Closing the Retirement Door and the Lump of Labor

Tito Boeri
Bocconi University, and INPS

Pietro Garibaldi
Collegio Carlo Alberto, University of Torino

Espen Moen
Norwegian Business School

May 29, 2017

Abstract

Economists are active militants against the popular idea that the number of jobs is fixed, so that decreasing labor input across one age group- for example by easing early retirement- makes room into the labor pool for another group of workers, typically the youngsters. Standard price theory suggests that this *lump of labor* concept is indeed a fallacy. Even when capital is fixed in the short run, and labor supply is rigid, changes in the retirement age are totally offset by wage adjustment. Yet, under short-run wage rigidity and with labor demand determined, an unexpected locking-in of older workers, associated with a partial closing of the retirement door for older workers, may affect youth employment. On the one hand, complementarity in production across age groups makes youth labor demand increasing in the locking-in of older workers. On the other hand, scale effects driven by short run decreasing returns to scale lead to a contraction of labor. Under these conditions, the effects of closing the retirement door on youth labor demand are an empirical matter. We take Italy as a case study as a major reform took place in December 2011 increasing the retirement by up to six years for some categories of workers. We have access to a unique dataset from the Italian social security administration (INPS) identifying in each private firm the fraction of workers locked-in by the sudden increase in the retirement age, and for how long. Our results indicate that an increase in the number of locked-in workers has indeed crowded out the youth. Quantitatively, the policy change accounts approximately for 60 percent of the reduction in youth employment and for 80 percent of the increase in the number of older workers in the average firm affected by the policy change. These results survive to a variety of robustness checks, and are relevant in light of the old-in young-out dynamics observed recently in Europe.

1 Introduction

Economists are active militants against the concept of the lump of labor, that is, the popular idea that the total number of jobs or of working hours is fixed (Walker, 2007). Since employment headcounts or hours worked are key endogenous variables, there is no reason to expect that their total number should be fixed. For long years economists have been fighting against arguments used to support mandatory reductions in working hours or introducing early retirement options, which were based on the creation of employment opportunities for those currently not working. The lump of labor concept can be shown to be fallacious on the basis of any 1.01 economics textbook. Standard price theory suggests that forced reductions in labor supply, induce wage adjustment partly or totally offsetting any potential creation of employment opportunities for those currently not working. Yet, this holds under perfect labor markets, where both wages and employment can freely adjust to changes in the institutional environment. Under more complex (and real world) institutional configurations, sound economic theory may generate a trade-off between employment at different age groups or working hours and headcounts. This would not generally replicate the lump of labor fixity of jobs or total hours, but would involve some crowding out effects at least in the short-run. Hence, not only theory, but also empirical work is needed to support or reject the arguments and the policies drawing on the lump of labor concept.

Most of the empirical work on these issues to date has been focusing on the intensive margin, analysing cases of mandatory workweek reductions. For instance Hunt (1999) analyzed the reduction of standard working hours enforced in Germany throughout collective agreements in the period 1984 to 1994, which reduced the standard workweek from 40 to 36 hours. Her main findings are that actual working hours followed standard hours quite closely, monthly wages were hardly affected by the reduction in working hours because workers bargained sufficient increases in their hourly wages to compensate for the reduction in working hours. As a result of this, the reductions in standard hours caused employment losses among men. France gave other natural experiments to researchers. In France the standard (mandatory) workweek was reduced from 40 to 39 hours in 1982. Crepon and Kramarz (2002) found that also in this case there was a reduction in employment: the reduction in the standard workweek increased the average wage rate, inducing a decline in total employment. Another French experiment which received considerable attention is the 1998 35-hours week introduced with the deliberate goal of reducing unemployment. Although this time the employment costs were partly mitigated by large state transfers to firms reducing working time (Estevao and Sa, 2008), there was an aggregate destruction of jobs. The lump of labor arguments were also falsified by a more recent study on mandatory working hours reductions in Korea (Kawaguki et al., 2012).

Surprisingly enough, there is fairly little empirical literature on the effects of policies operating along the extensive margin. In particular, changes in retirement age and labor demand of different age groups have only partly been investigated. This is partly because it is hard to get good data on retirement rules and firm-level employment adjustment, and partly because the literature on retirement is typically focused on the supply side, and hence ignores trade-offs between younger and older workers that may originate on the demand side. While an account of the main results of this scant literature is offered below, it is important to stress at this stage that economic theory on this issue needs stronger empirical guidance. The economics of an increase in retirement age and labor demand is indeed more subtle than a simple exogenous shift in labor supply. This is because most of the individuals involved are already employed and can not be easily fired.

In this paper we treat pension reforms increasing the retirement age as *forced expansions at the firm level*. We show that in a perfect labor market, with full wage flexibility, even when capital is fixed in the short run, an increase in retirement is totally offset by wage changes with a rigid labor supply. However, when wages are rigid in the short run, an unexpected closing of the retirement door that locks-in workers inside firms, has ambiguous short run effects on labor demand for youth and prime age workers. As our model indicates, there are two effects at work in this case. First, there is a *negative scale effect* due to decreasing returns to scale. The reform forces some of the older workers to stay employed rather than retire. Even though this tends to increase output, with decreasing marginal returns to scale in production, the marginal product of the other age group falls, and so does their hiring. Second, there is a potentially positive effect on employment of youngsters related to the *degree of complementarity* between young and older workers. Under these conditions, the effect of closing the retirement door on labor demand of other groups of workers is an empirical matter.

The core of our research investigates empirically the impact of an increase in retirement age on labor demand at the firm level. We take Italy as a case study as a major retirement reform took place in December 2011. In the middle of a run on the Italian public debt, and under the pressure of markets and international organizations, Italy suddenly increased the retirement age by up to six years for some categories of workers. This policy change is now known as the ''Monti Fornero reform", and the paper estimates its effect on labor demand at the firm level. We have access to a unique dataset from the Italian social security administration (INPS) identifying in each private firm the fraction of workers locked-in by the sudden increase in the retirement age. We estimate the effects of an unanticipated locking-in of older workers on overall employment growth, as well as employment growth at different age groups. Our results indicate that an increase in the number of locked-in workers has indeed crowded out the youth, and contributed to the old-in young-out equilibrium observed at the aggregate level. Quantitatively, the policy change accounts approximately for at least 60 percent of the reduction in youth employment and for at least 80 percent of the increase in old employment in the average firm affected by the reform. These results survive to a variety of robustness checks.

Our results are particularly relevant in light of plans in several countries to raise the retirement age as a response to the ageing of populations. They are also particularly timely in the understanding of the old-in young-out dynamics observed in Europe, notably during the Great Recession and the ensuing Euro debt crisis. For the Euro area as a whole, employment in the 15-24 age group declined by almost 17% in the 2007-13 period. Also in the 25 to 29 age group the percentage employment decline was above the two-digit level. At the other extreme of the age distribution, employment for people in the 55-65 age group increased by approximately 10 percent. Demographic developments played an important role in this context, but cannot account, by themselves, for these dramatic changes in the structure of employment by age groups. Indeed, not only employment levels, but also employment rates of young and senior workers moved in opposite directions (Figure 1). The increase of full time schooling and education attainment of the younger population is also partly responsible for this trend. In the case of Italy, for example, Oecd data suggest that the share of people in the 25-34 category with tertiary education increased from 16,1 in 2005 to 25,1 in 2015. In any event in Italy, the country on which our empirical work is based, the divergent dynamics of employment of young and older workers is dramatic: some two million of jobs were lost among young workers while employment of older workers had increased by some 15 basis points.[1]

[1]The strong increase of youth unemployment was predicted by the literature on contractual dualism. For instance,

The paper first briefly surveys the existing literature on retirement and employment (and productivity) across age groups. In section 3 we provide a conceptual framework to look at the age structure of labor demand. In section 4, we describe in some details the pension reform that took place in Italy in December 2011. In section 5 we describe the data, spell out the empirical strategy, and provide the basic estimates. Section 6 performs various robustness checks while section 7 interprets our findings and discusses the magnitude of the effects. Finally, Section 8 concludes, and points out basic policy implications.

Figure 1: Employment Rate of Young and Older Workers in the EU 15

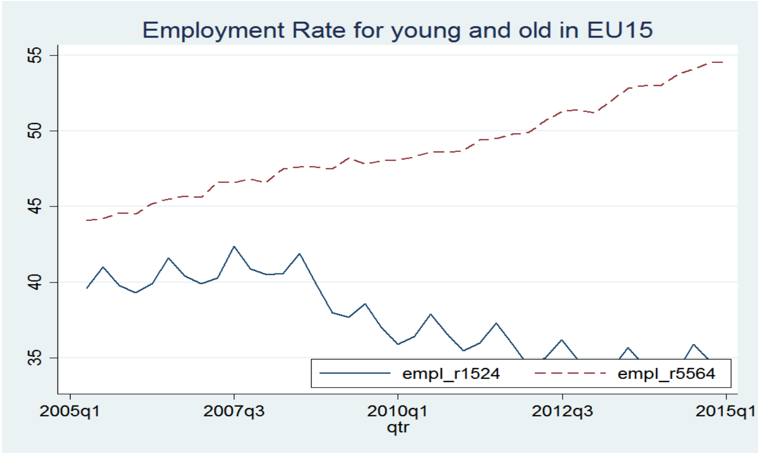
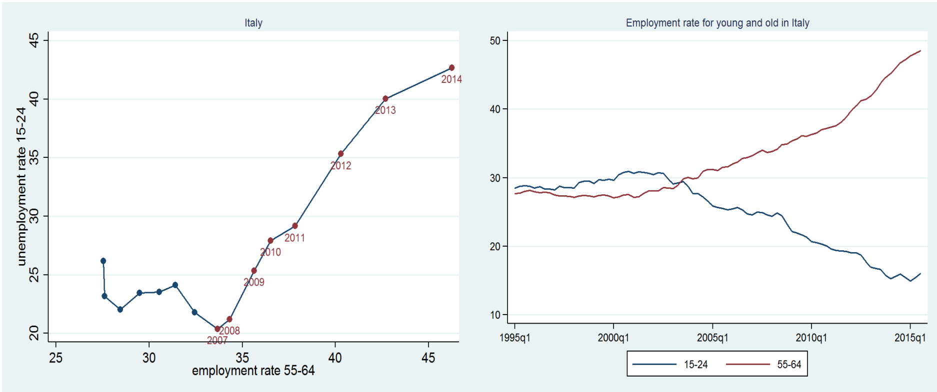


Figure 2: Employment Rate of Young and Older Workers in Italy



as suggested by Boeri and Garibaldi (2007) the honeymoon of youth unemployment following two-tier labor market reforms is followed by the nightmare of youth dis-employment as soon as macroeconomic conditions deteriorate. The large literature on contractual dualism, however, fails to explain divergent dynamics of employment rates in the rest of the age distribution.The pioneer work is Saint-Paul (1993). Boeri (2011) offers a survey of the literature up to the Great Recession. See Cahuc et al. (2016), and Berton and Garibaldi (2012) for more recent work

2 Literature review

As stressed above, the literature on retirement schemes is typically focused on the supply side, and often neglects the labor demand side. Most work on employment across age groups and early retirement was also done at the macro level. For instance, Boldrin et al. (1999) display cross-country correlations between effective retirement age and youth unemployment, pointing out that, if anything, the correlation is negative. Boeri and vanOurs (2013) likewise report a negative cross-country relationship between the employment rates of older workers (aged 55–64) and the unemployment rates of young workers (aged 20–29). Brugiavini and Peracchi (2010) find a negative correlation between youth unemployment and labor force participation of older workers in Italy both across and within cohorts. Hairault et al. (2010) find that early retirement increases joblessness, notably among those workers who are approaching the retirement age. The interpretations provided for these findings are mainly supply-driven and refer to incentives to job search of older workers or forward-looking behavior of the young generations concerning the generosity of pension systems. A partial exception is Vestad (2013) who uses micro-level, administrative data, to estimate the impact of an early retirement program in Norway. His focus is on employment of older workers, found to be negatively affected by the reform, and once more on the supply side.

Some of the findings summarized above may capture a long-run relationship between retirement age and youth employment/unemployment. In this paper, we focus on the short-run effects of a reform suddenly and steeply increasing the retirement age, and we use firm-level evidence on labor demand.

There is a strand of the existing literature which is relevant in the modeling of the interaction between retirement rules and labor demand and in interpreting our empirical results. It has to do with the relationship between age and productivity.

Research on the age-productivity relationship has to find proper measures of age-specific productivity, and often relies on perceptions of employers. For instance, Barth et al. (1993) report that, according to employers, older workers have higher health care costs and lower flexibility in accepting new assignments, and they may be less suitable for training. Older workers are also considered to be more consistent, cautious, slow, and conscientious. Johnson (1993) reports that most employers believe in a rule of thumb that average labor productivity declines after some age between 40 and 50. Remery et al. (2003) assessing employers' opinions about ageing in the Netherlands, find that employers are less favorable—higher wage costs, lower productivity—about older workers the higher the share of older workers in the firm, which may hint at complementarity between young and older workers.

