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GENDER AND AGE DIVERSITY. DOES IT MATTER FOR FIRMS' PRODUCTIVITY?

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Gender and age diversity. Does it matter for firms' productivity?[1]

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Abstract

We explore the link between the firm's workforce composition in terms of female and young workers and its performance in France. We consider three types of approaches: atypism, diversity and a non-linear approach. Our econometric estimates, based on administrative data from French companies, highlight several results. First, companies employing low or high proportion of female or young workers face productivity losses. Second, increasing diversity in terms of female or young workers generates productivity gains. Third, productivity gains decrease as the share of women or young workers is close to the diversity situation, either in terms of female or young workers employed in the company. Fourth, this positive relationship between female and young workers diversity and productivity is mainly attributable to a small number of industries: trade-hotels-restaurants, real estate-rental-business services and manufacturing. Consequently, this article seems to indicate sufficiently robust findings to inspire public policy actions in favor of diversity in terms of female or young workers.

***JEL Classification**: C26, J16, J24, J78.*
***Keywords**: female and young workers; firm performance; public policy; instrumental variables.*

1. Introduction

There is no shortage of calls for gender diversity in the labor market, whether promote the integration of young people, to guarantee equal access for men and women to jobs, functions and all levels of the hierarchy, to prevent discrimination based on origin, or to include people with disabilities in the workplace. Every time, corporate social responsibility is at stake. Managing the diversity of human resources in all these dimensions has become a real challenge for private and public organizations.

From this perspective, crucial questions are: what are the effects of diversity on business performance? Are mixed teams necessarily more effective? Is it costly to diversify human resources? Is there a trade-off between age / gender diversity and productivity in companies?

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Research in the social sciences, psychology and management does not provide definitive answers to these questions, which could inform the choices of human resources managers and public decision-makers. From a theoretical point of view, the mixing of work teams is associated with both the best and the worst. For some, it is a source of creativity, resilience and innovation. For others, it is a breeding ground for conflict and division in organizations. From an empirical point of view, studies emphasize the relative nature of this relationship by showing that the effects of diversity on performance also depend on the nature, variety and difficulty of tasks, as well as work contexts, the size of teams and companies, and the type of business sector. On all these topics, the management science literature, which has reportedly doubled in size every five years since the late 1980s, has not produced consistent results and has even been accused of being "weak, inconsistent, or both" (Harrison and Klein, 2007). While there is a very large number of publications on the association between age or gender diversity and company performance, only a small proportion of them is based on explicit empirical strategies that make it possible to account for the endogenous nature of gender diversity in top performing companies. Some of these publications focus on the effects of the feminization of boards and management teams (*e.g.*, Adams and Ferreira, 2009; Ahern and Dittmar, 2012; Bear *et al.*, 2010; Campbell and Minguez-Vera, 2008; Carter *et al.*, 2003; Dale-Olsen *et al.*, 2013; Erhard *et al.*, 2003; Green and Homroy, 2018; Solakoglu, 2013; Ben Slama *et al.*, 2019). Others, a minority, are interested in the age and gender diversity of the total workforce (Apesthegia *et al.*, 2012; Garnero *et al.*, 2014; Grund and Westergaard-Nielsen, 2008; Ilmakunas and Ilmakunas, 2011; Parrotta *et al.*, 2014; Vandenberghe, 2013). It is within this stream of literature that this article is situated.

We focus on diversity of companies' workforce in terms of female and young workers. These variables are also criteria of discrimination prohibited by law in France and in other numerous other developed countries. We have information on these variables in company-level databases. We also consider a single performance indicator for companies: apparent labor productivity measured at the company level. The aim of this article is to evaluate the productivity gains of diversity in the business workforce in terms of female and young workers, in France. To this end, we rely on individual tax and accounting databases with exhaustive coverage between 2009 and 2015, and on a plurality of econometric approaches that make it possible to overcome the reverse causality of performance in relation to age or gender diversity. We show that there is a positive link between productivity and gender or young workers diversity. In particular, employing a small or large share of female or young workers is associated with productivity losses for the company. Moreover, greater diversity in a company's workforce implies productivity gains. When the proportion of female or young workers employed by the company is low (respectively high), an increase (respectively decrease) in the proportion of female or young workers in the workforce generates productivity gains. These results are found in a few business sectors such as the real estate, rental and business services industry, but also in the manufacturing industries and to a lesser extent in the trade, hotels and restaurants industry.

