inequality: have computers changed the labor market? *The Quarterly journal of economics 113*(4), 1169–1213.

Bassanini, A. and F. Cingano (2019). Before it gets better: The short-term employment costs of regulatory reforms. *ILR Review 72*(1), 127–157.

Bassanini, A. and A. Garnero (2013). Dismissal protection and worker flows in OECD

countries: Evidence from cross-country/cross-industry data. *Labour Economics 21*, 25–41.

Berton, F., F. Devicienti, and S. Grubanov-Boskovic (2017). Employment protection legislation and mismatch: Evidence from a reform. *IZA Discussion Paper No. 10904. Institute of Labor Economics (IZA): Bonn.*.

Bjuggren, C. M. (2018). Employment protection and labor productivity. *Journal of Public Economics 157*, 138–157.

Boeri, T. (2011). Institutional reforms and dualism in european labor markets. Volume 4 of *Handbook of Labor Economics*, pp. 1173–1236. Elsevier.

Boeri, T. and P. Garibaldi (2019). A tale of comprehensive labor market reforms: Evidence from the Italian Jobs Act. *Labour Economics 59*, 33–48.

Bottasso, A., M. Conti, and G. Sulis (2017). Firm dynamics and employment protection: Evidence from sectoral data. *Labour Economics 48*, 35–53.

Bratti, M., M. Conti, and G. Sulis (2021). Employment protection and firm-provided training in dual labour markets. *Labour Economics 69*, 101972.

Cacciatore, M., R. Duval, G. Fiori, and F. Ghironi (2016). Market reforms in the time of imbalance. *Journal of Economic Dynamics and Control 72*, 69–93.

Cacciatore, M. and G. Fiori (2016). The macroeconomic effects of goods and labor markets deregulation. *Review of Economic Dynamics 20*, 1–24.

Cahuc, P., P. Carry, F. Malherbet, and P. S. Martins (2022). Employment effects of restricting fixed-term contracts: Theory and evidence. *CEPR Discussion Paper No. DP16875*.

Cahuc, P., O. Charlot, and F. Malherbet (2016). Explaining the spread of temporary jobs and its impact on labor turnover. *International Economic Review 57*(2), 533–572.

Cahuc, P., O. Charlot, F. Malherbet, H. Benghalem, and E. Limon (2020). Taxation of temporary jobs: good intentions with bad outcomes? *Economic Journal 130*(626), 422–445.

Cappellari, L., C. Dell'Aringa, and M. Leonardi (2012). Temporary employment, job flows and productivity: A tale of two reforms. *Economic Journal 122*(562), F188–F215.

Centeno, M. and Ã. A. Novo (2012). Excess worker turnover and fixed-term contracts: Causal evidence in a two-tier system. *Labour Economics 19*(3), 320–328.

Cerruti, G., G. Mazzarella, and M. Migliavacca (2022). Employment protection legislation and household formation: Evidence from Italy. *Review of Economics of the Household*, 1–27.

Charlot, O. and F. Malherbet (2013). Education and employment protection. *Labour Economics 20*, 3–23.

Chodorow-Reich, G. and L. Karabarbounis (2016). The cyclicality of the opportunity cost of employment. *Journal of Political Economy 124*(6).

Ciminelli, G., R. Duval, and D. Furceri (2022). Employment protection deregulation and labor shares in advanced economies. *Review of Economics and Statistics 104*(6), 1174–1190.

Cingano, F., M. Leonardi, J. Messina, and G. Pica (2016). Employment protection legislation, capital investment and access to credit: Evidence from Italy. *Economic Journal 126*(595), 1798–1822.

Daruich, D., S. Di Addario, and R. Saggio (2022). The effects of partial employment protection reforms: Evidence from italy. Technical report, Bank of Italy Working Paper n. 1390, forthcoming in *Review of Economic Studies*.

Davezies, L. and T. Le Barbanchon (2017). Regression discontinuity design with continuous measurement error in the running variable. *Journal of Econometrics 200*(2), 260–281.

Di Porto, E. and C. Tealdi (2022). Heterogeneous paths to stability. Technical report, Centre for Studies in Economics and Finance (CSEF), University of Naples, Italy.

Dolado, J. J., S. Ortigueira, and R. Stucchi (2016). Does dual employment protection affect TFP? Evidence from Spanish manufacturing firms. *SERIEs 7*(4), 421–459.

Faccini, R. (2014). Reassessing labour market reforms: Temporary contracts as a screening device. *Economic Journal 124*(575), 167–200.

Garibaldi, P. and G. L. Violante (2005). The employment effects of severance payments with wage rigidities. *Economic Journal 115*(506), 799–832.

Gianfreda, G. and G. Vallanti (2017). Institutions' and firms' adjustments: Measuring the impact of courts' delays on job flows and productivity. *Journal of Law and Economics 60*(1), 135–172.

Grasso, G. and K. Tatsiramos (2022). The impact of restricting fixed-term contracts on labor and skill demand. *mimeo*.

Griffith, R. and G. Macartney (2014). Employment protection legislation, multinational firms, and innovation. *Review of Economics and Statistics 96*(1), 135–150.

Hijzen, A., L. Mondauto, and S. Scarpetta (2017). The impact of employment protection on temporary employment: Evidence from a regression discontinuity design. *Labour Economics 46*(C), 64–76.

Ichino, A., M. Polo, and E. Rettore (2003). Are judges biased by labor market conditions? *European Economic Review 47*(5), 913–944.

Kugler, A. and G. Pica (2008). Effects of employment protection on worker and job flows: Evidence from the 1990 Italian reform. *Labour Economics 15*(1), 78–95.

Lazear, E. P. (1990). Job security provisions and employment. *The Quarterly Journal of Economics 105*(3), 699–726.

Leonardi, M. and G. Pica (2013). Who pays for it? The heterogeneous wage effects of employment protection legislation. *Economic Journal 123*(12), 1236–1278.

Maida, A. and D. Sonedda (2021). Breaking from the starting gate on the right foot: Employment effects of an investment in human capital. *Journal of Human Resources*, 1119–10578R2.

Martins, P. S. (2009). Dismissals for cause: The difference that just eight paragraphs can make. *Journal of Labor Economics 27*(2), 257–279.

O'Higgins, N. and G. Pica (2020). Complementarities between labour market institutions and their causal impact on youth labour market outcomes. *The BE Journal of Economic Analysis & Policy 20*(3), published online.

Oyer, P. and S. Schaefer (2002). Litigation costs and returns to experience. *American Economic Review 92*(3), 683–705.

Pigini, C. and S. Staffolani (2021). Firing costs and job loss: The case of the Italian Jobs Act. *Italian Economic Journal*, 1–39.

Pissarides, C. (2000). *Equilibrium Unemployment Theory*. 2nd edition, Cambridge, Mass: MIT Press.

Pries, M. and R. Rogerson (2005). Hiring policies, labor market institutions, and labor market flows. *Journal of Political Economy 113*(4), 811–839.

Schivardi, F. and R. Torrini (2008). Identifying the effects of firing restrictions through size-contingent differences in regulation. *Labour Economics 15*(3), 482–511.

Sestito, P. and E. Viviano (2018). Firing costs and firm hiring: Evidence from an Italian reform. *Economic Policy 33*(93), 101–130.

Wooldridge, J. (2022). Two-way fixed effects, the two-way Mundlak regression, and difference-in-differences estimators. *mimeo*.

Appendixes

A Dataset construction

In what follows, we illustrate in detail the construction of the dataset used in the analysis. Since information on education and occupation for hirings and separations is available only after 2010, we limit our attention to the period 2010-2014. We exclude 2015 onwards, as a second important reform took place in Italy, the "Jobs Act."

We start from INPS firm-level data (*INPS Aziende annuali*). For each firm we identify only one observation per year; i.e. we exclude firms that have multiple social security positions amounting to about 10% of observations. So we do exclude multi-plant firms, and this is relevant to compute firm's legal size. We initially select firms in the range 2-100 employees. In a second moment, we use UniLav-ISCO data to identify hirings and separations at the firm level, using only one observation per year for each firm-worker pair to avoid double counting. At the same time, in order to ensure comparability, we use the INPS workers' data (*Rapporti di lavoro Uniemens*) to identify for each firm both current stocks of employees and hirings and separations.

Then, we merge *Rapporti di Lavoro* Uniemens with firm-level data and then subsequently with UniLav-ISCO using the firm and worker unique identifiers. The resulting dataset is subsequently collapsed at the firm/year level. Finally, we merge this firm-level dataset with CERVED balance sheet data and with additional data on transformations at the firm/year level.[42]

The final dataset at the firm level for the years 2010-2014 comprises about 4 million observations, with about 790,000 observations per year. This is the population of firms in the range 2-100 employees. In Section 4 we provide details on the final sample used in the analysis.