Quantitative assessments of the age-productivity profile often rely on cross-sectional variation (Warr, 1998) at the plant level[2] . For instance, Boersch-Supan et al. (2006), based on a case study in a large manufacturer of cars in Germany, do not find that productivity declines with age. Errors are more frequent with older workers, but are also less severe than those made by young workers. Avolio et al. (1990) find that tenure is a better predictor of work performance than age, in jobs with high complexity. Vandenberghe (2013) finds that a larger share of older workers in a firm does not affect gross profits. Cross-sectional studies, however, cannot control for cohort effects. Indeed, it is often found (see Boeri and vanOurs (2013)) that the variance in performance is greater *within* age groups than *between* age groups.

More recent studies used matched employer-employee data to assess the relationship between age,

[2]See Garibaldi et al. (2011) for a review of this literature

productivity and wages. This research points to a crucial role of institutions, notably wage setting and employment protection. For instance, Hellerstein et al. (1999) using a U.S. matched worker-firm data found that for prime-aged workers and older workers, productivity and earnings increase at the same rate over the life cycle, while Crepon e Kramarz (2002) using the same methodology on French data found that older workers are relatively overpaid. The age profile of wages has a concave pattern, while the age profile of productivity stops rising and even decreases after some experience level. They conclude that a policy of raising the normal retirement age may be problematic because of the poor performance of older workers in the labor market. Ilmakunnas and Maliranta (2005), using Finnish firm data with matched average worker characteristics, similarly found that the wage-productivity gap increases with age. Dostie (2011), based on Canadian linked worker-firm data, found that both wage and productivity profiles are concave, but productivity diminishes faster than wages for workers aged 55 or older.

3 The labor demand effects of temporary pension reforms

A representative firm produces with two inputs, labor N and capital K. In the long run, both N and K are flexible, and the technology is characterized by a production function $y = F(N, K)$, which is quasi-concave and exhibits constant returns to scale. As we focus on labor demand in the short-run, we assume that the capital stock is fixed, so that the production function can be written as $y = f(N) \equiv F(N, K)$ for some fixed K. It follows that $f'(N) > 0$, $f''(N) < 0$. With the Cobb-Douglas specialization, $y = \tilde{A}N^{\alpha}K^{1-\alpha}$ and the short-run production function reads $y = AN^{\alpha}$, with $A = \tilde{A}K^{1-\alpha}$. We assume that there is a measure $\bar{L}_i$ of workers of each type, $i = 1, 2$.

The labor force consists of different cohorts of workers, with different degrees of experience. The different age groups may differ in overall productivity, and may have comparative advantages and disadvantages in different tasks, as suggested by the empirical literature reviewed in Section 2. Hence, different cohorts of workers may not be perfect substitutes. Suppose that workers can be divided into two categories: young and inexperienced/untrained workers, and older and experienced/trained workers. Let L_1 and L_2 denote the number of young and older workers, respectively. We assume that L_1 and L_2 units of young and older workers deliver a total of $N = g(L_1, L_2)$ efficiency units of the labor input, where the aggregator g exhibits constant returns to scale. For simplicity we finally assume that the supply of young and older workers is the same and is equal to 1.

We require that the composite function $\tilde{f}(L_1, L_2) \equiv f(g(L_1, L_2))$ is strictly concave. Denote the wages for young and older workers by w_1 and w_2, respectively. In a competitive labor market they are given by the following set of equations:

$$f'(N)g_1(L_1, L_2) = w_1 \tag{1}$$
$$f'(N)g_2(L_1, L_2) = w_2 \tag{2}$$
$$L_i = \bar{L}_i \qquad i = 1, 2 \tag{3}$$

where g_1 and g_2 denote the partial derivatives of g with respect to young and older workers, respectively.

Employment effects of reforms

Suppose that the Government unexpectedly introduces a pension reform that requires the firm to retain workers who were supposed to retire. The reform thus leads to a forced expansion of senior workers at the firm level. The reform is supposed to be temporary, and will therefore not influence the demand for young workers directly. It will act only indirectly through the effects on the stock of senior workers operating in the firm.

With flexible wages, it follows straightforwardly that the wages of both young and older workers will adjust so that demand again equals supply. Wages for older workers will certainly fall, while wages for young workers may fall or increase, as the discussion below highlights. Suppose instead that wages are downward rigid in the short run. If firms are free to adjust the number of senior workers (other than those who were supposed to retire), firms will reduce the stock of these workers accordingly, and the demand for young workers would be unaffected. However, with strict employment protection legislation (EPL), the firm cannot go this route.

Suppose therefore that the reform leads to an instantaneous increase in senior employees by ΔL efficiency units. With exogenous wages, the impact on the demand for young workers is given by

$$\begin{aligned} \frac{dL_1}{d\Delta L} &= -\frac{f'(N)g_{12} + f''(N)g_1 g_2}{f''(N)g_1^2 + f'(N)g_{11}} \\ &= k\left[f'(N)g_{12} + f''(N)g_1 g_2\right] \qquad (4) \end{aligned}$$

where $k = -1/(g_1^2 f''(N) + f'(N)g_{11}) = -1/\tilde{f}_{11} > 0$. Equation (4) represents our key theoretical prediction on the effect of a temporary increase of the retirement age on the demand for young workers. A forced expansion of older workers has two effects in this respect: The first effect, reflected in the first term on the right-hand side of (4), captures the *degree of complementarity* between young and older workers. If $g_{12} > 0$, more older workers will increase the marginal productivity of young workers, and this will tend to increase the demand for them. The second term reflects a negative effect due to *decreasing returns to scale in production.* As the reform forces some of the older workers to stay employed rather than to retire, this will, ceteris paribus, increase output. Since there are decreasing returns to scale in production, this will negatively affect the marginal product and hence also the demand for young workers. Consider the case in which $y = AN^{1-\alpha}$, $0 < \alpha < 1$. In the appendix we demonstrate that if young and older workers are perfect substitutes (g is linear), the demand for young workers will always fall after a forced expansion of older workers. If g is Cobb-Douglas, the demand for young workers will always increase. If g is a CES function, $g(L_1, L_2) = (aL_1^{\rho} + (1-a)L_2^{\rho})^{\frac{1}{\rho}}$, the demand for young workers will fall if $\rho > \alpha$, or equivalently, if $\sigma > \frac{1}{1-\alpha}$, where σ is the elasticity of substitution between young and older workers.

At the time of the reform, it is reasonable to assume that changes in demand for young workers will lead to a corresponding change in employment of young workers. A negative shift in the demand for young workers will lead to a fall in employment of young workers, both because young workers are less protected by EPL than older workers, and because firms can cut back on hiring of young workers. Symmetrically, firms can accommodate an increase in the demand for young workers insofar as there are enough young unemployed around who are available to work.

At the firm level, the effect of the reform will depend on the number of workers who are locked-in. This will vary from firm to firm, depending on the number of workers who were eligible for pensions according to the pre-reform pension rules, but not according to the post-reform rules, i.e., the size of the forced expansion in that firm. [3] Hence, in a given firm i, we expect a response function of the form

$$\Delta L_1^i = \gamma \Delta^i \tag{5}$$

where Δ^i is the forced expansion in firm i. A negative sign of γ implies a crowding out on the youth from the forced expansion.

In our data, the workforce is divided into three age bins: young, prime-age, and older workers. We expect that EPL will protect prime-age workers from replacement associated to the forced expansion of older workers. Moreover, the most important margin of adjustment of the workforce is the hiring of young workers. The empirical analysis below confirms that there is no significant effect on employment of prime-age workers of a forced expansion of older workers in a firm.

4 The 2011 pension reform in Italy

In the middle of the European sovereign crisis, in November 2011 Mario Monti became Prime Minister of Italy. His Government enacted in December 2011 a bold reform steeply increasing contributory and age requirements to obtain an early retirement or old-age pension. This reform was unanticipated and dictated by the need to restore confidence in Italian public finance after the interest on long-term Government bonds had reached an historical peak at 7.56% in the government auction of November 29, 2011. The sovereign crisis that hit Italy in the Fall of 2011 was both repentine and intense, and the fall of the Berlusconi Government was unlikely to be envisaged by Italian firms. Moreover, it was far from obvious what would happen after the fall of the Berlusconi Government. As the financial crisis unfolded, events took place over a very few days. Giorgio Napolitano, the President of the Italian Republic, appointed Mario Monti as life senator on November 9, 2011. The Berlusconi Government resigned on the hands of the President on November 12, and Mario Monti received the mandate to form a new government on November 13. He swiftly put together a technocrat government that took office on November 16. On December 4, the pension reform was approved, alongside a package of other austerity measures in a rescue package named "Save Italy". The reform was enacted as a Government decree, hence it become immediately effective. It is now known as the Fornero-Monti reform, named after the Labor Minister in office in the Monti Government.

The contribution required to be eligible for early pensions was increased by up to 6 years as the previous system of so-called *quotas* (combining seniority in contributions, and age requirements) was replaced by a pure contribution requirement and gender differences in the normal retirement age were removed. Table 1 provides details as to changes in seniority rules before and after the reform for the public sector. Old age pensions were also increased, notably for women, in the public sector and in self-employment, whose age requirements were increased by up to 3 years. All these changes were to be effective one month later, at the beginning of 2012. Under the defined-benefit (or mixed DB-DC) system applied to these cohorts of workers, it is convenient to retire as soon as possible, and hence almost 90 per cent of the workers take the retirement route within a year of getting this entitlement.

Figure 3 displays four real world profiles of contributory records as registered by the INPS archives. The first refers to a private sector employee with several career breaks, say Giulia, who was born

[3] Since both F and g exhibit constant returns to scale, so does the composite function. It follows that the capital stock does not influence the effects of ΔL on employment.

in 1951 and was planning to retire in November 2012 and was forced instead to stay until August 2018. The second refers to a worker, say Gianni, with less breaks in career than Giulia. He was born in 1950 and was palling to retire in 2012 at the age of 62. Nonetheless he was forced to leave in September 2017 almost five years after his original plans (December 2012). The third case considers Ludovica, a mostly part-time worker born in 1951 forced to retire on March 2018 rather than in June 2012. The last case considers Giovanni, a worker within the special railroad pension fund, a category of workers who typically enjoy preferential early retirement benefits. As a consequence of the reform, Giovanni was locked-in for six years.

While increasing drastically the retirement age for the cohorts planning to retire in the following years, the reform kept the flexibility in the retirement age for the cohorts of workers entered in the labor market after 1996 and subject to the new notionally defined contributory (NDC) system. Thus, the increase in the age requirement was bound from the very start to be temporary, allowing for greater flexibility in the retirement age as the cohorts entered in the labor market in 1996 would reach the range of retirement ages allowed by the new system.

The reform also involved an acceleration of the transition to the NDC system, forcing every worker to enter the new system on a flow basis. A lower indexation to price inflation of the highest pensions was finally introduced temporarily. Overall, the reform was supposed to involve cumulative savings of 80 billion between 2012 and 2021 (Inps, 2013), approximately 5 percent of GDP.

As the reform was completely unexpected, it involved many casualties. Among these, some 100,000 workers who had agreed to voluntarily leave a job in the context of collective bargaining agreements in the understanding that they would have drawn a pension. The Government had to intervene with 8 so-called safeguard measures in the following years for a cumulative cost to date of about 12 billions to (partly) fix this problem. Requests for further safeguard measures are still ongoing at the time of writing.

5 Data and empirical strategy

We draw on data extracted from the Italian social security (Inps) archives, tracking all dependent workers in the private and public sectors as part of the collection of contributions earmarked to pensions and social insurance. The dataset assembled for this analysis tracks all private firms with more than 15 employees that operated without discontinuities in contribution records between 2011 and 2014. In Italy, employment protection has a marked discontinuity at the 15 employees threshold in all three points of observation. Our empirical strategy also involves the pre-reform period. As we argue in more details below, the final database comprises approximately all firms below 150 employees affected by the reform and observed between 2008 and 2014. Each firm is thus observed approximately 7 times.[4]. The 150 employees threshold corresponds to 94 percent of the private Italian firms above 15 employees and almost 70 percent of total employment in the private sector for firms above 15. Larger firms have internal labor markets, and are likely to have more than one production unit. In other words, the largest firms are more sophisticated than the simple economics described in the previous section. Nevertheless, as a robustness check, we enlarge the sample to include all firms below 200 employees, which corresponds to 96 percent of the private firms and 75 percent of employment.