This article contributes to the literature on the relation between workforce diversity and labor productivity in several ways. We evaluate the effect of gender and young workers diversity from a new manner. To our knowledge, our paper is the first to combine three complementary approaches to analyze the effect of workforce diversity: one is called atypism and deals with the cost in terms of productivity that is linked to lack of diversity. Another one measures the distance for a firm to a norm for a given employment category; on that occasion, we built a Herfindahl-Hirschmann index that allows us to have a maximum value that does not assume equal proportions of different employment categories in the population. A last approach encompasses the first two, allowing us to explore for potential non linearities in the relation between diversity and productivity (like in

Chetty *et al.*, 2014). Another important contribution of our paper is that we study the age diversity not along the whole age distribution, but considering a particular sub-group, that of workers younger than 30 years old. We also address the potential endogeneity of our diversity indicators and to cope with reverse causality; in particular, we distinguish several kinds or instruments some of which were suggested in Parrotta *et al.* (2014), but also original instrumental variables. In the end, we study the relation between workforce diversity at the industry level; we thus investigate to what extent the findings for the overall economy rely on industries, considering six main business sectors.

In the second section we present an overview of the literature on the associations between the gender and age composition of a company's employment and its productivity. The third section is devoted to the presentation of the methods used to evaluate the effects of age and gender diversity on business performance. The fourth section presents the data and the fifth the results. The last section concludes.

2. Literature review

In the economic literature that analyzes the diversity of the labor input, we can distinguish (at least) two kinds of strand of literatures.

A first strand copes with expected effects of workforce diversity. Alesina and La Ferrara (2005) provide micro foundations to the relation between diversity and firm performances. The first way is to consider a heterogeneous population. If the individual preferences are increased by joining a group populated by individuals of its own type and decreasing by joining a group composed of individual of other types then the preferences for homogeneous group involve a negative relationship between diversity and firm performances. A second channel through which diversity can affect firm performance is strategic behavior. In case of market imperfections and in the absence of a preference for or against diversity it may be optimal from an efficiency perspective to prefer to interact with members of the same type. In this case the diversity has a negative impact on the firm performances. A third way to describe the relationship between diversity and firm performances is through the production function. Lazear (1999) describe how heterogeneity in skill can increase the productivity. He shows that the communication cost related to language, cultural, generational, educational differences can involve a tradeoff between firm performance and diversity. As to gender diversity and productivity, mixed-gender groups can foster the impact of group efficacy on performance according to Lee and Farh (2004). Indeed, the authors argue that gender diversity is likely to increase the heterogeneity in the values, beliefs, and attitudes of the members of a group, which in turn may stimulate critical thinking. On the other hand, Akerlof and Kranton (2000) introduce the concept of identity – which corresponds to a person's sense of self – into an economic model; they consider gender as an illustration of identity. The authors point out that social categories such as "men" and "women" are associated with prescribed behaviors and physical prescribed behaviors and ideal physical characteristics. As a result, women in male-dominated jobs may experience strong hostility and discrimination from their male counterparts. They predict that increasing gender diversity can have a negative impact on business performance, especially if men are a socially "dominant" group. Concerning the relation between age diversity (in terms of young workers) and productivity, young workers are assumed to learn faster (Skirbekk, 2004) and have better cognitive and physical skills (Hoyer and Lincourt, 1998) than their elders. However, age is also positively correlated with work experience and knowledge of intra-firm

structures, markets and relevant networks (Grund and Westergaard-Nielsen, 2008; Leonard and Levine, 2003).