[42] As we mention in Section 4, information on the type of transformations from temporary to permanent contracts was made available only at the end of the project. INPS handled us a very large dataset comprising many different types of transformations initially derived from their elaborations on UniLav-ISCO. After some steps in the cleaning procedure, we ended up with a dataset of about 2.5 million observations at firm/year level, comprising information on the number of transformations by skill, which is merged with our final dataset.

B Additional empirical results

Table B1: Robustness: Hirings. Alternative definitions of skills

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
			Panel A: skill measure is Mean			
post×above	-0.146***	-0.017	-0.012	-0.001	-0.096***	-0.007
	(0.035)	(0.012)	(0.014)	(0.006)	(0.027)	(0.009)
			Panel B: skill measure is Mode			
post×above	-0.166***	-0.001	-0.013	0.000	-0.102***	0.000
	(0.039)	(0.007)	(0.016)	(0.004)	(0.030)	(0.005)
			Panel C: skill measure is Occupation			
post×above	-0.167***	-0.002	-0.017	-0.000	-0.095***	-0.001
	(0.039)	(0.007)	(0.016)	(0.004)	(0.030)	(0.005)

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of hirings by skill and type of contract. In Panel A Skill is measured as Mean level of skill at the cell level, in Panel B Skill is measured as Mode level of skill at the cell level, in Panel C is measured as Occupation, see Section 4 for details. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects.

Table B2: Robustness: Separations. Alternative definitions of skills

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
			Panel A: skill measure is Mean			
post×above	-0.009	0.001	0.026*	0.001	-0.023*	-0.000
	(0.022)	(0.008)	(0.014)	(0.006)	(0.013)	(0.004)
			Panel B: skill measure is Mode			
post×above	0.009	-0.004	0.042***	-0.005*	-0.021	0.001
	(0.025)	(0.004)	(0.016)	(0.003)	(0.014)	(0.002)
			Panel C: skill measure is Occupation			
post×above	0.010	-0.004	0.042**	-0.004	-0.020	0.000
	(0.025)	(0.004)	(0.016)	(0.003)	(0.014)	(0.002)

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of separations by skill and type of contract. In Panel A Skill is measured as Mean level of skill at the cell level, in Panel B Skill is measured as Mode level of skill at the cell level, in Panel C is measured as Occupation, see Section 4 for details. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects.

Table B3: Robustness: Hirings. Alternative firm size, unbalanced panel (skill measure: Education)

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
			Panel A: Alternative definition of legal firm size			
post×above	-0.157***	0.004	-0.022	-0.005	-0.091***	0.008
	(0.038)	(0.007)	(0.016)	(0.004)	(0.028)	(0.006)
Observations	274,778	274,778	274,778	274,778	274,778	274,778
R-squared	0.084	0.047	0.029	0.014	0.066	0.038
Mean dep. variable	1.614	0.0558	0.341	0.0195	0.905	0.0302
% effect	-9.699	7.565	-6.351	-23.64	-10.07	25.89
			Panel B: Unbalanced panel			
post×above	-0.182***	0.000	-0.008	-0.000	-0.128***	0.003
	(0.038)	(0.007)	(0.016)	(0.004)	(0.029)	(0.006)
Observations	326,081	326,081	326,081	326,081	326,081	326,081
R-squared	0.542	0.517	0.432	0.410	0.544	0.486
firm FE	yes	yes	yes	yes	yes	yes
Mean dep. variable	1.839	0.0518	0.415	0.0150	0.995	0.0281
% effect	-9.908	0.909	-1.961	-2.111	-12.83	10.37

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of hirings by skill and type of contract. In Panel A we consider an alternative definition of employment (legal firm size, full-time workers count one and part-time 0.5), in Panel B we consider the unbalanced panel and include firm fixed effects. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. In panel B the measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100.

Table B4: Robustness: Separations. Alternative firm size, unbalanced panel (skill measure: Education)

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
			Panel A: Alternative definition of legal firm size			
post×above	0.005	0.003	0.031*	-0.000	-0.013	0.003
	(0.024)	(0.004)	(0.016)	(0.003)	(0.013)	(0.002)
Observations	274,778	274,778	274,778	274,778	274,778	274,778
R-squared	0.043	0.023	0.034	0.014	0.018	0.012
Mean dep. variable	0.775	0.0266	0.380	0.0159	0.218	0.00716
% effect	0.600	9.454	8.061	-1.968	-6.024	38.98
			Panel B: Unbalanced panel			
post×above	0.055*	-0.003	0.101***	-0.003	-0.038***	0.000
	(0.029)	(0.004)	(0.021)	(0.003)	(0.013)	(0.001)
Observations	326,081	326,081	326,081	326,081	326,081	326,081
R-squared	0.447	0.511	0.410	0.521	0.456	0.470
firm FE	yes	yes	yes	yes	yes	yes
Mean dep. variable	1.265	0.0282	0.711	0.0187	0.294	0.00553
% effect	4.355	-11.98	14.19	-16.64	-12.87	5.099

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variable is the number of separations by skill and type of contract. In Panel A we consider an alternative definition of employment (legal firm size, full-time workers count one and part-time 0.5), in Panel B we consider the unbalanced panel and include firm fixed effects. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. In panel B the measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100.

Table B5: Robustness Results: Sample of stayers (skill measure: Education)

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
			Panel A: hirings			
above	0.866***	0.016***	0.147***	0.004*	0.489***	0.007*
	(0.048)	(0.005)	(0.017)	(0.002)	(0.035)	(0.004)
post×above	-0.441***	0.000	-0.095***	-0.002	-0.213***	0.004
	(0.042)	(0.006)	(0.016)	(0.003)	(0.032)	(0.005)
Observations	222,178	222,178	222,178	222,178	222,178	222,178
R-squared	0.078	0.033	0.028	0.014	0.058	0.026
Mean dep. variable	1.544	0.0398	0.317	0.0126	0.849	0.0203
% effect	-28.55	0.886	-29.94	-18.93	-25.07	20.09
			Panel B: separations			
above	0.121***	0.001	-0.033**	-0.001	0.101***	0.001
	(0.026)	(0.002)	(0.014)	(0.001)	(0.015)	(0.001)
post×above	0.106***	0.001	0.149***	0.003	-0.040***	-0.002
	(0.026)	(0.003)	(0.017)	(0.002)	(0.014)	(0.001)
Observations	222,178	222,178	222,178	222,178	222,178	222,178
R-squared	0.040	0.019	0.032	0.012	0.018	0.011
Mean dep. variable	0.601	0.0140	0.250	0.00712	0.202	0.00460
% effect	17.68	8.315	59.52	43.07	-19.62	-34.21

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. Sample of stayers, i.e firms that remain on the same side of the 15-employee cutoff during the whole estimation period. The dependent variable is the number of hirings and separations by skill and type of contract. Skill is defined on the basis of reported Education, see Section 4 for details. Above is a dummy equal to one for employment above 15 employees, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Regressions include industry×year and province×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100.

Table B6: Additional Results: Instrumental Variables (IV) - DID (skill measure: Education)

Variables	(1) unskilled	(2) skilled	(3) unsk. perm.	(4) sk. perm.	(5) unsk. temp.	(6) sk. temp.
			Panel A: hirings			
above (2011)	0.700***	0.022**	0.087***	0.006	0.433***	0.012*
	(0.068)	(0.009)	(0.025)	(0.004)	(0.052)	(0.007)
post×above (2011)	-0.257***	0.003	-0.018	-0.001	-0.158***	0.005
	(0.061)	(0.012)	(0.025)	(0.006)	(0.047)	(0.009)
First-stage						
above (Jan. 2010)			0.619***			
			(0.004)			
post× above (Jan. 2010)			0.619***			
			(0.004)			
K-P rk Wald F statistic[(a)]			11888.50			
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.009	0.000	0.002	0.000	0.006	0.000
Mean dep. variable	1.564	0.0452	0.323	0.0138	0.878	0.0243
% effect	-16.41	6.391	-5.459	-6.122	-18.04	18.67
			Panel B: separations			
above (2011)	0.267***	0.016*	0.081***	0.011	0.109***	0.003
	(0.039)	(0.008)	(0.023)	(0.007)	(0.023)	(0.003)
post×above (2011)	0.022	-0.005	0.066**	-0.004	-0.029	-0.000
	(0.039)	(0.006)	(0.026)	(0.005)	(0.021)	(0.002)
First-stage						
above (Jan. 2010)			0.619***			
			(0.004)			
post× above (Jan. 2010)			0.619***			
			(0.004)			
K-P rk Wald F statistic[(a)]			11888.50			
Observations	275,668	275,668	275,668	275,668	275,668	275,668
R-squared	0.002	-0.000	0.000	-0.000	0.001	-0.000
Mean dep. variable	0.753	0.0240	0.366	0.0155	0.218	0.00580
% effect	2.886	-19.62	18.07	-27.05	-13.23	-0.177

Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The dependent variables are the number of hirings and separations by skill and type of contract. Skill is defined on the basis of reported Education, see Section 4 for details. Above is a dummy equal to one for employment above 15 employees in 2011, post is a dummy equal to one after 2011. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. Above and post×above are instrumented using above in January 2010 and its interaction with above, respectively. All models include province×year and industry×year fixed effects. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. The % effect is computed by dividing the coefficient on post×above variable by the mean of the dependent variable and multiplying the result by 100. Only the coefficient on above (Jan. 2010) for the above (2011) equation and that on post× above (Jan. 2010) in the post× above (2011) first-stage equations are reported. [(a)] Kleibergen-Paap rk Wald F statistic.