The unit of observation is the individual employer responsible for the payment of social security

[4]Some firms have zero employees before 2011

Table 1: Changes in Retirement Age for Seniority Pensions in December 2011

	Old Rules [a]			New Rules [b]	
Year		Age	Years of Contrib.	Men	Woman
2011	Quota 96:	60	35		
	or Minimum Contrib. [b]		40		
2012	Quota 96:	60	35	(Quota phased out)	(Quota phased-out)
	or Minimum Contrib.		40	42 years 1 mon.	41 years 1 mon.
2013	Quota 97.3:	61.25	35	(Quota phased-out)	(Quota phased-out)
	or Minimum Contrib.		40	42 years 4 mon.	41 years 4 mon.
2014	Quota 97.3 :	61.25	35	(Quota phased-out)	(Quota phased-out)
	or Minimum Contrib.		40	42 years 5 mon.	41 years 5 mon.
2015	Quota 97.3:	61.25	35	(Quota phased-out)	(Quota phased-out)
	or Minimum Contrib.		40	42 years 5 mon.	41 years 5 mon.
2016	Quota 97.3 :	61.25	35	(Quota phased-out)	(Quota phased-out)
	or Minimum Contrib.		40	42 years 8 mon.	41 years 8 mont.
2017	Quota 97.6:	61.6	35	(Quota phased-out)	(Quota phased-out)
	or Minimum Contrib.		40	42 years 8 mon.	41 years 8 mon.
2018	Quota 97.6 :	61.6	35	(Quota phased-out)	(Quota phased-out)
	or Minimum Contrib.		40	42 years 8 mon.	41 years 8 mon.

[a] In the old rules seniority pension was accessible either via a Quota or via a minimum contribution

[a] In the new rules the Quota system is phased out

contributions to Inps. In 96 per cent of the cases this unit corresponds to a firm. In the remaining 4 per cent these units belong to the same group. We do not have access to the records of each individual worker, but we know the average characteristics of workers in these firms (age, gender, blue-collar or white-collar position, fixed-term or open-ended contract).

As Inps knows the contribution seniority of each individual worker, we could also establish how many workers in each firm have been locked-in by the 2011 reform. In particular, the contribution record of all workers who, at the time of the reform, were in the 55 to 64 age group was extracted from the archives. Then all workers who had before the reform the option to retire in 2013 or 2014 were identified and from these, the so-called *salvaguardati* were excluded, that is, those workers who were offered the pre-reform option as they had already accepted an early retirement plan with the firm. The number of years of increase in the earliest possible retirement age for each worker locked-in was also obtained. Thus, we have for each firm how many workers were locked-in and for how long as well as how many workers were involved in one of the safeguard measures mentioned above.

For each firm we also observe the total number of employees, the (one digit) sector of operation, the region, the number of part time employees, the number of blue and white collars, the number of temporary contract workers. We also have information on the age distribution of employees, in particular the number of employees aged less than 30 and more than 50. Finally we know the average wage overall and for young and older workers as well as average earning of white and blue collar workers.

5.1 Definitions

In each firm we classify workers in three groups based on their age: young, prime-age, and older workers. Young workers are aged less than 30. Older workers are aged more than 55. Prime-age workers are the employees within these two thresholds. If $n_{i,t}$ is total employment if firm i in year t, it follows that in each firm i

$$n_{i,t} = \sum_{j=1}^{3} n_{ij,t} \qquad \text{j= 1: young, 2: prime- age, 3: older} \tag{6}$$

We are interested in the employment variation at the firm level as well as in each age group j within the same firm. We normalize the change in each age group by total employment in 2011, the year in which the reform took place. This normalization rule allows for subgroups with zero employees. Our main outcome is thus

$$g_{ij,t} = \frac{n_{ij,t} - n_{ij,t-1}}{n_{2011}} = \frac{\Delta n_{ij,t}}{n_{2011}} \qquad \text{j= young, older, prime age, total} \tag{7}$$

The treatment variable concerns the number of workers locked-in in 2011 in each firm. We also classify workers locked-in on the basis of the number of years for which they were locked-in. In particular, we distinguish between workers who are locked in for more than 3 years, more than 2 years and more than 1 year. This amounts to having three different definitions of the treatment, depending on the severity of the locking-in within each firm. The size of the locked-in population in each firm is normalized by the number of workers aged more than 54, since, to be locked-in, a worker must be at least 54 in 2011. Formally, the treatment is defined as follows

$$T_i^s = \frac{Locked_{in}\ old\ workers\ in\ firm\ i for\ at\ least\ s\ year}{old\ workers\ in\ 2011} \qquad \text{s=1,2,3} \tag{8}$$

Note that, by construction, T_i^s can not be larger than one. This definition of the treatment, in terms of the population at risk, captures the intensity of the shock to employers. Under the pension rules applied to older workers, it is convenient to retire as soon as possible in presence of a non-increasing wage profile. Employers planning before the reform on the voluntary separation (on the retirement) of a given fraction of their older workforce, found out all of the sudden in December 2011 that this fraction was lower. To give a quantitative sense, $T_i^3 = 0.25$ means that the employer of firm i found out that 25 percent of its older workforce had been locked-in for at least 3 years.

We are also interested in the pre-trend impact of the policy variables, or the effect of the policy in the years 2009, 2010 and 2011. The policy variables imputed to these earlier years will act as a *placebo* in our regression analysis.

As we consider different severity levels for the treatment, T_i^s, the sample size changes together with the definition of the treatment. When we allow for locked-in workers for at least 1 year, the number of firms considered is as large as [21,662], while it shrinks to [8,472] when we refer to a 3-years locking-in. We initial exclude firms that had workers safeguarded by the Government intervention exempting some workers from the enforcement of the reform. This is because the timing of this exemption is not always clear as the identification of the workers to be safeguarded was a rather lengthy process, and hence it is not clear whether employers meanwhile were considering also these workers as a component of the workforce being locked-in. Later on, we will perform robustness tests including also firms with workers involved in the *salvaguardie*.

5.2 Specifications

Our specification is a generalized difference in difference of locked_old in on the growth rate of different subgroups. The panel estimate is a fixed effect model in the growth rate, including time dummies. The placebo and treatment variables S_i^s and T_i^s are interacted with the time dummies so as to obtain the following specification

$$g_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{k=2008}^{2014} \beta_k I_k T_i^s \qquad s = 1, 2, 3 \tag{9}$$

where I_j and I_k are time dummies, α_i are the firm fixed effects and T_i^s are defined as above while δ is a pure constant. In the regressions below, the interaction between the treatment T^i and the year dummy is labeled $locked3\_old\_2012$ when the year is 2012. At the same time, the interaction between T^i and the year dummy is labeled $placebo3\_old\_2011$, when the year is 2011. In other words, from 2008 until 2011 T^i acts as a placebo variable while it works as a treatment variable between 2012 and 2014. In equation 9 the j group refers to young, prime age and older workers and different regressions are run for different groups. As a robustness check, we also allow the left-hand-side to be the absolute variation in employment in group j so that

$$\Delta n_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{k=2012}^{2014} \beta_k I_k T_i^s \qquad s = 1, 2, 3 \tag{10}$$

We are clearly aware that fixed firm effects only capture time-invariant characteristics of firms. Among these, we are particularly concerned with size, which is associated to a different exposure to shocks as also suggested by the descriptive statistics in the next section. The appendix contains transition matrices of firms across size classes (defined either in terms of quintiles or of some given threshold scales). As the matrices suggest, mobility was very limited: stayer coefficients are of the order of 90 per cent.

6 Empirical Results

6.1 Summary Statistics

Table 2 displays values of our measures of the policy shock for different years. As the reform took place in December 2011, and we observe firms until 2014, the most precise and binding measure of the treatment is $locked3\_old$, or the share of older workers whose retirement age was postponed by at least three years, so that the workers involved will still be in the firm in 2014. Such a restriction is definitely binding in the years 2012, 2013 and 2014. The first rows of Table 2 show that there are 8,472 firms that have some workers locked in 2011 for more than 3 years.

The average value of our preferred treatment, $locked3\_old$, is 0.279, suggesting that the firms considered have, on average, three older workers out of 10 who are locked-in for at least 3 years. The table provides also information on the distribution of the locking-in. Firms in the top quantile have, on average, more than 66 per cent of the older workers locked-in for at least 3 years, while in lower quantiles the incidence of the locking-in grows continuously starting from 8 per cent in the first quantile. In the other rows of Table 2 we report the same quantile distributions for the other measures of the locking-in of older workers. In particular, locked2up_old refers to the share of older workers who, in 2011, were locked for at least two years, so that their retirement had to be postponed to 2013 and beyond. Clearly locked3_old is a subset of locked2up_old, and the number of locked-in firms always increases as we consider less and less restrictive measures of the locking-in. While locked2up_old concerns 11,085 firms, when we consider all workers locked-in for at least 1 year (locked1up_old), the number of firms increases to to 21,662.

We take $locked3\_old$ as the most precise variable to measure the intensity of the policy shock that hit firms in December 2011. In Figure 4 we plot the distribution of locked3_old by firm size, region, sector and average age of the workers in the firm. Each variable is plotted by decile. Smaller firms have a larger share of locked-in workers for at least 3 years. The distribution of locked3_old by average age of the workforce is unsurprisingly declining as there are more older workers in the firm (the denominator of our measure of locking-in). Figure 4 shows also that the most exposed sectors to the locked-in shock were ICT, professional activities as well as transportation and trade. The distribution across regions is rather uniform.

The key outcome variable is employment growth across the different age subgroups. Since we are mainly interested in the short-run response at the firm level, we report summary statistics in 2012, 12 months after the reform was enacted. We are particularly interested in the growth of youth employment. This is our key outcome variable. Hence, in the descriptive statistics, we focus on this variable.

Figure 5 reports youth employment growth by firm size, region, sector and age of the workforce. Firm size appears somewhat correlated with employment growth, suggesting that smaller firms destroyed many more youth jobs than larger firms in the period considered. Across regions, youth employment growth was particularly negative in the Southern regions, such as Molise, Sicily and Abruzzo. Across sectors, ICT and construction destroyed most youth jobs. When we look at the average age of the firm workforce, it appears that firms with younger workers were the only firms to grow in 2012. Figure 6 provides the same information for the growth rate of workers with open-ended contracts. Comparing Figure 5 and Figure 6 it is clear that the growth rate of open-ended contract workers is lower (in absolute value) than the corresponding growth rate for total employment. The distribution by size, region, sector and workers's age is similar. Overall, we expect open-ended employment growth to be less responsive to the policy shock than total employment, due to the stronger employment protection of permanent contracts with respect to fixed-term contracts.

Table 3 and Figure 7 report joint information on the policy shock and on the growth rates of the average firm. In Table 3 growth rates are provided by quantiles of locked3_old, where the quantiles are constructed among firms with positive locked3_old. Two results in the top part of Table 3 are striking. First, the growth rate of young workers declines monotonically as we move up on the quantiles of the distribution of locked3_old. In the first quantile (Column 2) the growth rate is -0.0019, while it falls to -0.0126 in the fifth quantile (Column 6). At the same time, the growth rate of older workers rises monotonically as the quantile of locked3_old increases. These results refer to 2012, the first year in which the reform was in place. The bottom line of Table 3 refers to 2011, the last year before the reform. Remarkably, in 2011 we do not observe the same patterns of 2012 for the growth of youth employment and for the dynamics of older workers. When we focus on total employment growth (*dn_rate*), we instead observe the same pattern in 2011 and 2012: employment growth declines monotonically moving from the first quantile to the fifth quantile in both years.

Figure 7 reports the time profile of the growth rate of different age groups at different quintiles for the youth and older workers distributions. The vertical line corresponds to the year in which the reform took place. The growth rate in the top quantile falls in 2012 and 2013, and tends to go back to the value of the first quantile only in 2014. As far as the older workers are concerned, there is a remarkable growth in 2012 for firms in the top quantile.

Table 4 reports summary statistics for the key covariates across the same categories of locked3_old. The distribution of the placebo in 2011 is clearly identical to that of the treatment in 2012. Firms with more locked-in older workers for at least 3 years do not have a larger share of workers aged more than 54 as well as a higher average age of employees. The only exception is firms in the highest percentile, that are smaller than in the other quantiles.

In Table 5 we report the average transition matrix across firm size in the sample. In the top part we divide firms into 5 size cells (16-25; 24-50; 50-80; 80-110 and 110-150) while in the bottom part we use the quantile obtained from the size distribution between 16 and 150. In both cases, firms across different size categories appear fairly stable, with a probability of persistence within each size category around 80 percent, both in the top and bottom transition matrices.