Another strand of literature deals with the empirical evidence regarding the impact of workforce diversity (young or female workers) on labor productivity. Corresponding studies are rare and often inconclusive. One reason for this lack of consensus undoubtedly lies in the complexity of the questions asked. Research on the subject is confronted with three series of methodological difficulties, which it overcomes to differing degrees. The first difficulty is the heterogeneity of situations. There is a very wide variety of business situations in terms of the composition of the workforce by age and sex, and there is also a wide variety of situations in terms of work organization, technology or market context. Monographic studies which carry out in-depth research limited to a few company cases do not allow these different sources of heterogeneity to be dealt with. To produce general knowledge that is representative on the scale of the productive fabric of a national economy, it is important to use statistical approaches based on large matched samples of data from companies and employees.

Beyond this heterogeneity in the observable characteristics of companies and employees, a second difficulty relates to the effects of unobservable determinants of company performance, which can sometimes be correlated with the greater or lesser diversity of their human resources. To control for the effect of this unobservable heterogeneity, the most classic approach is to use panel data and estimates with company effects that are fixed across time, which requires a sufficiently long-term dimension.

A third difficulty lies in the potentially endogenous nature of the diversity, which may be due at least in part to companies' performance. The researcher who wishes to identify the causal impact of age or gender diversity on productivity must guard against the feedback effect of productivity on age or gender diversity (reverse causality). Because a highly efficient company generates high profits and is able to offer attractive remuneration, it may choose a proactive policy to promote diversity. It may then automatically attract particular profiles of job applicants most interested in these elements, who may be over-represented in certain socio-demographic groups, leading to a statistical bias in the estimates. This is an example of one of several mechanisms that lead to the existence of a reverse causality from performance to age or gender diversity, the existence of which requires the researcher to implement a particular data processing strategy to offset this type of bias (instrumental variable methods in particular). Only a very small number of studies have faced these three difficulties head-on, using large samples of matched employer-employee panel data, with a time dimension long enough to neutralize unobservable heterogeneity using company fixed effects, and with an explicit identification strategy to deal with endogeneity bias.

The effect of gender diversity on the economic and financial performance of companies has been extensively studied empirically with regard to the composition of boards of directors and management teams, which is one of the area's best covered in the literature. One of the most widely cited studies is that of Adams and Ferreira (2009), which indicates that the proportion of women in the executive ranks of large companies changes governance and decision-making, without having an unequivocal effect on their economic and financial performance. This is because the statistical methods used take into account the reverse causality of performance towards gender diversity. The reader is also referred to the evaluation of the effects of the feminization of boards of directors and management teams carried out by Solakoglu (2013), who uses data from large Turkish companies.

The work of Ilmakunnas and Ilmakunnas (2011) uses data from Finnish plants belonging only to mining, manufacturing and construction industries over the period 1990-2004, and analyze the relation between age-education diversity and productivity or wages. In particular, they show a