Table B7: Additional Results: Firm Performance

Variables	(1) ln revenues	(2) ln labor costs	(3) ln revenues per worker	(4) ln labor costs per worker
post×above	-0.001	-0.003	0.011**	0.009***
	(0.005)	(0.004)	(0.005)	(0.003)
Observations	192,341	192,597	192,341	192,597
R-squared	0.311	0.272	0.344	0.304
Mean dep. variable	7.889	6.389	4.831	3.331

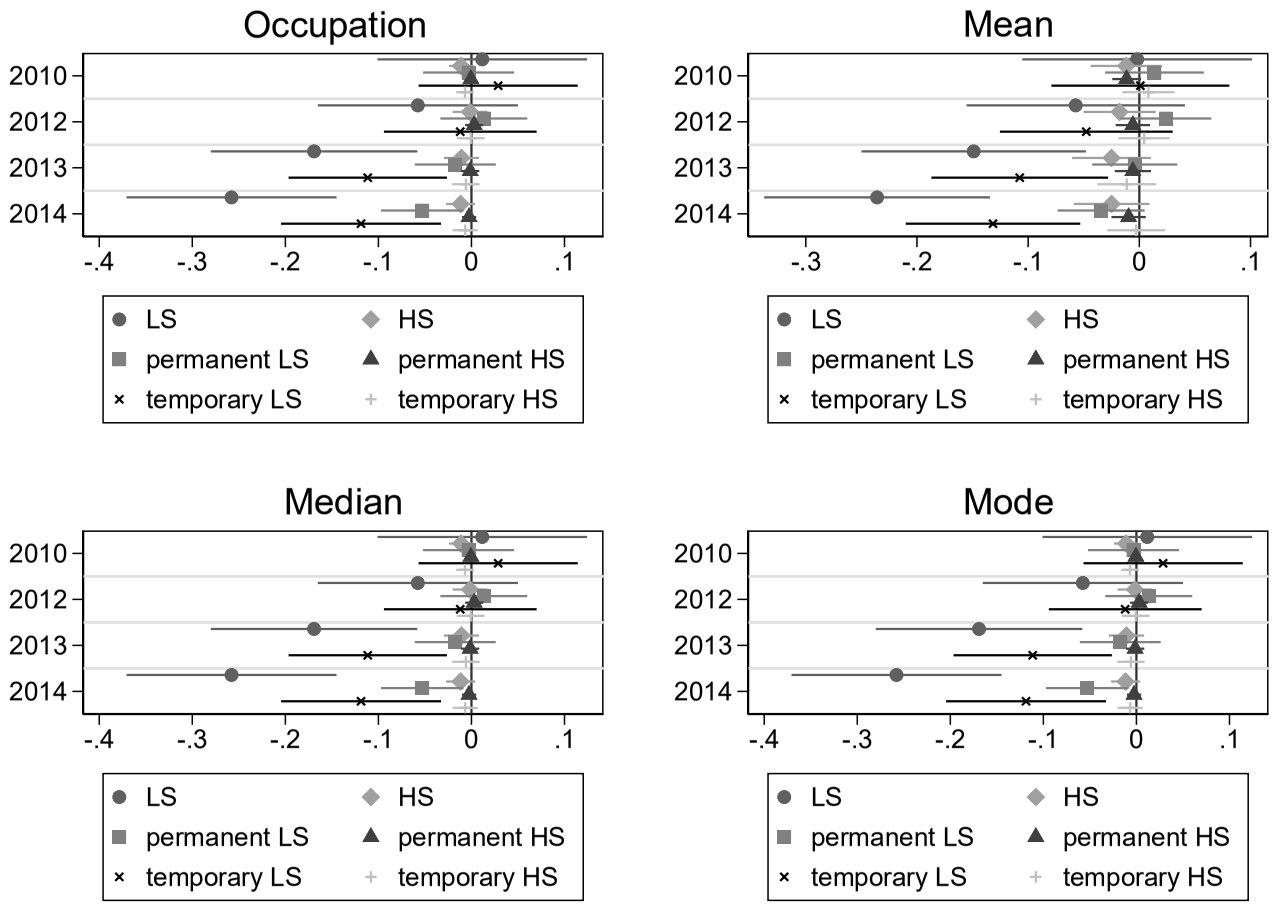
Note. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses, with cluster dimension at firm level. The measure of employment is *Forza aziendale* and normalized to 15 employees. A size-bandwidth of 10–20 employees is imposed to select the estimation sample. The mean of the dependent variable is computed for firms above the 15-employee cutoff in the pre-reform period. Regressions include industry×year and province×year fixed effects.

Table B8: Correlation between different skills measures, hirings and separations

	LS-OCC	HS-OCC	LS-MEAN	HS-MEAN	LS-MED	HS-MED	LS-MODE	HS-MODE	LE	HE
Panel A: Hirings										
LS-OCC	1.00	-0.01	0.94	0.18	0.99	-0.01	0.99	0.02	0.98	0.05
HS-OCC	-0.01	1.00	0.00	0.59	0.03	0.89	0.02	0.86	0.03	0.73
LS-MEAN	0.94	0.00	1.00	-0.02	0.93	-0.01	0.94	-0.01	0.94	0.00
HS-MEAN	0.18	0.59	-0.02	1.00	0.20	0.55	0.17	0.61	0.16	0.59
LS-MED	0.99	0.03	0.93	0.20	1.00	-0.01	0.99	0.03	0.98	0.06
HS-MED	-0.01	0.89	-0.01	0.55	-0.01	1.00	-0.01	0.91	0.01	0.76
LS-MODE	0.99	0.02	0.94	0.18	1.00	-0.01	1.00	-0.01	0.98	0.05
HS-MODE	0.02	0.86	-0.01	0.61	0.03	0.91	-0.01	1.00	0.02	0.76
LE	0.98	0.03	0.94	0.16	0.98	0.01	0.98	0.02	1.00	-0.01
HE	0.05	0.73	0.00	0.59	0.06	0.76	0.05	0.76	-0.01	1.00
Panel B: Separations										
	LS-OCC	HS-OCC	LS-MEAN	HS-MEAN	LS-MED	HS-MED	LS-MODE	HS-MODE	LE	HE
LS-OCC	1.00	-0.01	0.93	0.22	0.99	0.00	0.99	0.01	0.98	0.04
HS-OCC	-0.01	1.00	0.00	0.57	0.02	0.93	0.02	0.91	0.02	0.81
LS-MEAN	0.93	0.00	1.00	-0.02	0.92	-0.01	0.93	-0.01	0.93	0.01
HS-MEAN	0.22	0.57	-0.02	1.00	0.23	0.54	0.22	0.58	0.20	0.57
LS-MED	0.99	0.02	0.92	0.23	1.00	-0.01	0.99	0.01	0.98	0.05
HS-MED	0.00	0.93	-0.01	0.54	-0.01	1.00	-0.01	0.94	0.01	0.83
LS-MODE	0.99	0.01	0.93	0.22	1.00	-0.01	1.00	-0.01	0.98	0.04
HS-MODE	0.01	0.91	-0.01	0.58	0.01	0.94	-0.01	1.00	0.02	0.83
LE	0.98	0.02	0.93	0.20	0.98	0.01	0.98	0.02	1.00	-0.01
HE	0.04	0.81	0.01	0.57	0.05	0.83	0.04	0.83	-0.01	1.00