6.2 Regression Analysis

Table 6 reports the basic regressions when the the workers are locked-in for at least 3 years. The sample size corresponds to 8,474 firms being active between 2008 and 2014. The table reports the size of the treatment, and the placebo in each row. Columns 1 and 2 display the coefficients (and the robust standard errors) for the growth of youth employment, considering both the total number of young workers and only the young workers with open-ended contracts. The coefficients in Column (1) are negative and statistically significant in 2012 and 2013 while they are close to zero in 2014, suggesting that in the medium-run the shock is absorbed by firms. Note that the coefficient is not significant in 2010 and 2011, when the policy was not in place. The fact that the placebo effect is not significant is one of the key results in Column (1). Young workers with open-ended contracts do not appear to be significantly affected by the shock (Column 2) perhaps because they have the same employment security as prime-age and older workers (in Italy up to 2015 employment protection was not tenure-related for firms with more than 15 employees). Yet, as we will show below, when we consider the outcome in terms of absolute variations, as in Section 7 below, the effect is negative and significant also for youth employment with open-ended contracts.

In columns (3) and (4) we report the results for employment growth among older workers. The coefficient is positive and significant from 2012 both for all workers as well as for open-ended contracts. In the latter case, the size of the coefficient is one half (Column 3, 0.034; Column 4, 0,028) exactly as we should expect, even though the difference between the two contractual types is almost negligible in 2013 and 2014. The results in the first 4 columns are certainly in line with the young_out old_in pattern described in Section 1 for the aggregate economy.

Columns (5) and (6) of Table 6 report the regressions for total employment growth. The policy and the placebo regressions are never significant, suggesting that the policy contributed to a reshuffling of employment across the age distribution, but had no overall negative employment effect. Unreported results for the growth of the prime-age workforce are in line with this: the coefficient for workers in the middle of the age distribution is never statistically significant.

Table 7 works with a definition of treatment that includes also older workers locked-in for at least two years. The number of firms involved increases to 11,088. Note that Table 7 reports the same set of regressions used in Table 6[5]. The results in Column (1) are reassuring, since the coefficient on locked2up_old is negative and significant in 2012. The magnitude is also coherent with the results obtained in Table 6, Column 1. The value for 2013 is smaller, as one would expect. The results for older employment are also similar and statistically significant.

Table 8 extends the sample to all firms in which there is at least one worker locked-in for at least one year. The number of firms involved increases to 21,666. The coefficients on youth employment growth are no longer significant, suggesting that firms did not have to adjust their young workforce for only one year of locking-in. The coefficient for older workers are still significant and positive, albeit the value is smaller than those reported in Table 7 and 6.

6.3 Robustness

We run three main robustness checks. First, we run the analysis under the alternative specification in which the outcome is measured in absolute variation, as described by equation 10. Second, we broaden the sample by including firms up to 200 employees. Third we include also firms with some older workers being exempted from the reform (the so-called *salvaguardati*).

Table 9 reports the regressions results under the alternative specification of equation 10 when we consider workers locked-in for at least 3 years. The policy variable is thus T_i^3. Table 10 reports the same set of regressions when the locked-in treatment is defined as T_i^2. If anything, the results are even stronger than those obtained in the specification where the treatment is normalized in the 0-1 range by the number of older workers in the firm. Figure 11 reports the coefficients over time for Δ^{young} and Δ^{old}. While the magnitude of the effect changes, as we discuss in the next Section, the sign of the coefficient indicates a clear old_in young_out effect in 2012.

In table 11 we report the regressions when the sample of firms includes units with up to 200 (but more than 15) employees. The coefficients are very similar to those of the main specification as the sample increases from the 8,474 firms of Table 6 to 9,210 of Table 11.

[5]We use the same format in all regressions reported in this paper.

Table 12 reports results from the the baseline specification when firms with safeguarded workers are included. Note that the number of firms treated increases to 8,650, indicating that there are approximately 200 firms where some workers involved in redundancies agreed before December 2011 were exempted from the enforcement of the reform. Our key results are unaffected by the inclusion of these firms.

We did further robustness checks not reported here for brevity[6]. First we run regressions excluding firms when they had fallen below the 15 employees threshold, where employment protection is less stringent. Our data include firms having more than 15 employees when the reform took place, but it is clearly possible that they had less than 15 employees either before or after the reform, and our model applies to firms facing strict employment protection legislation. This reduces by approximately 20 per cent the total number of observations and creates an unbalanced panel. In another robustness check we measure age specific growth rates by taking, as denominator, the average number of employees over the entire period or just in the years predating the reform (2008-2011). This check aims at controlling for potential regression to the mean effects. Our key results are, once more, unaffected: we observe a negative and statistically significant negative effect of the treatment on the growth of young workers, and a positive effect on net hiring of older workers.

7 Interpretation

The evidence provided in the previous section appears fairly robust, and it is clear that the average firm reallocated labor demand at the two extremes of the age distribution of the workforce in response to the locking-in of some older workers. In this section we try to summarize the evidence reported in light of the theoretical results of Section 3.

Let us focus on the average firm in 2012. As documented in Table 2, in 2012 the average value of *locked*3*_old* was 0.28, suggesting that almost 3 out of 10 older workers were locked-in for more than 3 years in the affected firms. If we consider also the average growth rate displayed in Table 3, the evolution of the average treated firm is

$$\underbrace{n_{2012}}_{\approx 53.16} = \underbrace{n_{2011}}_{\approx 52.70} + \underbrace{\Delta n^{young}_{12,11}}_{\approx -0.33} + \underbrace{\Delta n^{prime}_{12,11}}_{\approx +0.18} + \underbrace{\Delta n^{old}_{12,11}}_{\approx 0.59} \tag{11}$$

The regression estimates suggest that for group j

$$\hat{\Delta} n^{j}_{12,11} = \hat{\gamma}\overline{n}_{2011}\overline{locked3\_old} \quad \text{j=young} \quad \text{old} \tag{12}$$

The basic quantitative implications of the results from our regressions are summarized in Table 14. We consider the coefficient in 2012 from our baseline specification. We can obtain

$$\begin{cases} \hat{\Delta} n^{young}_{12,11} = \underbrace{\hat{\gamma}}_{\approx -0.014} \underbrace{n_{2011}}_{\approx 52.70} \underbrace{\overline{locked3\_old}}_{\approx 0.28} = -0.207 \\ \hat{\Delta} n^{old}_{12,11} = \underbrace{\hat{\gamma}}_{\approx 0.03} \underbrace{n_{2011}}_{\approx 52.70} \underbrace{\overline{locked3\_old}}_{\approx 0.28} = 0.59 \end{cases}$$

[6] Results are available, upon request, from the authors

Comparing the obtained estimates with the average growth rate, we can argue that the policy change accounts for 62 percent of the fall in youth employment and 85 percent of the growth in older employment in 2012 among treated firms

$$\begin{cases} \frac{\hat{\Delta} n^{young}_{12,11}}{\Delta n^{young}_{12,11}} & = & \frac{-0.207}{-0.33} = 0.626 \\ \\ \frac{\hat{\Delta} n^{old}_{12,11}}{\Delta n^{old}_{12,11}} & = & \frac{0.502}{0.59} = 0.85 \end{cases} \tag{13}$$

Notice that the same accounting exercise applied to the regressions in absolute variations (Table 9) implies a larger share of youth employment losses that can be attributed to the reform. In other words, the increase in the retirement age accounts for at least 60 percent of the underlying old-in young-out pattern experienced by the firms affected by the 2011 pension reform.

8 Conclusions and Policy Implications

Economists challenge, mostly for good reason, the popular idea that the number of jobs and working hours is somewhat fixed. All standard labor economics textbooks refer to the so-called *lump of labor fallacy*. Yet, in the short-run and under some realistic institutional configurations it is fairly possible that policies operate as if employers could only reshuffle workers, without changing their plans as to total employment levels. In a simple model of labor demand and different age-cohorts of workers as inputs, we show that a temporary pension reform increasing the retirement age has two effects. First, there is a negative scale effect due to decreasing returns to scale. The reform forces some of the older workers to stay employed rather than retire. Even though this tends to increase output, with decreasing marginal returns to scale in production, the marginal product of young workers falls, and so does their hiring. Second, there is an effect that depends on the degree of complementarity between young and older workers. In the short run with wage rigidity, the crowding out effect depends on which one of the two effects dominates.

Ultimately, the contribution of the paper is empirical. The experience of the Italian pension reform in the middle of the 2011 sovereign debt crisis provides a perfect setting for testing the relationship between the locking-in of older workers and the potential crowding out of other age groups. The bold pension reform was unanticipated and repentine, and happened in the middle of a deep recession. We had access to a unique dataset drawn from the Italian Social Security Administration that identifies at the firm level the intensity and the number of workers locked-in by the postponement of their retirement age. The data set covers all private sector firms with more than 15 employees between 2008 and 2014. The cross sectional variation in the firms' exposures to the mandatory delay in retirement allows us to estimate the impact of the locking-in of older workers on youth net hiring at the firm level. Our results suggest that the abrupt and steep tightening of retirement rules had major effects at the two extremes of the age distribution of workers. It reduced employment of youngsters, and increased that of older workers, without significantly affecting employment among the prime-age group, and overall employment levels of the firms directly affected by the reform. The magnitude of the effects is non-negligile as the locking-in of older workers accounts for at least 60 per cent of employment losses among youngsters and at least 80 per cent of employment gains among older workers, experienced by the private firms with some locked-in workers in the three years after the reform.

The policy implications of our results should be drawn with great caution. Nevertheless, we can make two points. First, reducing the generosity of pensions in the middle of the European sovereign crisis was probably inevitable, despite the severe recession that Southern European economies were experiencing. But this tightening could have been engineered by reducing pension levels of those retiring before the normal retirement age, and hence allowing firms to encourage the exit of the least productive older workers. With an hindsight, as well as with the scientific evidence provided in the paper, we also feel that much more should have been done by European policy makers to help and sustain young workers who were about to enter the labor market in the same years. The odd "old in-young out" equilibrium in which Southern European labor market entered in the last decade, is unlikely to be a desirable outcome, and the risk of a lost European generation is certainly there. Second, the retirement age should be as flexible as possible. As far as Italy is concerned, the long-run DC system will ensure a viable and sustainable system. Yet, such a system has a prolonged transition phase. Along this medium run adjustment to the new system, policy attempts to increase flexibility in retirement in an actuarially neutral fashion should be taken seriously into account.

References

[1] Abadie, A., Drukker, D., Herr, J. L., and Imbens, G. W. (2004). "Implementing matching estimators for average treatment effects in Stata", Stata journal 4, 290-311.

[2] Abadie A. and Imbens, G. (2006), "Large sample properties of matching estimators for average treatment effects", Econometrica 74(1), 235-267.

[3] Aubert P. (2003), " Les quinquagnaires dans lemploi salari privé", conomie et Statistique, n 368, dossier Les travailleurs gs face lemploi, pp. 65-94.

[4] Avolio, B.J., D.A. Wasldman, and M.A. McDaniel (1990), " Age and work performance in non-managerial jobs: The effects of experience and occupational type". Accademy of Management Journal 33 (2), 407-22

[5] Bass, B. M., and Avolio, B. J. (1990). "The Multifactor Leadership Questionnaire". Palo Alto, CA: Consulting Psychologists Press.

[6] Barth, Michael C., William McNaught, and Philip Rizzi, 1993. "Corporations and the Aging Workforce." Building the Competitive Workforce: Investing in Human Capital for Corporate Success, ed. Philip H. Mirvis: John Wiley and Sons.

[7] Berton, F. and Garibaldi, P. , "Workers and firms sorting into temporary jobs" *The Economic Journal* 122 (562), F125-F154

[8] Boeri, T (2011), "Institutional reform and dualism", *Handbook of Labor Economics 4b* ed. D. Card and O. Ashenfelter. Elsevier.

[9] Boeri, T. and Garibaldi, "Two Tier Reforms of Employment Protection: a Honeymoon Effect?" *The Economic Journal* 117 (521), F357-F385

[10] Boeri, T. and J. vanOurs, (2013) *The Economics of Imperfect Labor Market* Princeton University Press

[11] Boldrin, M., Dolado, J.J., Jimeno, J.F., and F. Peracchi "The Future of Pension Systems in Europe. A Reappraisal" , Economic Policy , vol. 29, October 1999

[12] Boersch-Supan, Axel; Dzgn, Ismail; Weiss, Matthias (2006): "Age and Productivity: Evidence from the Assembly Line". In: Demographie - Mitteilungen der Deutschen Gesellschaft fr Demographie e.V., 5 (9), pp. 9.

[13] Brown, C. and J. Medoff, "The Employer Size-Wage Effect" *Journal of Political Economy.* Vol. 1998, vol. 97, no. 5. pp 1027-1059.