positive (respectively a negative) link between age (respectively education) diversity in the company and total factor productivity, labor productivity or wages.
The study by Garnero *et al.* (2014) examines the effects of gender, age, and educational attainment on productivity, wages, and firm profitability, using Belgian individual data covering the period 1999-2006. It shows that the variety of educational levels increases wages and productivity, while that of ages reduces them, which is strictly the opposite of the results of Ilmakunnas and Ilmakunnas (2011). In addition, the feminization of the workforce produces beneficial effects in high-tech intensive business sectors but negative effects in more traditional industries. The study also highlights a strong effect of company size. Unlike gender, there is a link between age and productivity. Productivity evolves according to the life cycle on an inverted *U* pattern: increase at the beginning of a career, stagnation, then decrease at the end of a career. Activities involving experience and verbalization are less subject to a decrease in productivity at the end of a career compared to activities requiring a good capacity for problem-solving, learning or even speed. The study by Garnero *et al.* (2014) also found a difference in the result between age and gender on the productivity of the company, measured by the value added per hour worked, depending on whether the variable is introduced as an average or as a dispersion. Thus, high average age has a positive effect on a company's productivity, while age dispersion has a negative effect, as does gender dispersion. For an increase of one standard deviation, productivity decreases by 4% on average. Gender diversity is beneficial only in high-tech sectors (from + 2.5% to 6% increase in productivity). The dispersion of age also has a positive effect in that people of different ages can perform the same task if they have the same level of education (Ilmakunnas and Ilmakunnas, 2011).
Parrotta *et al.* (2014) use Danish data sources that provide information on all companies from private business industries to form a panel for the period 1995-2005. They show that more educational diversity is associated to an increase in the total factor productivity. On the contrary, workforce diversity in ethnicity is negatively associated to the TFP, but this result is inversed when considering a more structural approach. Finally, there seems to be no association between the demographic index (built from the intersection of age and gender quartiles/quintiles) and total factor productivity.. By distinguishing companies according to their level of investment in research and development, they do not confirm that their results differ according to this type of expenditure.
Among the studies that rely on a research strategy to analyze the causal effect of gender diversity on performance, the contribution of experimental economics should also be mentioned. Several studies have proposed laboratory experiments making it possible to link the composition of work teams by gender and age with the functioning and efficiency of these teams. These experiences are based on a large strand of literature in psychology that highlights individual psychological traits and preferences that differ by gender and age. For example, women are shown to be more altruistic and not to value competitive contexts as much as men. Therefore, the gender composition of teams is a potential explanatory factor for team decisions, and their performance and is a subject of study for laboratory experiments (Azmat and Petrongolo, 2014).

3. Identifying the effects of atypism and diversity of workforce

There are several ways to approach diversity in the company. In a widely cited article on this subject, Harrison and Klein (2007) stress the need to conceptually distinguish between different approaches, and propose to consider three types of diversity. First, separation refers to the diversity of points of view and systems of attitude. Second, variety expresses the diversity in the nature of

experiences and expertise. Third, disparity refers to differences in level of experience and expertise. In the current study, we adopt a more restrictive definition of diversity by considering only the composition of the salaried workforce of companies in terms of female and young workers. We use the term "age-gender diversity" to qualify this composition.

The methodology must be adapted to the particularities of these two variables. Gender is a dichotomous variable, summarized at the company level by the proportion of women in the workforce. In addition, gender is generally assumed to be independent of productivity. Age is a continuous variable, which can also be expressed as an ordered polytomous qualitative variable. The age distribution may be imperfectly summarized by the share of those under 30, for example. Unlike gender, age is correlated with productivity (Lazear, 1976). Because of these differences, identification is carried out separately for age and sex. In this article, the methodology is first applied to female workers and then transposed to the case of workers under 30 ("young workers"), and then to female workers younger than 30.

We measure business performance, considering a single synthetic indicator, the company's apparent labor productivity. Given the high sensitivity of this indicator to the economic situation, we assess it on average over the duration of a business cycle (7 to 15 years, depending on the considered time period).

We implement three types of complementary approaches to identify the causal effect of age or gender diversity on business performance. Each of these approaches has informational content and also specific limitations. By combining them, we seek to produce robust results, which make it possible to produce valid conclusions irrespective of the assumptions, indicators and specification choices specific to each of the approaches considered.

- The first approach is that of atypism and consists in measuring the productivity of companies in which the share of female or young workers is located at the extremes of the distributions. This is a dichotomous measure in that it separates companies according to whether they are at the center or at the ends of the distributions.
- The second approach is to assess productivity gaps according to the distance of the share of female or young workers in each company, from the economy or industry norm (average share at a more or less aggregated industry level). This is a linear and continuous measure of the association between (resp. effect of) gender or age diversity and (resp. on) labor productivity that is averaged across all firms in the sample.
- The third approach consists in measuring locally, per quartile of firms, the impact of an additional diversity on labor productivity. The measure focuses on the effects of a gain of one percentage point or of one position, in the ranking of firms, for the employment category (female or young workers). It is based on the indicators used in the study by Chetty *et al.* (2014) on the determinants of intergenerational social mobility.