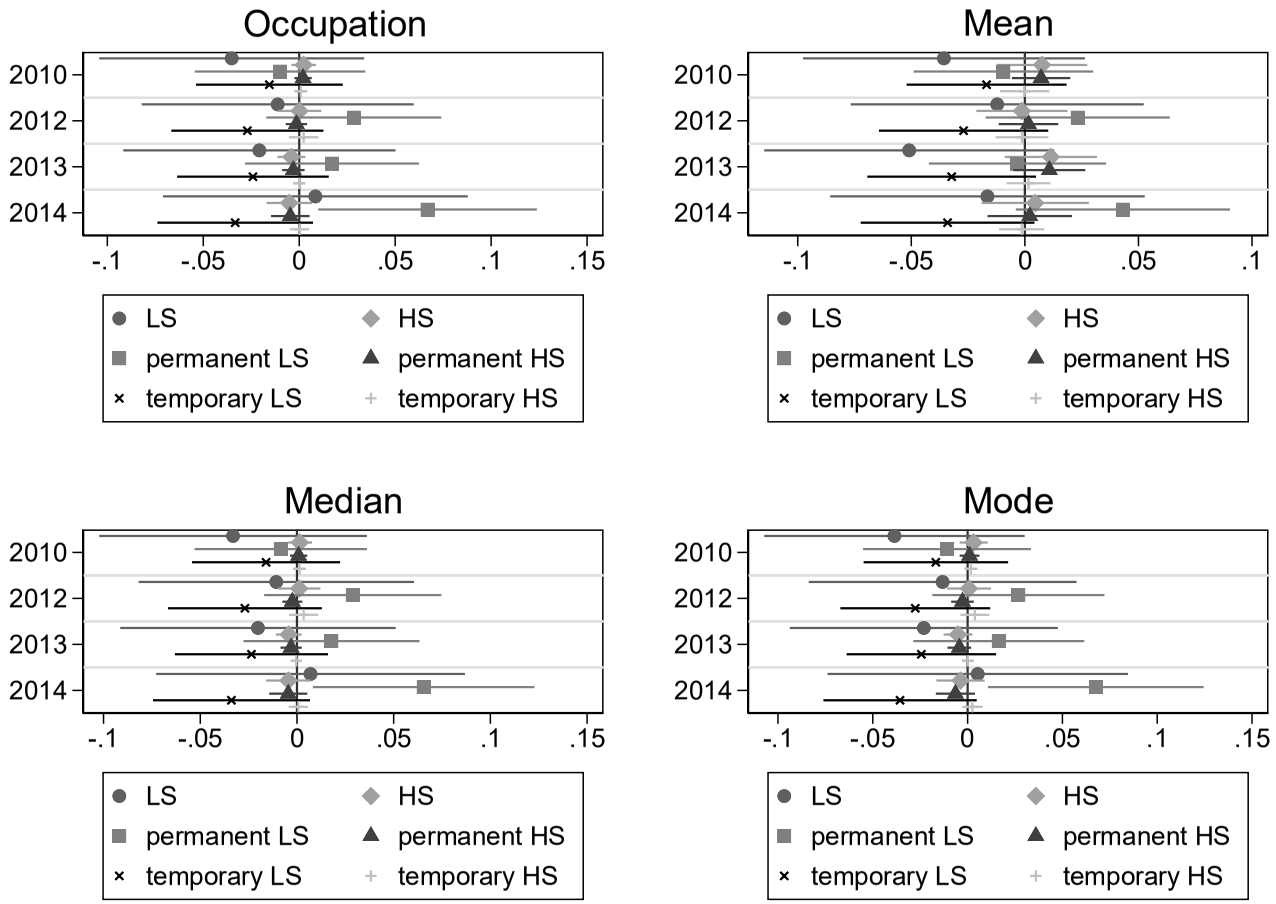
Note. The table reports correlation coefficients between hirings and firings measured according to different definitions of skills. LS and HS refer to low skilled and high skilled, respectively (skill definition Education); OCC, MEAN, MED, MODE refer to the different criteria used to define high and low skilled workers. See Section 4 for details.

Figure B1: Event study, Hirings with different measures of skills



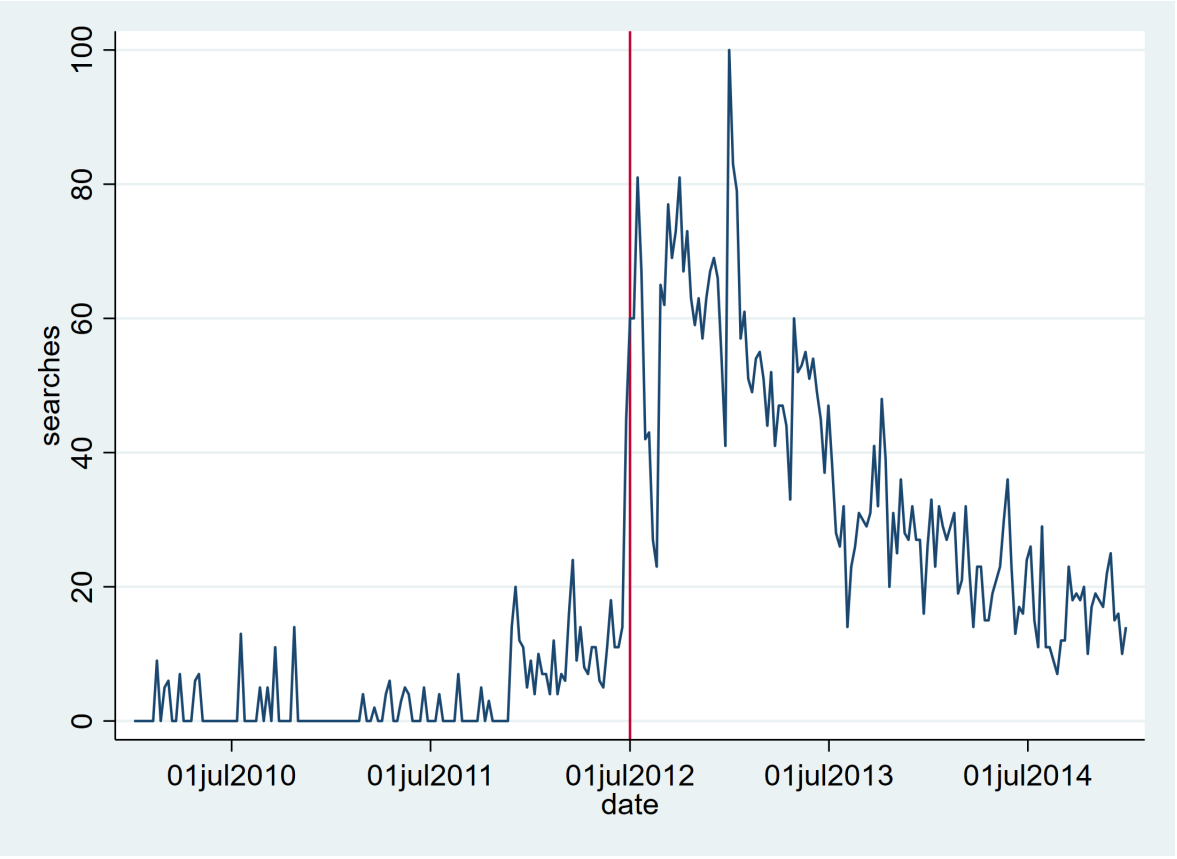
Note. The figure presents the event-study DID estimates of the effect of the reform on hirings and separations. 2011 is the year immediately preceding the introduction of the 2012 Fornero Reform and is omitted from the graph. Bars represent 95% confidence intervals and symbols point estimates. LS and HS stand for low skilled and high skilled, respectively.

Figure B2: Event study, Separations with different measures of skills



Note. The figure presents the event-study DID estimates of the effect of the reform on hirings and separations. 2011 is the year immediately preceding the introduction of the 2012 Fornero Reform and is omitted from the graph. Bars represent 95% confidence intervals and symbols point estimates. LS and HS stand for low skilled and high skilled, respectively.

Figure B3: Google Trends results of “riforma Fornero” searches



Note. The graph shows the trend of Google searches (source: Google Trends) for “riforma Fornero” between January 1, 2010 and December 31, 2014. The Fornero Law was passed on June 28, 2012. The graph plots an index number, where 100 is the maximum number of searches during the period.