[14] Brugiavini, A. and F. Peracchi, Youth Unemployment and Retirement of the Elderly: The Case of Italy, in Gruber, J. and D. Wise (eds.) Social Security Programs and Retirement around the World: The Relationship to Youth Employment, University of Chicago Press, 2010.

[15] Campbell and Mankiw, 1989, "Consumption, Income and Interest Rates: Reinterpreting the Time Series Evidence". In *NBER Macroeconomics Annual 1989, Volume 4*

[16] Pierre Cahuc, Olivier Charlot, and Frank Malherbet (2016) *International Economic Review* Explaining, "The Spread of Temporary Jobs and Its Impact on Labor Turnover", Volume 57, Issue 2, pages 533572, May 2016

[17] Crèpon, B., N. and F. Kramarz 2002. Employed 40 hours or not employed 39: Lessons from the 1982 mandatory reduction of the workweek, Journal of Public Economics, 110, 1355-89.

[18] Dostie, B. 2011. "Wages, Productivity and Aging". De Economist (2011) 159: 139.

[19] Marcello Estevao, and Filipa Sa, 2008. "The 35-hour workweek in France: Straightjacket or welfare improvement?," Economic Policy, CEPR;CES;MSH, vol. 23, pages 417-463, 07.

[20] Garibaldi, P. and Oliveira-Martins, J. and Van Ours (2011), "Ageing, Health and Productivity", Oxford University Press.

[21] Hellerstein, J. K. and David N. and K. R. Troske (1999). "Wages, Productivity and Worker Characteristics: Evidence From Plant Level Production Function and Wage Equations., Journal of Labor Economics, No. 17, pp. 409-446.

[22] Hairault, J.O., F. Langot and T. Sopraseuth), 2010 Distance to Retirement and Older Wokers' Employment: The Case For Delaying The Retirement Age, Journal of European Econmic Association, vol 8 (5), pp. 1034-1076.

[23] Junt, J. (1999) "Has work-sharing worked in Germany? The Quarterly Journal of Economics 114 (1), 117-148

[24] Ilmakunnas, P. and M. Maliranta (2005) "Technology, worker characteristics, and wage-productivity gaps", Oxford Bulletin of Economics and Statistics, 67, 623-645.

[25] Johnson, P. (1993) "Aging and European economic demography", in: Johnson, P. and K.F. Zimmermann (eds.) Labor markets in an ageing Europe, Cambridge University Press, Cambridge.

[26] Kawaguki, D., L.Jungmin and D. Hamermesh (2012) A gift of time, IZA Discussion Paper 6700, IZA, Bonn.

[27] Maliranta, Mika 2005. "Foreign-owned Firms and Productivity-enhancing Restructuring in Finnish Manufacturing Industries," Discussion Papers 965, The Research Institute of the Finnish Economy.

[28] Nickell, S.J., 1986, "Dynamic Models of Labor Demand", in *Handbook of Labor Economics*, Volume 1, Orley Ashenfelter and Richard Layard eds. Chapter 9, 473-522 North Holland

[29] Remery, C., K. Henkens, J. Schippers and P. Ekamper (2003), "Managing an Aging Workforce and a tight labor market: Views held by Dutch employers", *Population Research and Policy Review* 22, 21-44

[30] Saint Paul, G. (1993), "On the Political Economy of Labor Market Flexibility", *NBER Macroeconomic Annual* 151-192

[31] Vanderberghe, V. (2013), "Are firms willing to employ a greying and feminizing workforce?", Labour Economics, n.22, June 2013, 30-46.

[32] Vestad, O. L. (2013), "Early Retirement and Youth Employment in Norway", Statistic Norway

[33] Walker, T. (2007), "Why Economists Dislike the Lump of Labor", *Review of Social Economy*, Vol. 65, No. 3, Sepptember, 279-91

[34] Warr,P. (1998) Age,competence and learning at work, in .Kilbom, (Ed.) "Ageing of the workforce. Key-note presentations and abstracts from a workshop in Brussels", March 23-24, 1998. Solna: Arbetslivsinstitutet

Appendix: Employment Effects with Simple Production Function

Consider first the case where young and older workers are perfect substitutes, and write $g(L_1, L_2) = a_1 L_1 + a_2 L_2$. It follows that $g_1 = a_1$, $g_2 = a_2$, and that $g_{12} = g_{11} = g_{22} = 0$. It follows that

$$\frac{dL_2}{\Delta L} = -a_2/a_1 \tag{14}$$

In this case, increasing the number of older workers employed reduces the number of young workers, efficiency unit by efficiency unit. At the other extreme, if the production technology is Leontief, an increase in the number of older workers employed increases the scope for employment of the young proportionally.

Let $f(N) = AN^{\alpha}$ as above. Suppose first that g is Cobb-Douglas, $g(L_1, L_2) = L_1^{\beta} L_2^{1-\beta}$. In this case,

$$\frac{dL_1}{d\Delta L} = \frac{\alpha\beta}{1-\alpha\beta} l > 0 \tag{15}$$

Hence an increases in L_2 always increases L_1.

Finally, suppose g is a CES-function, $g(L_1, L_2) = (aL_1^{\rho} + (1-a)L_2^{\rho})^{\frac{1}{\rho}}$. It follows that

$$\frac{\partial \tilde{f}}{\partial L_2} = a\alpha L_1^{\rho}(aL_1^{\rho} + (1-a)L_2^{\rho})^{\frac{\alpha-\rho}{\rho}} \tag{16}$$

It follows that the marginal product of young workers, $\frac{\partial \tilde{f}}{\partial L_2}$, and hence also the demand for young workers, is decreasing in L_2 if and only if $\rho > \alpha$. Since the elasticity of substitution, σ, is given by $\frac{1}{1-\rho}$, it follows that the demand for young workers is decreasing in L_2 if and only if $\sigma > \frac{1}{1-\alpha}$.

Table 2: Summary *locked_k_old* of k years in 2011 by quantile for different years of delay

	(1)	(2)	(3)	(4)	(5)	(6)
	All	1	2	3	4	5
	mean	mean	mean	mean	mean	mean
	a	b	b	b	b	b
locked3_old ^{c}	0.279	0.084	0.147	0.224	0.329	0.665
N	8472	1862	1773	1984	1173	1680
locked2up_old ^{d}	0.292	0.094	0.157	0.226	0.334	0.684
N	11085	2634	1832	2595	1808	2216
locked1up_old ^{e}	0.367	0.127	0.225	0.324	0.475	0.902
N	21662	4905	5240	4036	4491	2990

All variables refer to locked_old for k years

^{a} All firms in the sample with positive *lockedk_old*

^{b} From column (2) to column (6) firms with different shares of locked-in_old in 2011 for quantile.

^{c} locked_old for at least 3 years

^{d} locked_old for at least 2 years

^{e} locked_old for at least 1 year

Table 3: Summary growth rates for different quantiles of *locked3_old*

	(1)	(2)	(3)	(4)	(5)	(6)
	All	1	2	3	4	5
	Average Values for 2012					
	[a]	[b]				
T_3^i, locked3_old [c]	0.2790	0.0835	0.1470	0.2241	0.3287	0.6651
dyoung_rate [d]	-0.0072	-0.0019	-0.0061	-0.0071	-0.0099	-0.0126
dn_rate [e]	0.0030	0.0011	0.0176	0.0023	-0.0084	-0.0015
doldr_rate [f]	0.0097	0.0081	0.0112	0.0076	0.0081	0.0134
dprage_rate [g]	0.0005	-0.0051	0.0124	0.0018	-0.0067	-0.0023
totworkers [h]	53.1335	84.3217	59.1929	46.8095	36.8201	31.0304
N	8472	1862	1773	1984	1173	1680
	Average Values for 2011					
T_3^i, placebo3_old [a]	0.2790	0.0835	0.1470	0.2241	0.3287	0.6651
dyoung_rate	-0.0024	-0.0037	-0.0010	-0.0044	-0.0018	-0.0003
dn_rate	0.0373	0.0306	0.0410	0.0320	0.0363	0.0478
doldr_rate	0.0176	0.0270	0.0262	0.0185	0.0126	0.0002
dprage_rate	0.0221	0.0072	0.0158	0.0179	0.0255	0.0478
totworkers	52.6782	83.5473	58.6475	46.0474	37.0324	30.9202
N	8472	1862	1773	1984	1173	1680

[a] All firms with $locked - in$ for at least 3 years

[b] Frocum Column (2) to (6) different quantiles of *locked3_old*

[c] Firms with $locked - in$ for at least 3 years

[c] employment growth for youth below the age of 30

[d] employment change for the entire workforce

[e] employment change for the workers above 55

[e] employment change for prime age ormalized by employment in 2011.

[d,e,f,g] all growth rates normalized by employment in 2011. See equation (7)

[h] Total employment

Table 4: Summary Key Variables for different degrees of $locked3\_old$

	(1)	(2)	(3)	(4)	(5)	(6)
	All	1	2	3	4	5
	mean	mean	mean	mean	mean	mean
placebo3_old	0.28	0.08	0.15	0.22	0.33	0.67
oldshare	0.15	0.20	0.18	0.15	0.13	0.08
w	26048.16	29091.03	26282.02	25476.57	25169.83	23717.11
wperm	25400.32	28413.28	25639.16	24935.67	24589.72	22923.58
wyperm	14722.97	15692.22	14976.72	14274.73	14340.48	14177.33
woperm	29620.76	32578.84	29866.21	29209.24	29135.53	26907.95
age	43.09	45.12	44.10	43.23	42.17	40.24
N	8472	1862	1773	1984	1173	1680

All variables refer to youth below age of 30

[a] All firms in the sample with $locked - in\_share = 0$

[b] From column (3) to column (7) firms with different shares of locked-in_share in 2011 for quantile.

[d] Share of old worker

[e] Average wage; [f] average wage of workers with open ended contract

[g] average wage of young workers with open ended contract

[h] average wage of old workers with open ended contract

[i] average age of employees

[l] Share of blue collar ; m share of white collar

[n] Share of women

Table 5: Average Transition Matrices Across Size Categories in the Sample

	16-25[a]	25-50	50-80	80-110	110-150	Total
16-25[a]	12260	1046	145	88	43	13582
	90.27	7.7	1.07	0.65	0.32	100
25-50	972	14253	702	53	17	15997
	6.08	89.1	4.39	0.33	0.11	100
50-80	86	668	7059	605	84	8502
	1.01	7.86	83.03	7.12	0.99	100
80-110	42	46	547	4022	487	5144
	0.82	0.89	10.63	78.19	9.47	100
110-150	23	21	71	411	3488	4014
	0.57	0.52	1.77	10.24	86.9	100
Total	13383	16034	8524	5179	4119	47239
	28.33	33.94	18.04	10.96	8.72	100.00
	Quantile					
	21	32	48	80	150	Total
21	9046	1216	223	153	112	10750
	84.15	11.31	2.07	1.42	1.04	99.98
32	1218	7909	968	68	27	10190
	11.95	77.62	9.5	0.67	0.26	99.99
48	174	1046	7823	872	48	9963
	1.75	10.5	78.52	8.75	0.48	99.99
80	80	72	846	8084	811	9893
	0.81	0.73	8.55	81.71	8.2	100
150	57	19	46	740	9186	10048
	0.57	0.19	0.46	7.36	91.42	100
Total	10575	10262	9906	9917	10184	50844
	20.80	20.18	19.48	19.50	20.03	100.00

[a] Size categories in the sample

[b] Quantile threshold

Table 6: Regressions on Locked3_old [a]

VARIABLES	(1) [a] dyoung_r [b]	(2) [a] dpmyoungr_r [c]	(3)[a] doldr_r [d]	(4)[a] doldpmr_r [e]	(5)[a] dn_r [f]	(6)[a] dnperm_r [g]
placebo3_old_2010	0.008	0.006	0.000	0.002	0.029	0.033**
	(0.006)	(0.005)	(0.003)	(0.003)	(0.018)	(0.017)
placebo3_old_2011	0.009	0.009*	-0.016***	-0.008***	0.023	0.035
	(0.006)	(0.005)	(0.003)	(0.003)	(0.023)	(0.023)
locked3_old_2012	-0.014**	-0.006	0.034***	0.028***	-0.020	-0.001
	(0.006)	(0.005)	(0.004)	(0.004)	(0.024)	(0.025)
locked3_old_2013	-0.013**	-0.007	0.020***	0.021***	-0.002	0.011
	(0.006)	(0.005)	(0.007)	(0.007)	(0.029)	(0.029)
locked3_old_2014	-0.007	-0.003	0.034***	0.036***	0.016	0.030
	(0.005)	(0.005)	(0.004)	(0.004)	(0.023)	(0.023)
Constant	-0.009***	-0.007***	0.010***	0.009***	0.010***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	50,844	50,844	50,844	49,128	50,844	50,844
R-squared	0.004	0.003	0.002	0.002	0.003	0.003
Number of firms	8,474	8,474	8,474	8,474	8,474	8,474

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] Specification in growth rate described by equation 9 with $T_i^s = S_i^s = locked3\_old$

$g_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{j=2008}^{2011} \beta_j I_j S_i^s + \sum_{k=2012}^{2014} \beta_k I_k T_i^s \quad s = 3$

[b] Dependent variable: employment growth for youth below the age of 30 regardless of contract

[c] Dependent variable: employment growth for youth below the age of 30 under open ended contract

[d] Dependent variable: employment growth for the workers above 55 regardless of contract

[e] Dependent variable: employment growth for workers above 55 under open ended contract

[f] Dependent variable: employment growth for the entire workforce regardless of contract.