C Proofs of Propositions 1 and 2

Properties of $S_{t,i,j}$

Consider equation (9). We have that

$$\begin{aligned}\frac{d\,S_{t,i,j}}{d\,\lambda} &= -\int_0^{\Delta} y_i e^{-(\lambda+r)\tau}\tau d\tau - \Delta\cdot e^{-(\lambda+r)\Delta}\cdot\max\left[S_{p,i,j}(\lambda),0\right] + \\ &+ e^{-(\lambda+r)\Delta}\cdot\frac{d\left\{\max\left[S_{p,i,j},0\right]\right\}}{d\,\lambda}\end{aligned} \tag{11}$$

for $i\in\{l,h\}$ and $U_j\in\left[\underline{U},\overline{U}\right]$. The last term on the RHS is either equal to zero if $\max\left[S_{p,i,j},0\right]=0$ or negative in case $\max\left[S_{p,i,j},0\right]=S_{p,i,j}$ because $S_{p,i,j}$ is decreasing in λ. So, to know the sign of $\frac{d\,S_{t,i,j}}{d\,\lambda}$, we need to solve the integral part:

$$\begin{aligned}-\int_0^{\Delta} y_i e^{-(\lambda+r)\tau}\tau d\tau &= -y_i\left[-\frac{\Delta}{r+\lambda}\cdot e^{-(\lambda+r)\Delta}+\frac{1}{(\lambda+r)^2}-\frac{e^{-(\lambda+r)\Delta}}{(\lambda+r)^2}\right] = \\ &= \frac{y_i}{(\lambda+r)^2}\left\{e^{-(\lambda+r)\Delta}\left[1+\Delta(\lambda+r)\right]-1\right\}<0\end{aligned} \tag{12}$$

for $i\in\{l,h\}$. The expression is negative because $e^{-x}(1+x)-1<0$. So $S_{t,i,j}$ is decreasing in λ for any $i\in\{l,h\}$ and $U_j\in\left[\underline{U},\overline{U}\right]$.
From equation (10) we also get that, as $\lambda\to 0$,
$S_{t,i,j}=\left(\frac{y_i}{r}-U_j\right)\left(1-e^{-r\Delta}\right)-c_t+e^{-r\Delta}\max\left[S_{p,i,j}(0),0\right]$.
This expression is positive as long as $y_i>rU_j+c_t$.
Moreover, $\lim_{\lambda\to+\infty}S_{t,i,j}=-U_j\left(1-e^{-r\Delta}\right)-c_t<0$. For continuity, there exists a unique value of λ, denoted $\lambda_{t,i,j}$, that verifies $S_{t,i,j}=0$ for any $i\in\{l,h\}$ and $U_j\in\left[\underline{U},\overline{U}\right]$.

Proof of Proposition 1

We are considering the labor market $i\in\{l,h\}$ for workers j with $U_j\in\left(F,\overline{U}\right]$. We have already proved that $S_{t,i,j}$ and $S_{p,i,j}$ are decreasing functions of λ for any $i\in\{l,h\}$ and $U_j\in\left[\underline{U},\overline{U}\right]$. As Figure 2 makes it clear, in order to see which kind of jobs are created (if any), we need to study the difference $S_{p,i,j}-S_{t,i,j}$ and find under which conditions we have

$S_{p,i,j} - S_{t,i,j} = 0.$

Existence and uniqueness of $\lambda_{s,i,j}$

We denote with $\Lambda_{s,i,j} \equiv S_{p,i,j} - S_{t,i,j}$. Using the first equation in (5) and equation (10), we get:

$$\begin{aligned}\Lambda_{s,i,j} \;=\; & \frac{y_i - rU_j - \lambda F}{r+\lambda} - c_p - \frac{y_i}{r+\lambda}\cdot\left(1-e^{-(\lambda+r)\Delta}\right) + \\ & + U_j\left(1-e^{-r\Delta}\right) + c_t - e^{-(\lambda+r)\Delta}\max\left[\frac{y_i - rU_j - \lambda F}{r+\lambda} - c_p\;,\;0\right]\end{aligned} \tag{13}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$.
We prove first that there exists a unique $\lambda_{s,i,j}$ that satisfies $\Lambda_{s,i,j} = 0$.
Notice that if $\lambda \to 0$, then $\Lambda_{s,i,j} = -c_p\left(1-e^{-r\Delta}\right) + c_t > 0$ since we have assumed that $c_t \cong c_p$. As $\lambda \to +\infty$, we have $\Lambda_{s,i,j} = -F - c_p + c_t + U_j\left(1-e^{-r\Delta}\right)$.
If this expression is negative, for continuity at least one value of $\lambda_{s,i,j}$ exists. As $c_t \cong c_p$, we need to impose that $-F + U_j\left(1-e^{-r\Delta}\right) < 0$. Isolating Δ and rearranging terms, such inequality may be written as $\Delta < \frac{1}{r}\cdot\log\left(\frac{U_j}{U_j - F}\right)$, for $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$. The term on the RHS corresponds to the upper bound of the condition presented in Proposition 1.

To prove uniqueness, we compute the derivative $\frac{d\Lambda_{s,i,j}}{d\lambda}$ and check the sign at $\lambda = \lambda_{s,i,j}$. If such a derivative is negative, then a unique equilibrium exists, because if there were multiple equilibria at least in one of them the derivative should be positive (more than one equilibrium would imply that $\Lambda_{s,i,j}$ crosses the horizontal axis from below at least once). We get:

$$\frac{d\Lambda_{s,i,j}}{d\lambda} \;=$$

$$\begin{cases} \dfrac{1}{r+\lambda}\left\{\dfrac{r\left(U_j - F\right)}{r+\lambda}\left[1-e^{-(\lambda+r)\Delta}\right] - \left[rU_j + \lambda F + c_p(r+\lambda)\right]e^{-(\lambda+r)\Delta}\Delta\right\} & \text{if } \max\left[S_{p,i,j},0\right] = S_{p,i,j} \\ \dfrac{1}{(r+\lambda)^2}\left\{r\left(U_j - F\right) - y_i e^{-(\lambda+r)\Delta}\left[1+\Delta(r+\lambda)\right]\right\} & \text{if } \max\left[S_{p,i,j},0\right] = 0 \end{cases} \tag{14}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$.

Consider first the derivative in the case max $\left[S_{p,i,j},0\right] = S_{p,i,j}$. We use the equilibrium equation $\Lambda_{s,i,j}(\lambda_{s,i,j}) = 0$. Rearranging the expression for $\Lambda_{s,i,j}$ in (13), we get:

$$c_p \cdot e^{-(\lambda_{s,i,j}+r)\Delta} = \frac{rU_j + \lambda_{s,i,j}F}{\lambda_{s,i,j}+r}\left[1-e^{-(\lambda_{s,i,j}+r)\Delta}\right] - U_j\left(1-e^{-r\Delta}\right) \tag{15}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. We substitute $c_p \cdot e^{-(\lambda_{s,i,j}+r)\Delta}$ with the RHS of (15) into the first equation of (14). After some algebra (details are available on request), we have:

$$\begin{aligned}\frac{d\Lambda_{s,i,j}}{d\lambda}\Big|_{\lambda=\lambda_{s,i,j}} &= -\Delta\left[F - U_j\left(1-e^{-r\Delta}\right)\right] + \\ &+ \frac{r(U_j-F)}{\left(r+\lambda_{s,i,j}\right)^2}\left[1 - e^{-(\lambda_{s,i,j}+r)\Delta} - \left(\lambda_{s,i,j}+r\right)\Delta\right]\end{aligned} \tag{16}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. The second term on the RHS of (16) is negative, because $1-e^{-x}-x<0$ for any $x>0$. The first term on the RHS of (16) is negative if $-F+U_j\left(1-e^{-r\Delta}\right)<0$, that is the condition we have just obtained for the existence of an equilibrium.

Therefore the condition imposed for the existence of $\lambda_{s,i,j}$ also guarantees that such equilibrium is unique in the case max $\left[S_{p,i,j},0\right] = S_{p,i,j}$.

Now we turn to the derivative $\frac{d\Lambda_{s,i,j}}{d\lambda}$ in the case max $\left[S_{p,i,j},0\right] = 0$ (the second equation in (14)). Again, we want to evaluate this derivative at $\lambda = \lambda_{s,i,j}$. So we consider the equation $\Lambda_{s,i,j} = 0$ in the case max $\left[S_{p,i,j},0\right] = 0$. Using the expression in (13), we can write:

$$\frac{y_i}{\lambda_{s,i,j}+r} \cdot e^{-(\lambda_{s,i,j}+r)\Delta} = \frac{rU_j + \lambda_{s,i,j}F}{\lambda_{s,i,j}+r} - U_j\left(1-e^{-r\Delta}\right) \tag{17}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. We substitute $\frac{y_i}{\lambda_{s,i,j}+r} \cdot e^{-(\lambda_{s,i,j}+r)\Delta}$ with the RHS of (17) into the second equation of (14). After some algebra (details are available on request), we have:

$$\frac{d\Lambda_{s,i,j}}{d\lambda}\Big|_{\lambda=\lambda_{s,i,j}} = -\frac{1}{\lambda_{s,i,j}+r}\left[F - U_j\left(1-e^{-r\Delta}\right)\right] - \frac{y_i}{\lambda_{s,i,j}+r}e^{-(\lambda_{s,i,j}+r)\Delta}\Delta \tag{18}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$. It is easy to see that this derivative is negative if $-F + U_j\left(1-e^{-r\Delta}\right) < 0$, that is the condition we have just obtained for the existence of an equilibrium. Even in the case $\max\left[S_{p,i,j},0\right] = 0$, such a condition is also sufficient for the uniqueness of the equilibrium.