[g] Dependent variable: employment growth for the entire workforce under open ended contract.

[b,c,d,e,f,g] all growth rates normalized by employment in 2011. See equation (7)

Table 7: Regressions on Locked2_old [a]

VARIABLES	(1) [a] dyoung_r [b]	(2) [a] dpmyoungr_r [c]	(3)[a] doldr_r [d]	(4)[a] doldpmr_r [e]	(5)[a] dn_r [f]	(6)[a] dnperm_r [g]
placebo2up_old_2010	0.003	0.002	-0.003	0.001	0.015	0.019
	(0.005)	(0.004)	(0.002)	(0.002)	(0.015)	(0.014)
placebo2up_old_2011	0.007	0.005	-0.018***	-0.009***	0.014	0.020
	(0.005)	(0.004)	(0.002)	(0.002)	(0.018)	(0.018)
locked2up_old_2012	-0.013***	-0.007	0.034***	0.029***	-0.016	-0.005
	(0.005)	(0.004)	(0.003)	(0.003)	(0.020)	(0.020)
locked2up_old_2013	-0.011**	-0.006	0.020***	0.021***	-0.003	0.008
	(0.005)	(0.004)	(0.006)	(0.006)	(0.025)	(0.025)
locked2up_old_2014	-0.005	-0.005	0.035***	0.038***	0.021	0.023
	(0.005)	(0.004)	(0.003)	(0.003)	(0.019)	(0.018)
Constant	-0.010***	-0.008***	0.010***	0.008***	0.006**	0.011***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)	(0.003)
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	66,528	66,528	66,528	64,258	66,528	66,528
R-squared	0.003	0.002	0.003	0.002	0.003	0.003
Number of firms	11,088	11,088	11,088	11,088	11,088	11,088

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] Specification in growth rate described by equation 9 with $T_i^s = S_i^s = locked2\_old$

$g_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{j=2008}^{2011} \beta_j I_j S_i^s + \sum_{k=2012}^{2014} \beta_k I_k T_i^s \quad s = 2$

[b] Dependent variable: employment growth for youth below the age of 30 regardless of contract

[c] Dependent variable: employment growth for youth below the age of 30 under open ended contract

[d] Dependent variable: employment growth for the workers above 55 regardless of contract

[e] Dependent variable: employment growth for workers above 55 under open ended contract

[f] Dependent variable: employment growth for the entire workforce regardless of contract.

[g] Dependent variable: employment growth for the entire workforce under open ended contract.

[b,c,d,e,f,g] all growth rates normalized by employment in 2011. See equation (7)

Table 8: Regressions on Locked1_old [a]

VARIABLES	(1) [a] dyoung_r [b]	(2) [a] dpmyoungr_r [c]	(3)[a] doldr_r [d]	(4)[a] doldpmr_r [e]	(5)[a] dn_r [f]	(6)[a] dnperm_r [g]
placebo1up_old_2010	0.011***	0.009***	0.018*	0.014	-0.004**	0.000
	(0.003)	(0.002)	(0.009)	(0.009)	(0.002)	(0.002)
placebo1up_old_2011	0.014***	0.010***	0.023**	0.019*	-0.014***	-0.006***
	(0.003)	(0.002)	(0.010)	(0.010)	(0.002)	(0.002)
locked1up_old_2012	-0.002	0.002	0.015	0.013	0.032***	0.028***
	(0.003)	(0.003)	(0.012)	(0.011)	(0.002)	(0.003)
locked1up_old_2013	0.002	0.002	0.012	0.008	0.020***	0.021***
	(0.003)	(0.002)	(0.014)	(0.014)	(0.004)	(0.004)
locked1up_old_2014	0.007***	0.005**	0.031***	0.024**	0.023***	0.027***
	(0.003)	(0.002)	(0.010)	(0.009)	(0.002)	(0.002)
Constant	-0.013***	-0.010***	0.002	0.008***	0.011***	0.009***
	(0.000)	(0.000)	(0.002)	(0.002)	(0.000)	(0.000)
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	129,996	129,996	129,996	129,996	129,996	123,322
R-squared	0.004	0.002	0.003	0.003	0.005	0.004
Number of firms	21,666	21,666	21,666	21,666	21,666	21,666

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] Specification in growth rate described by equation 9 with $T_i^s = S_i^s = locked2\_old$

$g_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{j=2008}^{2011} \beta_j I_j S_i^s + \sum_{k=2012}^{2014} \beta_k I_k T_i^s \quad s = 1$

[b] Dependent variable: employment growth for youth below the age of 30 regardless of contract

[c] Dependent variable: employment growth for youth below the age of 30 under open ended contract

[d] Dependent variable: employment growth for the workers above 55 regardless of contract

[e] Dependent variable: employment growth for workers above 55 under open ended contract

[f] Dependent variable: employment growth for the entire workforce regardless of contract.

[g] Dependent variable: employment growth for the entire workforce under open ended contract.

[b,c,d,e,f,g] all growth rates normalized by employment in 2011. See equation (7)

Table 9: Regressions of Employment Changes on Locked3 [a]

VARIABLES	(1) [a] dyoung [b]	(2) [a] dpmyoung [c]	(3)[a] dn [d]	(4)[a] dnperm [e]	(5)[a] dold [f]	(6)[a] doldperm [g]
placebo3_old_2010	-0.085	0.020	-0.337	0.414	-0.196	-0.158
	(0.273)	(0.170)	(0.914)	(0.755)	(0.127)	(0.125)
placebo3_old_2011	-0.041	0.004	-1.347	-0.801	-1.074***	-0.825***
	(0.256)	(0.188)	(0.913)	(0.830)	(0.121)	(0.119)
locked3_old_2012	-0.914***	-0.487**	-1.068	-0.049	0.829***	0.681***
	(0.267)	(0.189)	(0.993)	(0.943)	(0.181)	(0.184)
locked3_old_2013	-0.615**	-0.390**	0.654	1.140	0.246	0.292
	(0.248)	(0.171)	(1.110)	(0.997)	(0.249)	(0.249)
locked3_old_2014	-0.529**	-0.235	2.230**	3.200***	1.067***	1.090***
	(0.251)	(0.183)	(0.985)	(0.902)	(0.196)	(0.196)
Constant	-0.486***	-0.381***	0.534***	0.798***	0.498***	0.436***
	(0.038)	(0.027)	(0.177)	(0.162)	(0.036)	(0.038)
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	50,844	50,844	50,844	50,844	50,844	49,128
R-squared	0.002	0.002	0.004	0.004	0.003	0.002
Number of firms	8,474	8,474	8,474	8,474	8,474	8,474

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] Specification in growth rate described by equation (10) with $T_i^s = S_i^s = locked3\_old$

$\Delta n_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{j=2008}^{2011} \beta_j I_j S_i^s + \sum_{k=2012}^{2014} \beta_k I_k T_i^s$ 3

[b] Dependent variable: employment change for youth below the age of 30 regardless of contract

[c] Dependent variable: employment change for youth below the age of 30 under open ended contract

[d] Dependent variable: employment change for the entire workforce regardless of contract.

[e] Dependent variable: employment change for the entire workforce under open ended contract.

[f] Dependent variable: employment change for the workers above 55 regardless of contract

[g] Dependent variable: employment change for workers above 55 under open ended contract

Table 10: Regressions of Employment Changes on Locked2 [a]

VARIABLES	(1) [a] dyoung [b]	(2) [a] dpmyoung [c]	(3)[a] dn [d]	(4)[a] dnperm [e]	(5)[a] dold [f]	(6)[a] doldperm [g]
placebo2up_old_2010	-0.216	-0.046	-0.779	-0.048	-0.314***	-0.199*
	(0.226)	(0.143)	(0.757)	(0.628)	(0.109)	(0.108)
placebo2up_old_2011	-0.195	-0.123	-1.734**	-1.226*	-1.186***	-0.898***
	(0.205)	(0.151)	(0.730)	(0.664)	(0.106)	(0.104)
locked2up_old_2012	-0.830***	-0.452***	-0.765	-0.002	0.806***	0.697***
	(0.211)	(0.152)	(0.787)	(0.741)	(0.148)	(0.150)
locked2up_old_2013	-0.610***	-0.354**	0.397	0.861	0.142	0.199
	(0.203)	(0.145)	(0.952)	(0.863)	(0.213)	(0.214)
locked2up_old_2014	-0.537***	-0.325**	2.276***	2.932***	1.068***	1.126***
	(0.205)	(0.148)	(0.786)	(0.716)	(0.159)	(0.156)
Constant	-0.529***	-0.399***	0.410***	0.697***	0.474***	0.409***
	(0.034)	(0.023)	(0.156)	(0.143)	(0.030)	(0.031)
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	66,528	66,528	66,528	66,528	66,528	64,258
R-squared	0.002	0.002	0.003	0.004	0.003	0.003
Number of firms	11,088	11,088	11,088	11,088	11,088	11,088

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] Specification in growth rate described by equation (10) with $T_i^s = S_i^s = locked2\_old$

$\Delta n_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{j=2008}^{2011} \beta_j I_j S_i^s + \sum_{k=2012}^{2014} \beta_k I_k T_i^s \quad 2$

[b] Dependent variable: employment change for youth below the age of 30 regardless of contract

[c] Dependent variable: employment change for youth below the age of 30 under open ended contract

[d] Dependent variable: employment change for the entire workforce regardless of contract.

[e] Dependent variable: employment change for the entire workforce under open ended contract.

[f] Dependent variable: employment change for the workers above 55 regardless of contract

[g] Dependent variable: employment change for workers above 55 under open ended contract

Table 11: Regressions on Locked3 with larger firms [a],[h]

VARIABLES	(1) [a] dyoung_r [b]	(2) [a] dpmyoungr_r [c]	(3)[a] doldr_r [d]	(4)[a] doldpmr_r [e]	(5)[a] dn_r [f]	(6)[a] dnperm_r [g]
placebo3_old_2010	0.008	0.007	-0.000	0.002	0.027	0.032**
	(0.005)	(0.005)	(0.003)	(0.003)	(0.017)	(0.016)
placebo3_old_2011	0.009	0.009*	-0.015***	-0.007***	0.025	0.037*
	(0.005)	(0.005)	(0.002)	(0.002)	(0.022)	(0.022)
locked3_old_2012	-0.013**	-0.005	0.031***	0.026***	-0.015	0.004
	(0.005)	(0.005)	(0.004)	(0.004)	(0.023)	(0.024)
locked3_old_2013	-0.012**	-0.006	0.019***	0.020***	0.003	0.016
	(0.006)	(0.005)	(0.006)	(0.006)	(0.027)	(0.027)
locked3_old_2014	-0.006	-0.002	0.033***	0.034***	0.018	0.032
	(0.005)	(0.005)	(0.003)	(0.003)	(0.022)	(0.023)
Constant	-0.009***	-0.007***	0.010***	0.009***	0.010***	0.015***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)	(0.003)
Observations	55,260	55,260	55,260	53,442	55,260	55,260
R-squared	0.004	0.003	0.002	0.002	0.003	0.003
N Number of firms	9,210	9,210	9,210	9,210	9,210	9,210

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] Specification in growth rate described by equation 9 with $T_i^s = S_i^s = locked3\_old$

$g_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{j=2008}^{2011} \beta_j I_j S_i^s + \sum_{k=2012}^{2014} \beta_k I_k T_i^s \quad s = 2$

[b] Dependent variable: employment growth for youth below the age of 30 regardless of contract

[c] Dependent variable: employment growth for youth below the age of 30 under open ended contract

[d] Dependent variable: employment growth for the workers above 55 regardless of contract

[e] Dependent variable: employment growth for workers above 55 under open ended contract

[f] Dependent variable: employment growth for the entire workforce regardless of contract.

[g] Dependent variable: employment growth for the entire workforce under open ended contract.

[b,c,d,e,f,g] all growth rates normalized by employment in 2011. See equation (7)

[h] Sample size up to firms of 200 employees.