The condition for $\lambda_{s,i,j} < \lambda_{p,i,j}$

Inspecting Figure 2, it is easy to see that an equilibrium with both temporary and permanent jobs requires not just that there exists a unique $\lambda_{s,i,j}$ that satisfies $S_{t,i,j} - S_{p,i,j} = 0$, but we also need that $\lambda_{s,i,j} < \lambda_{p,i,j}$, for any $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$. If $\lambda_{s,i,j}$ were greater than $\lambda_{p,i,j}$, functions $S_{p,i,j}$ and $S_{t,i,j}$ would cross each other in the negative fourth orthant. Since we have seen that at $\lambda \to 0$ $\Lambda_{s,i,j} > 0$ (i.e. $S_{p,i,j} > S_{t,i,j}$ at $\lambda \to 0$), this would imply that the surplus of permanent jobs would be greater than the surplus of temporary ones as long as they are both positive. No temporary contract would be signed.
As Figure 2 illustrates, imposing $\lambda_{s,i,j} < \lambda_{p,i,j}$ is equivalent to imposing $S_{t,i,j}(\lambda_{p,i,j}) > 0$. Recall that at $\lambda = \lambda_{p,i,j}$ we have $S_{p,i,j} = 0$, so $\max\left[S_{p,i,j},0\right] = 0$. So, from equation (10), we have:

$$S_{t,i,j}(\lambda_{p,i,j}) = \frac{y_i}{r+\lambda_{p,i,j}}\left(1-e^{-(r+\lambda_{p,i,j})\Delta}\right) - U_j\left(1-e^{-r\Delta}\right) - c_t \tag{19}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$. Using the first equation in (6), we have that:

$$-c_p = -\frac{y_i - rU_j - \lambda_{p,i,j}F}{r+\lambda_{p,i,j}} \tag{20}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$. Since $c_p \cong c_t$, we can substitute the RHS of equation (20) into the RHS of equation (19) and get:

$$S_{t,i,j}(\lambda_{p,i,j}) = \frac{1}{r+\lambda_{p,i,j}}\left[-y_i \cdot e^{-(r+\lambda_{p,i,j})\Delta} + \lambda_{p,i,j}\left(F-U_j\right)\right] + U_j \cdot e^{-r\Delta} \tag{21}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F, \overline{U}\right]$. After some easy algebra, we can write this equation as

follows:

$$S_{t,i,j}(\lambda_{p,i,j}) = \frac{-y_i \cdot e^{-(r+\lambda_{p,i,j})\Delta} + rU_j \cdot e^{-r\Delta} - \lambda_{p,i,j}U_j\left(1-e^{-r\Delta}\right) + \lambda_{p,i,j} \cdot F}{r+\lambda_{p,i,j}} \tag{22}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. Notice that the condition imposed for the existence of $\lambda_{s,i,j}$ implies that the sum of the two last terms at the numerator of (22) is positive. So, in order to have $S_{t,i,j}(\lambda_{p,i,j}) > 0$ we just need to impose that:

$$rU_j > y_i \cdot e^{-\lambda_{p,i,j}\Delta}$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. Rearranging, this is equivalent to:

$$\Delta > \frac{1}{\lambda_{p,i,j}} \log\left(\frac{y_i}{rU_j}\right)$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. Using the expression for $\lambda_{p,i,j}$ in the first equation of (6) and the fact that $c_p \cong c_t$, this inequality can be written as:

$$\Delta > \frac{F+c_t}{y_i - r\left(U_j+c_t\right)} \log\left(\frac{y_i}{rU_j}\right)$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. Finally, as we are in the case $U_j \in \left(F,\overline{U}\right]$, the inequality above holds *a fortiori* if

$$\Delta > \frac{U_j+c_t}{y_i - r\left(U_j+c_t\right)} \log\left(\frac{y_i}{rU_j}\right)$$

for any $i \in \{l,h\}$ and $U_j \in \left(F,\overline{U}\right]$. The term at the RHS is the lower bound for Δ in Proposition 1. If this inequality holds, $S_{t,i,j}(\lambda_{p,i,j}) > 0$ and $\lambda_{p,i,j} > \lambda_{s,i,j}$.

Proof of Proposition 2

The proof of Proposition 2 closely follows the same steps carry out to prove Proposition 1. We first show that there exists a unique $\lambda_{s,i,j}$ that solves $\Lambda_{s,i,j} \equiv S_{p,i,j} - S_{t,i,j} = 0$, in the labor market $i \in \{l,h\}$ for workers j with $U_j \in [\underline{U},F]$. Then we impose a condition that

ensures $\lambda_{s,i,j} < \lambda_{p,i,j}$.

Using the second equation in (5) and equation (10), $\Lambda_{s,i,j} \equiv S_{p,i,j} - S_{t,i,j} = 0$ can be written as:

$$\begin{aligned} &\frac{y_i}{r+\lambda_{s,i,j}} - U_j - c_p - \frac{y_i}{r+\lambda_{s,i,j}} \cdot \left(1 - e^{-(\lambda_{s,i,j}+r)\Delta}\right) + \\ &+ U_j \left(1 - e^{-r\Delta}\right) + c_t - e^{-(\lambda_{s,i,j}+r)\Delta} \max\left[S_{p,i,j}\,,\, 0\right] = 0 \end{aligned} \tag{23}$$

for any $i \in \{l, h\}$ and $U_j \in [\underline{U}, F]$.

We are interested in an equilibrium in which both temporary and permanent jobs coexist. As we have seen in the proof of Proposition 1, this is possible only if $\lambda_{s,i,j} < \lambda_{p,i,j}$. But, as an inspection of Figure 2 elucidates, this condition is equivalent to imposing that in the point in which functions $S_{p,i,j}$ and $S_{t,i,j}$ cross each other, $S_{p,i,j}$ is positive. In turn, this is equivalent to imposing that: (i) in the equation (23), the term $\max\left[S_{p,i,j},\, 0\right] = S_{p,i,j}$; (ii) the equilibrium value $\lambda_{s,i,j}$ that solves the equation (23) is lower than $\lambda_{p,i,j}$.

Imposing $\max\left[S_{p,i,j},\, 0\right] = S_{p,i,j}$ in the equation (23) and doing some algebra, we get:

$$\lambda_{s,i,j} = \frac{1}{\Delta} \log\left(\frac{U_j + c_p}{U_j \cdot e^{-r\Delta} + c_p - c_t}\right) \tag{24}$$

for any $i \in \{l, h\}$ and $U_j \in [\underline{U}, F]$. This equilibrium value of $\lambda_{s,i,j}$ must be lower than $\lambda_{p,i,j}$. Using (24) and the second equation in (6), a necessary and sufficient condition for that is

$$\frac{y_i}{U_j + c_p} - r > \frac{1}{\Delta} \log\left(\frac{U_j + c_p}{U_j \cdot e^{-r\Delta} + c_p - c_t}\right)$$

for any $i \in \{l, h\}$ and $U_j \in [\underline{U}, F]$. Rearranging and using the fact that $c_p \cong c_t$, we get:

$$\Delta > \frac{U_j + c_t}{y_i - r\left(U_j + c_t\right)} \cdot \log\left(\frac{U_j + c_t}{U_j}\right)$$

This is the condition presented in Proposition 2.

D Proofs of Propositions 3 and 4

Proof of Proposition 3

We divide the proof of Proposition 3 in three parts. First we show how a percentage increase in c_t lowers $\lambda_{t,i,j}$ and that such a percentage reduction is larger in absolute value when $i = l$ compared to $i = h$, for any $U_j \in \left[\underline{U}, \overline{U}\right]$.
In the second part, we prove that c_t raises $\lambda_{s,i,j}$ and that the increase is the same for both labor markets l and h, for any $U_j \in \left[\underline{U}, \overline{U}\right]$.
In the final part, we simply show how these changes affect the interval $\left(\lambda_{t,h,j} - \lambda_{s,h,j}\right)$.