Table 12: Regressions on Locked3 including firms with safeguarded workers [a]

VARIABLES	(1) [a] dyoung_r [b]	(2) [a] dpmyoungr_r [c]	(3)[a] doldr_r [d]	(4)[a] doldpmr_r [e]	(5)[a] dn_r [f]	(6)[a] dnperm_r [g]
placebo3_old_2010	0.008	0.006	-0.002	0.000	0.028	0.032*
	(0.006)	(0.005)	(0.003)	(0.003)	(0.017)	(0.017)
placebo3_old_2011	0.009	0.009*	-0.017***	-0.009***	0.023	0.035
	(0.006)	(0.005)	(0.003)	(0.003)	(0.023)	(0.023)
locked3_old_2012	-0.014**	-0.006	0.032***	0.027***	-0.020	-0.001
	(0.006)	(0.005)	(0.004)	(0.004)	(0.024)	(0.025)
locked3_old_2013	-0.013**	-0.007	0.018***	0.020***	-0.003	0.010
	(0.006)	(0.005)	(0.007)	(0.007)	(0.028)	(0.028)
locked3_old_2014	-0.007	-0.003	0.033***	0.035***	0.016	0.029
	(0.005)	(0.005)	(0.004)	(0.004)	(0.023)	(0.023)
Constant	-0.009***	-0.007***	0.010***	0.008***	0.009***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
Observations	51,900	51,900	51,900	50,138	51,900	51,900
R-squared	0.004	0.003	0.002	0.002	0.003	0.003
Number of firms	8,650	8,650	8,650	8,650	8,650	8,650

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] Specification in growth rate described by equation (10) with $T_i^s = S_i^s = locked3\_old$

$\Delta n_{ij,t} = \delta + \alpha_i + \sum_{k=2008}^{2014} \gamma_k I_k + \sum_{j=2008}^{2011} \beta_j I_j S_i^s + \sum_{k=2012}^{2014} \beta_k I_k T_i^s \quad 3$

[b] Dependent variable: employment change for youth below the age of 30 regardless of contract

[c] Dependent variable: employment change for youth below the age of 30 under open ended contract

[d] Dependent variable: employment change for the entire workforce regardless of contract.

[e] Dependent variable: employment change for the entire workforce under open ended contract.

[f] Dependent variable: employment change for the workers above 55 regardless of contract

[g] Dependent variable: employment change for workers above 55 under open ended contract

Table 13: Employment Dynamics in the Average firm with Locked3_old [a]

	n [b]	n^{young} [c]	n^{prime} [d]	n^{old} [e]	Δ^{young} [f]	Δ^{prime} [g]	Δ^{old} [h]
2011	52.70	5.50	39.93	7.27	-	-	
2012	53.16	5.17	40.11	7.86	-0.33	0.18	0.59
2013	53.15	4.80	39.64	8.71	-0.37	-0.47	0.85
2014	52.30	4.51	38.54	9.25	-0.29	-1.10	0.54

[a] Average across firms in the sample.

[b] Average employment size

[c] Average youth employment (below the age of 30)

[d] Average prime age employment

[e] Average old employment

[f] Average change in youth employment

[g] Average change in prime age employment

[h] Average old employment

Table 14: Estimates of Crowding Out Due to Locked3_old

	Young				
	$\hat{\gamma}$ [a]	Locked3_old [b]	$\hat{\Delta}^{young}$ [c]	Δ^{young} [d]	Share $\frac{\hat{\Delta}^{young}}{\Delta^{young}}$ [e]
2012	-0.014	0.280	-0.207	-0.33	**0.626**
2013	-0.013	0.280	-0.192	-0.37	**0.518**
2014	-0.007	0.280	-0.103	-0.29	**0.356**
	Older Workers				
	$\hat{\gamma}$ [f]	Locked3_old [b]	$\hat{\Delta}^{old}$ [g]	Δ^{old} [h]	Share $\frac{\hat{\Delta}^{old}}{\Delta^{old}}$ [i]
2012	0.034	0.280	0.502	0.59	**0.850**
2013	0.020	0.280	0.295	0.85	**0.347**
2014	0.034	0.280	0.502	0.54	**0.929**

[a] Estimate from Table 6, column (1)

[b] Average value of Locked3_old from Table 2

[c] Average estimate of $\hat{\Delta}^{young}$ from equation (12)

[d] Average value of Δ^{young} from Table 13

[e] Share of Δ^{young} accounted for by Column [c]

[e] Average old employment

[f] Estimate from Table 6, column (5)

[g] Average estimate of $\hat{\Delta}^{old}$ from equation (12)

[h] Average value of Δ^{old} from Table 13

[i] Share of Δ^{young} accounted for by Column [g]

Figure 3: Actual Contribution Histories of selected locked-in Workers

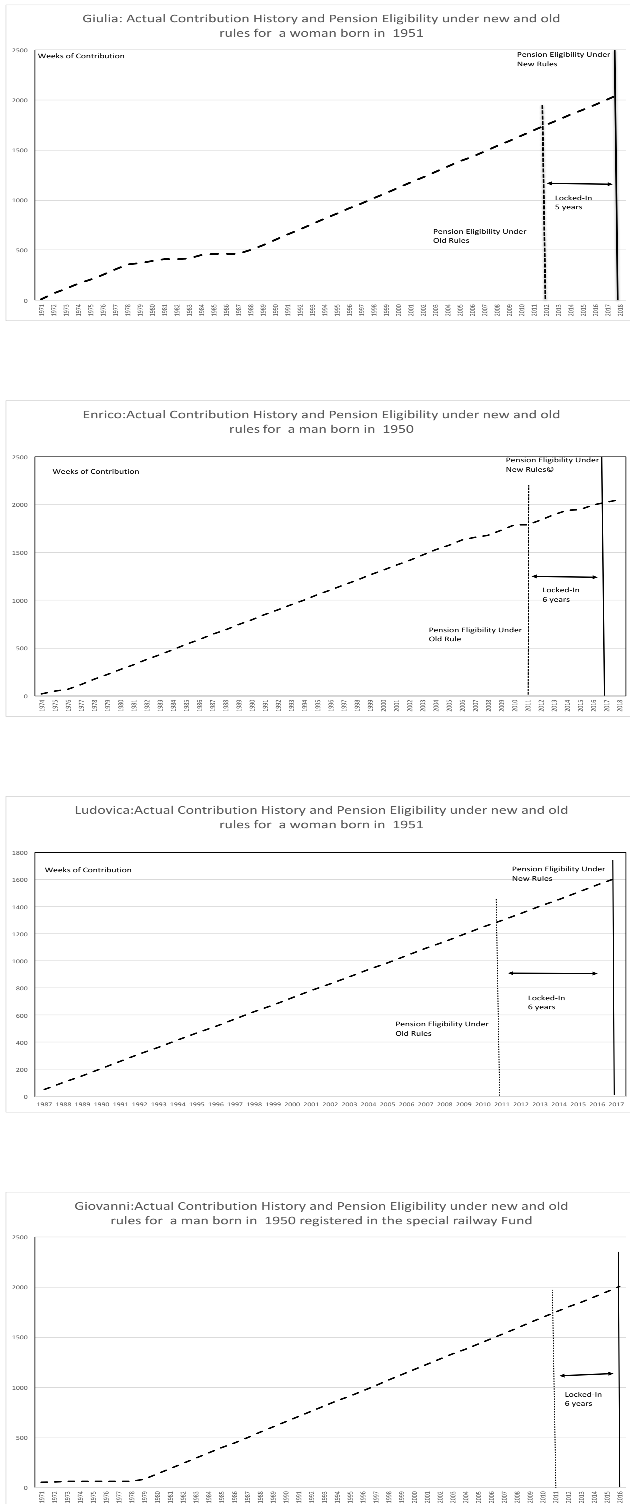


Figure 4: Locked3_old by Size, Region and Sector and Workers' Age

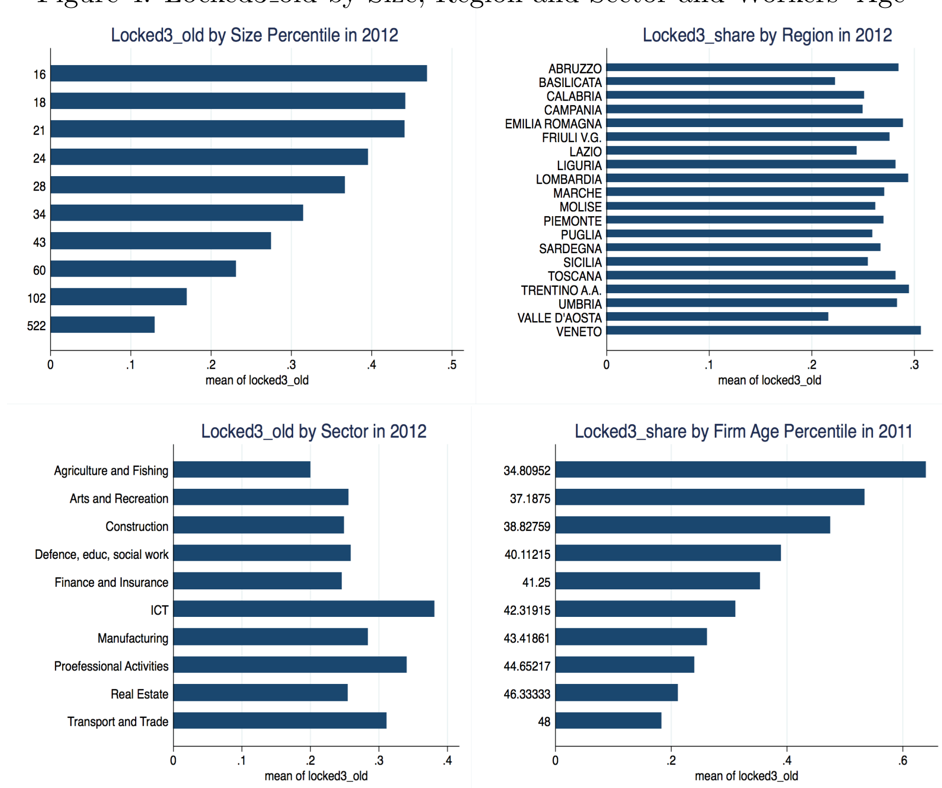


Figure 5: Youth Employment Growth 2012 by Size, Region and Sector and Workers' Age

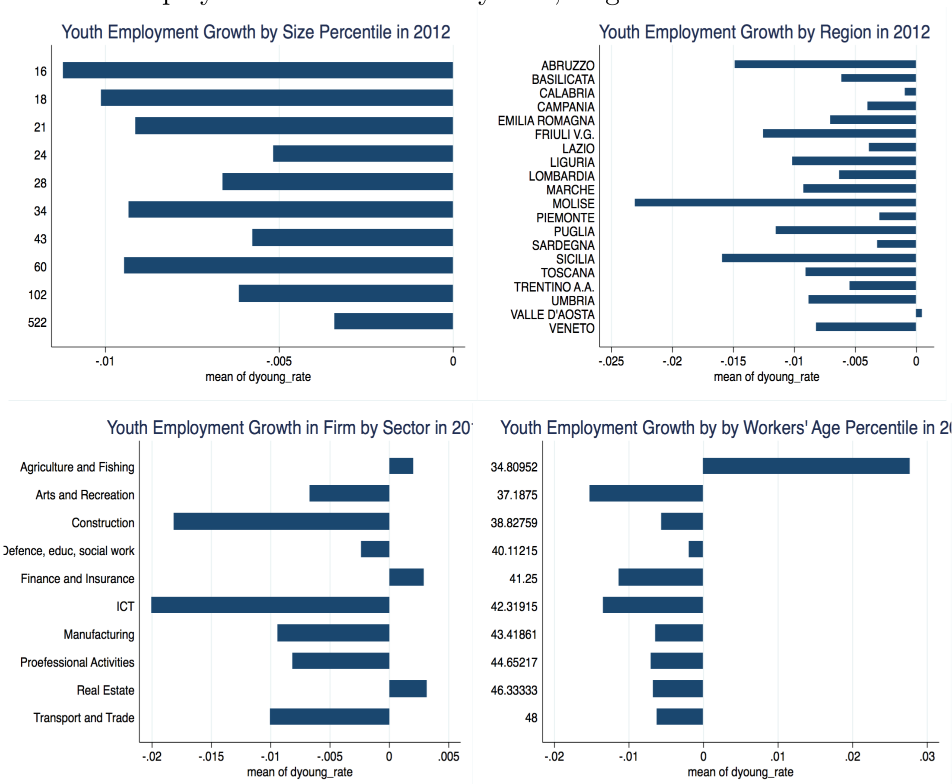


Figure 6: Youth Open Ended Employment Growth 2012 by Size, Region and Sector and Workers' Age