The effect of c_t on $\lambda_{t,i,j}$

Applying the implicit function theorem to $S_{t,i,j}(\lambda_{t,i,j}) = 0$, we get:

$$\frac{d\,\lambda_{t,i,j}}{d\,c_t} \cdot \frac{c_t}{\lambda_{t,i,j}} \;=\; -\frac{S'_{t,i,j}(c_t)}{S'_{t,i,j}(\lambda_{t,i,j})} \cdot \frac{c_t}{\lambda_{t,i,j}}$$

in which $S'_{t,i,j}(c_t) \equiv \frac{d\,S_{t,i,j}}{d\,c_t}$ and $S'_{t,i,j}(\lambda_{t,i,j}) \equiv \frac{d\,S_{t,i,j}}{d\,\lambda_{t,i,j}}$ for any $i \in \{l, h\}$ and $U_j \in \left[\underline{U}, \overline{U}\right]$.
As Figure 2 makes it clear, we have $\lambda_{t,i,j} > \lambda_{p,i,j}$ for any $i \in \{l, h\}$ and $U_j \in \left[\underline{U}, \overline{U}\right]$. This means that at $\lambda = \lambda_{t,i,j}$, the term $\max\left[S_{p,i,j},\, 0\right]$ in the equation for $S_{t,i,j}$, (10), is equal to 0. Using this and equations (11) and (12), we get:

$$\frac{d\,\lambda_{t,i,j}}{d\,c_t} \cdot \frac{c_t}{\lambda_{t,i,j}} \;=\; \frac{c_t}{\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j})} \tag{25}$$

with

$$\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j}) \;=\; -\frac{y_i\,\lambda_{t,i,j}}{\left(r + \lambda_{t,i,j}\right)^2} \cdot \left\{1 - e^{-(r+\lambda_{t,i,j})\Delta}\left[1 + \left(\lambda_{t,i,j} + r\right)\Delta\right]\right\}. \tag{26}$$

This derivative is negative for any $i \in \{l, h\}$ and $U_j \in \left[\underline{U}, \overline{U}\right]$ because $1 - e^{-x}(1+x)$ is a positive number.
Now we want to show that $\frac{d\,\lambda_{t,i,j}}{d\,c_t} \cdot \frac{c_t}{\lambda_{t,i,j}}$ is less negative when $i = h$ compared to the case

$i = l$, for any $U_j \in \left[\underline{U}, \overline{U}\right]$. This is tantamount to proving that the denominator on the RHS of (25) is decreasing in y_i (recall that $y_h > y_l$). So we need to prove that

$$\frac{d\left[\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j})\right]}{d\,y_i} = \frac{\partial\left[\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j})\right]}{\partial\,y_i} + \frac{\partial\left[\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j})\right]}{\partial\,\lambda_{t,i,j}} \cdot \frac{\partial\,\lambda_{t,i,j}}{\partial\,y_i} < 0$$

for any $U_j \in \left[\underline{U}, \overline{U}\right]$. Notice the twofold effect of y_i on $\left[\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j})\right]$: the direct one and the one mediated by the change on $\lambda_{t,i,j}$.
Applying the implicit function theorem to $S_{t,i,j}(\lambda_{t,i,j}) = 0$ and using equation (10), we get:

$$\frac{d\,\lambda_{t,i,j}}{d\,y_i} = \frac{r + \lambda_{t,i,j}}{y_i} \cdot \frac{1 - e^{-(r+\lambda_{t,i,j})\Delta}}{1 - e^{-(r+\lambda_{t,i,j})\Delta}\left[1 + \left(\lambda_{t,i,j} + r\right)\Delta\right]}. \tag{27}$$

This derivative is positive for any $i \in \{l, h\}$ and $U_j \in \left[\underline{U}, \overline{U}\right]$ because $1 - e^{-x}(1 + x)$ is a positive number.
Differentiating equation (26), we obtain:

$$\frac{\partial\left[\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j})\right]}{\partial\,y_i} = -\frac{\lambda_{t,i,j}}{\left(r + \lambda_{t,i,j}\right)^2} \cdot \left\{1 - e^{-(r+\lambda_{t,i,j})\Delta}\left[1 + \left(\lambda_{t,i,j} + r\right)\Delta\right]\right\} \tag{28}$$

and

$$\frac{\partial\left[\lambda_{t,i,j} \cdot S'_{t,i,j}(\lambda_{t,i,j})\right]}{\partial\,\lambda_{t,i,j}} = -\frac{y_i \lambda_{t,i,j}}{\left(r + \lambda_{t,i,j}\right)^3} \cdot$$
$$\left\{\left(r - \lambda_{t,i,j}\right)\left[1 - e^{-(r+\lambda_{t,i,j})\Delta}\left(1 + \left(\lambda_{t,i,j} + r\right)\Delta\right)\right] + \lambda_{t,i,j} \cdot e^{-(r+\lambda_{t,i,j})\Delta}\left(r + \lambda_{t,i,j}\right)^2 \cdot \Delta^2\right\} \tag{29}$$

for any $i \in \{l, h\}$ and $U_j \in \left[\underline{U}, \overline{U}\right]$.
Now we can put together equations (27), (28), and (29). For a more compact notation, let us

denote $x \equiv (r+\lambda_{t,i,j})\Delta$. Doing some algebra we obtain:

$$\frac{d\left[\lambda_{t,i,j}\cdot S'_{t,i,j}(\lambda_{t,i,j})\right]}{dy_i} = -\frac{1}{\left(r+\lambda_{t,i,j}\right)^2}\cdot \left\{ r\left(1-e^{-x}\right)+\lambda_{t,i,j}\cdot\frac{\left[1-e^{-x}(1+x)\right]^2-\left(1-e^{-x}\right)\left[1-e^{-x}\left(1+x(1+x)\right)\right]}{1-e^{-x}(1+x)}\right\} \tag{30}$$

for any $i\in\{l,h\}$ and $U_j\in\left[\underline{U},\overline{U}\right]$. Since $1-e^{-x}(1+x)$ is a positive number, the denominator in the second line of (30) is positive. So the term on the RHS is negative if the numerator in the second line of (30) is positive. Doing some algebra, we get:

$$\begin{aligned}&\left[1-e^{-x}(1+x)\right]^2-\left(1-e^{-x}\right)\left[1-e^{-x}(1+x(1+x))\right]=\\&=e^{-2x}(1+x)^2-2e^{-x}(1+x)+e^{-x}+e^{-x}\left(1-e^{-x}\right)\left(1+x+x^2\right)=\\&=e^{-2x}x-e^{-x}x+e^{-x}x^2=\\&=e^{-x}x\cdot\left(x-1+e^{-x}\right)\end{aligned} \tag{31}$$

This expression is positive because $x-1+e^{-x}>0$ for any $x>0$. Therefore the derivative $\frac{d\left[\lambda_{t,i,j}\cdot S'_{t,i,j}(\lambda_{t,i,j})\right]}{dy_i}$ is decreasing in y_i.
In turn, from equation (25), this implies that the elasticity $\frac{d\lambda_{t,i,j}}{dc_t}\cdot\frac{c_t}{\lambda_{t,i,j}}$ is less negative at $i=h$ than at $i=l$, for any $U_j\in\left[\underline{U},\overline{U}\right]$.

The effect of c_t on $\lambda_{s,i,j}$

We first show that $\lambda_{s,i,j}$ is independent of y_i both in the case $U_j\in\left(F,\overline{U}\right]$ and in the case $U_j\in[\underline{U},F]$. Then we prove that $\frac{d\lambda_{s,h,j}}{dc_t}\frac{c_t}{\lambda_{s,h,j}}=\frac{d\lambda_{s,l,j}}{dc_t}\frac{c_t}{\lambda_{s,l,j}}>0$.
Consider first the case in which $U_j\in\left(F,\overline{U}\right]$. Recall that $\lambda_{s,i,j}<\lambda_{p,i,j}$. So, substituting $\max\left[\frac{y_i-rU_j-\lambda F}{r+\lambda}-c_p\ ,\ 0\right]=\frac{y_i-rU_j-\lambda F}{r+\lambda}-c_p$ in equation (13) and doing some algebra, we

get:

$$\begin{aligned}\Lambda_{s,i,j} \equiv & -\frac{rU_j}{r+\lambda_{s,i,j}}\left[1-e^{-(\lambda_{s,i,j}+r)\Delta}\right]-\frac{\lambda_{s,i,j}}{r+\lambda_{s,i,j}}F\cdot\left[1-e^{-(\lambda+r)\Delta}\right]+\\ & -c_p\cdot\left[1-e^{-(\lambda+r)\Delta}\right]+c_t+U_j\cdot\left[1-e^{-r\Delta}\right]=0\end{aligned} \tag{32}$$

for $i\in\{l,h\}$ and $U_j\in\left(F,\overline{U}\right]$. From Proposition 1, there exists a unique $\lambda_{s,i,j}$ that solves equation (32) for $i\in\{l,h\}$ and $U_j\in\left(F,\overline{U}\right]$. Moreover, productivity y_i does not appear in equation (32) and therefore does not affect $\lambda_{s,i,j}$. So we can drop the subscript i and write $\lambda_{s,j}$.