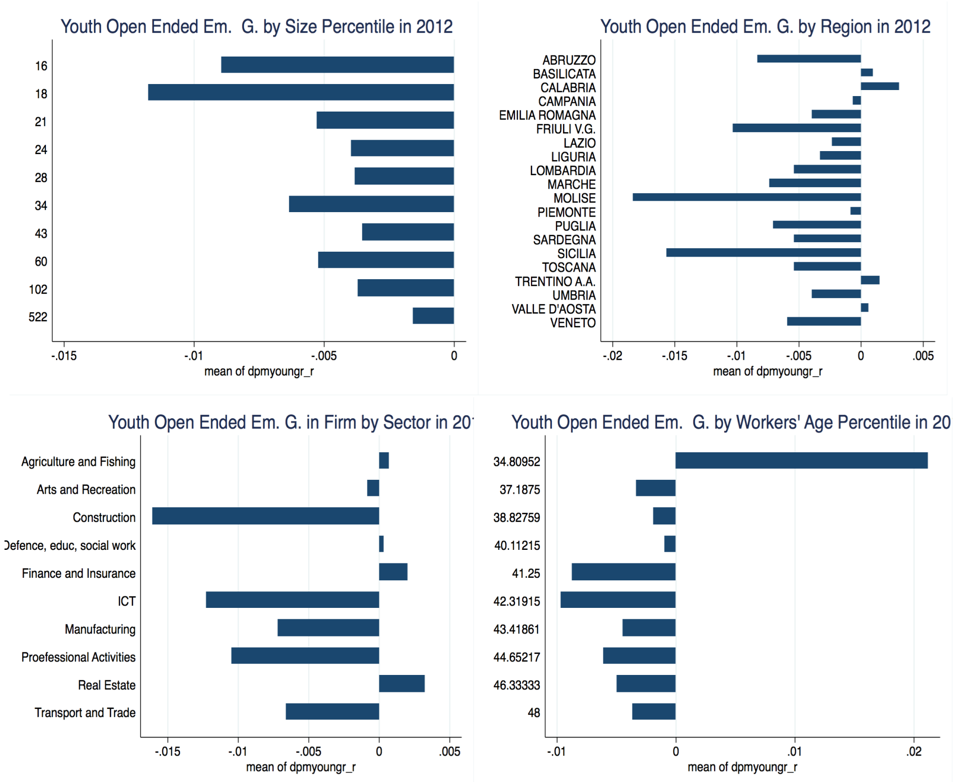


Figure 7: Firm Growth of Young, Old Prime age by Quantile of Locked3_old

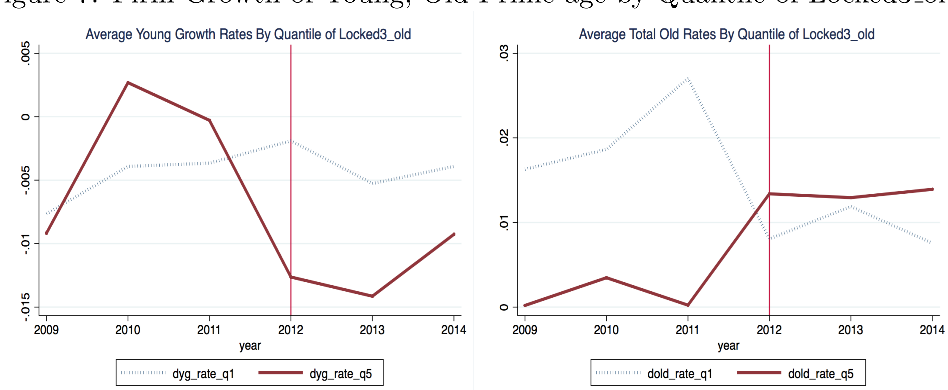


Figure 8: Coefficients on Young Growth

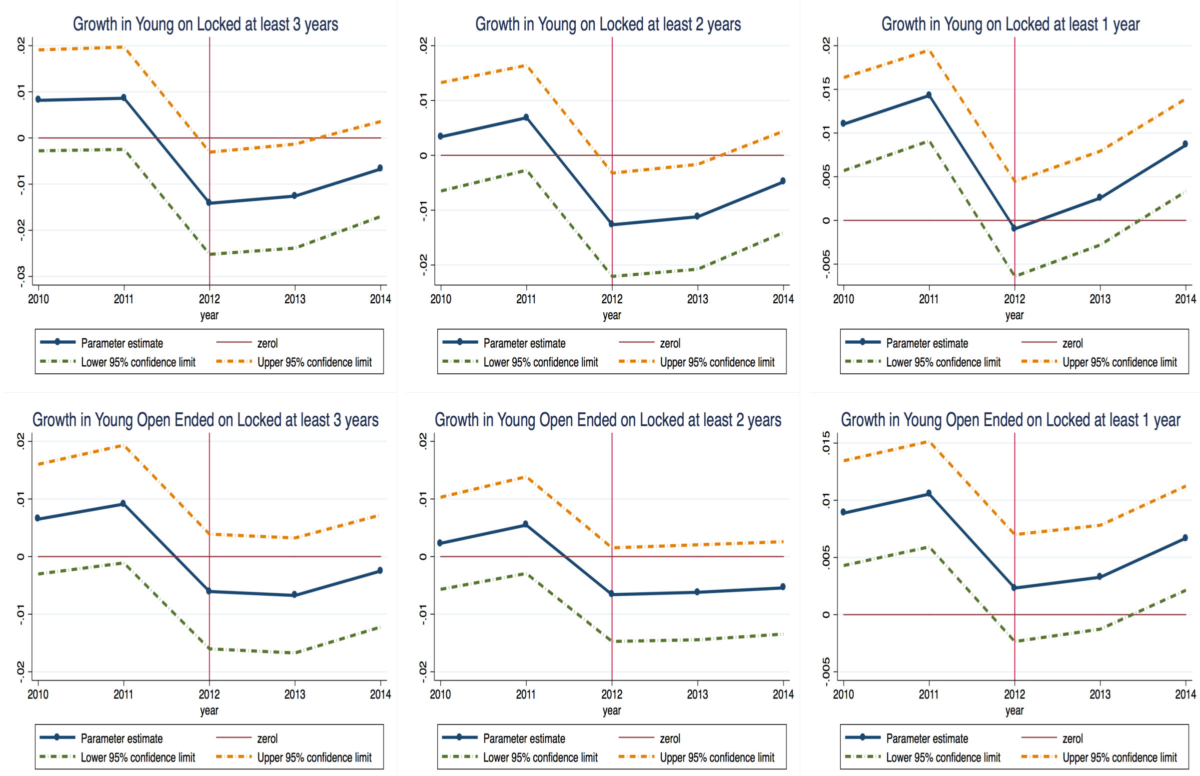


Figure 9: Coefficients on Old

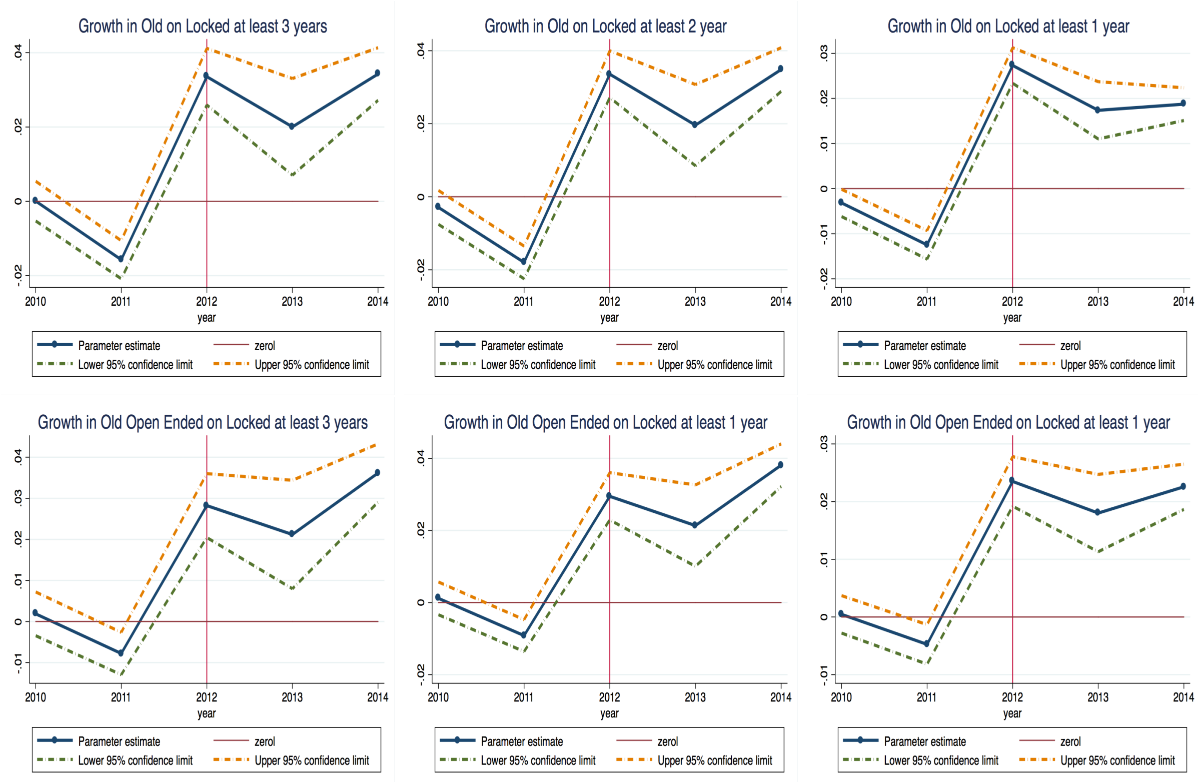


Figure 10: Coefficients on Total Employment

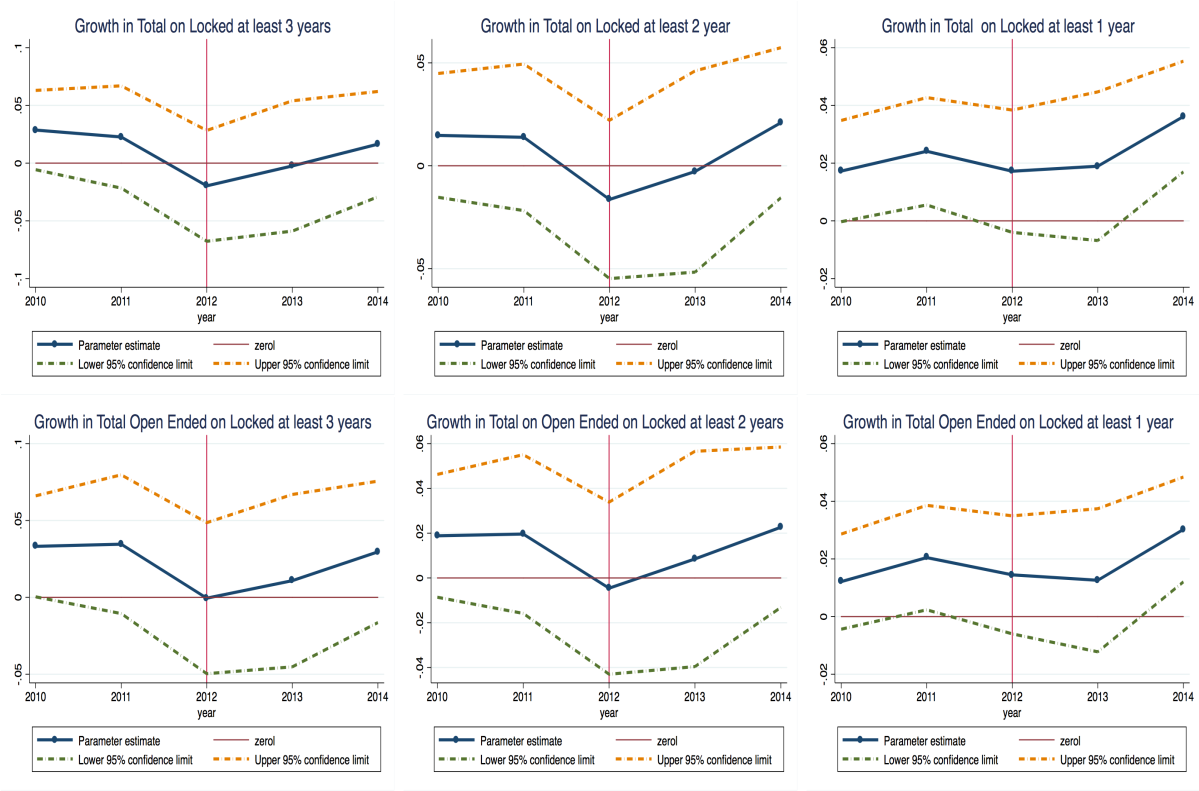


Figure 11: Coefficients on Old and Young in Changes