Applying the implicit function theorem to equation (32) , we have:

$$\frac{d\lambda_{s,j}}{dc_t}\frac{c_t}{\lambda_{s,j}}=\frac{c_t}{\lambda_{s,j}}\cdot\frac{1}{\Delta\left[F-U_j\left(1-e^{-r\Delta}\right)\right]+\frac{r}{\left(r+\lambda_{s,j}\right)^2}\left(U_j-F\right)\left[\Delta\left(r+\lambda_{s,j}\right)+e^{-(\lambda_{s,j}+r)\Delta}-1\right]}$$

for any $U_j\in\left(F,\overline{U}\right]$. This expression is positive because we have imposed $F>U_j\left(1-e^{-r\Delta}\right)$ for the existence of an equilibrium value $\lambda_{s,j}$ (see the proof of Proposition 1 in Appendix C) and because $x+e^{-x}-1$ is always a positive number.

Consider now the case in which $U_j\in[\underline{U},F]$. The equilibrium value of $\lambda_{s,j}$ is determined in equation (24): even in this scenario y_i does not influence $\lambda_{s,j}$. It is also trivial to see that c_t positively affects $\lambda_{s,j}$ and therefore $\frac{d\lambda_{s,j}}{dc_t}\frac{c_t}{\lambda_{s,j}}>0$ for any $U_j\in[\underline{U},F]$.

The effect of c_t on $\lambda_{t,i,j}-\lambda_{s,j}$

Consider the following elasticity:

$$\begin{aligned}\frac{d\lambda_{t,i,j}-\lambda_{s,j}}{dc_t}\cdot\frac{c_t}{\lambda_{t,i,j}-\lambda_{s,j}}&=\left(\frac{d\lambda_{t,i,j}}{dc_t}-\frac{d\lambda_{s,j}}{dc_t}\right)\cdot\frac{c_t}{\lambda_{t,i,j}-\lambda_{s,j}}=\\ &=\frac{d\lambda_{t,i,j}}{dc_t}\cdot\frac{c_t}{\lambda_{t,i,j}}\cdot\frac{\lambda_{t,i,j}}{\lambda_{t,i,j}-\lambda_{s,j}}-\frac{d\lambda_{s,j}}{dc_t}\cdot\frac{c_t}{\lambda_{s,j}}\cdot\frac{\lambda_{s,j}}{\lambda_{t,i,j}-\lambda_{s,j}}\end{aligned} \tag{33}$$

for any $i\in\{l,h\}$ and $U_j\in\left[\underline{U},\overline{U}\right]$. This expression is negative because we have just shown that $\frac{d\lambda_{t,i,j}}{dc_t}<0$ and $\frac{d\lambda_{s,j}}{dc_t}>0$.

We also want to prove that the elasticity in (33) is increasing in y_i, i.e. it is lower in absolute

value at $i = h$ compared to $i = l$.

Recall first that $\frac{d\lambda_{t,i,j}}{dc_t} \cdot \frac{c_t}{\lambda_{t,i,j}}$ is increasing in y_i. Therefore, since $\frac{d\lambda_{s,j}}{dc_t} \cdot \frac{c_t}{\lambda_{s,j}}$ is independent of y_i, the elasticity in (33) is increasing in y_i if both $\frac{\lambda_{t,i,j}}{\lambda_{t,i,j}-\lambda_{s,j}}$ and $\frac{\lambda_{s,j}}{\lambda_{t,i,j}-\lambda_{s,j}}$ are decreasing in y_i. Computing the derivatives, we get:

$$\frac{d\,\frac{\lambda_{t,i,j}}{\lambda_{t,i,j}-\lambda_{s,j}}}{dy_i} = \frac{d\,\frac{\lambda_{s,j}}{\lambda_{t,i,j}-\lambda_{s,j}}}{dy_i} = \frac{-\lambda_{s,j}}{\left(\lambda_{t,i,j}-\lambda_{s,j}\right)^2} \cdot \frac{d\lambda_{t,i,j}}{dy_i} \tag{34}$$

for any $i \in \{l,h\}$ and $U_j \in \left[\underline{U}, \overline{U}\right]$. These derivatives are negative because $\frac{d\lambda_{t,i,j}}{dy_i} > 0$ from equation (27). Therefore we conclude that the elasticity in (33) is negative and lower in absolute value for $i = h$ compared to $i = l$.

Proof of Proposition 4

A marginal decrease in F affects unproductive workers with utility $U_{j^*} = F$. Before the reduction, the share of them that had been hit by a negative shock, thereby becoming unproductive, remained employed. Once F is reduced, they are fired. Here we show that the extent of these layoffs is larger in the low-skilled sector if $L_l \cdot h_l(F) > L_h \cdot h_h(F)$.

From Figure 2, notice first that workers with $U_{j^*} = F$ have a permanent position if they have randomly selected a value of $\lambda \in \left[\lambda_{min,j^*}, \lambda_{s,j^*}\right]$. Such an interval is the same for $i \in \{l,h\}$ because (i) we have assumed that λ_{min,j^*} is equal across labor market segments (high and low skilled); (ii) we have proved that λ_{s,j^*} is is equal across labor market segments (it is unaffected by y_i). Since the cumulative distribution $G(.)$ for type λ is also independent of $i \in \{l,h\}$, we conclude that the rate at which workers become unproductive is the same across skill segments.

In addition, notice that for workers with $U_j \in [\underline{U}, F]$, permanent employment is an absorbing state, in the sense that once you get a permanent position, you never leave it.[43] This implies that at the steady state all the labor force with $U_{j^*} = F$ will be permanently employed: $E_{p,i,j^*} = L_i \cdot h_i(U_{j^*}) = L_i \cdot h_i(F)$ for $i \in \{l,h\}$.[44]

[43] On the contrary, both the unemployment status and the temporary employment one have a positive exit rate.

[44] If we are in the transitional dynamics and we are approaching the steady state we can write $E_{p,i,j^*} \longrightarrow$

Therefore, the measure of unproductive permanent workers with $U_{j^*} = F$ that will be laid off as F marginally decreases is larger in the low-skilled segment than in the high-skilled one if the former has a larger labor force: $L_l \cdot h_l(F) > L_h \cdot h_h(F)$.
As concerns the effect of F on $\lambda_{s,j}$ and $\lambda_{p,i,j}$ for $U_j \in \left(F, \overline{U}\right]$ and $i \in \{l, h\}$, differentiating the first equation in (6) and the equation $\Lambda_{s,i,j} = 0$ (with $\Lambda_{s,i,j}$ defined as in (13)) respectively, we obtain:

$$\begin{aligned}
&\frac{d\lambda_{p,i,j}}{dF} \cdot \frac{F}{\lambda_{p,i,j}} = \frac{-F}{F + c_p} \\
&\frac{d\lambda_{s,j}}{dF} \frac{F}{\lambda_{s,j}} = \frac{-\left(1 - e^{-(\lambda_{s,j}+r)\Delta}\right) \frac{F}{r+\lambda_{s,j}}}{\Delta\left[F - U_j\left(1 - e^{-r\Delta}\right)\right] + \frac{r}{\left(r+\lambda_{s,j}\right)^2}\left(U_j - F\right)\left[\Delta\left(r + \lambda_{s,j}\right) + e^{-(\lambda_{s,j}+r)\Delta} - 1\right]}
\end{aligned} \tag{35}$$

for any $i \in \{l, h\}$ and $U_j \in \left(F, \overline{U}\right]$. The second derivative is negative because we have imposed $F > U_j\left(1 - e^{-r\Delta}\right)$ for the existence of an equilibrium value $\lambda_{s,j}$ (see the proof of Proposition 1 in Appendix C) and because $x + e^{-x} - 1$ is always a positive number. Both elasticities are independent of y_i — so their magnitude is the same for $i = l$ and $i = h$ — as we have proved that $\lambda_{s,j}$ is not affected by y_i.

$L_i \cdot h_i(U_{j^*}) = L_i \cdot h_i(F)$ for $i \in \{l, h\}$.