For each of these approaches, we perform several variants according to the definitions of thresholds and standards, in order to assess the sensitivity of the results to the modeling choices. For the same purpose, we also use two estimation methods: ordinary least squares and instrumental variables. These three approaches are implemented on individual business administrative data covering the period 2009-2015. We mention all these aspects in the remainder of this paper.

Before implementing each of these approaches, a first step consists in purging or netting out the empirical distributions of the share of female or young workers in the company's workforce, to account for factors related to productive choice or organizational choice not directly related to the diversity.

In fact, firms gradually build up their workforce through hiring and firing. Even if they have no particular bias in favor of a particular structure in terms of female or young workers, they hire people from employment pools whose structure varies over time and space. In these different recruitment pools, the proportion of women is not the same over time (due to the increasing numbers of women in the workforce), and location (due to a specific geography of female activity), and depending on the industry and profession (in a context marked by phenomena of gendered educational orientation, school segregation and occupational segregation of women). The same holds also for young workers, which is variable in the temporal (aging workforce) and spatial dimensions.

A first step therefore consists in neutralizing all the gender or age determinants of professional structures which could explain the differences between companies. For example, the proportion of women differs from one profession to another and companies recruit from various professional structures. To neutralize these differences, *ceteris paribus*, it is important to reconstruct the proportion of women in each company, by controlling all of its determinants: technological and organizational choices, job structure by qualification, etc. It is a question of netting out the empirical distributions of the firm workforce by sex or age. To do so, we have regressed at the level of each company the average share (in the time dimension) of women on the average age of the firm, its average capital intensity, and its average wage share in value added. We also take into account the structure of jobs by adding, in the explanatory variables, the average shares of blue-collar workers, intermediate occupations and executive workers. We include the dummies corresponding to industries to which the company belongs (French NAF2003-rev. 2, disaggregation according to the nomenclature in 31 levels; NAF2003). Finally, we take into account the size of the company's workforce by considering 7 size ranges (20-50, 50-100, 100-250, 250-500, 500-1000, 1000-2000, 2000-5000, 5000 workers and more).

Thus, the estimated model stands as follows:

$$\overline{\text{share}}_i = \alpha_0 + \alpha_1 \overline{\text{firm\_age}}_i + \alpha_2 \overline{\text{CI}}_i + \alpha_3 \overline{\text{s\_wages}}_i + \alpha_4 \overline{\text{s\_blue-collar}}_i + \alpha_5 \overline{\text{s\_inter\_occup}}_i + \alpha_6 \overline{\text{s\_excutives}}_i + \alpha_7 \overline{\text{s\_full\_time}}_i + \sum_{b=1}^{B} \beta_b \text{business}_{b,i} + \sum_{s=1}^{S} \beta_s \overline{\text{firm\_size}}_{s,i} + \sum_{r=1}^{R} \beta_r \overline{\text{s\_region}}_{r,i} + u_i \quad (1)$$

where $\overline{\text{share}}_i$ is the share of female (or young) workers and u_i is the error term; $\overline{\text{firm\_age}}_i$ refers to the average age of the firms over the period considered; $\overline{\text{CI}}_i$ to the average capital intensity; $\overline{\text{s\_wages}}_i$ to the (average) share of wages in value added; $\overline{\text{s\_blue\_collar}}_i$; $\overline{\text{s\_inter\_occup}}_i$; $\overline{\text{s\_executives}}_i$; $\overline{\text{s\_full\_time}}_i$ to the shares of different job categories in the workforce of the given company; the dummies $\text{business}_{b,i}$ and $\overline{\text{firm\_size}}_{s,i}$ correspond respectively to the business sector *b* and to the size group *s* of company *i* (on the basis of average workforce over the considered time period); $\overline{\text{s\_region}}_{r,i}$ the share of jobs in company *i* located in region *r*. In the equation for the share of female workers we add the share of those workers older than 49, and in those relating to young workers we add the share of women.

This equation is estimated at the level of the economy as a whole, and for each business sector (considering six main industries). It allows us to obtain a distribution of the variables of interest (female or young workers' share) that excludes technological choices, employment structure and company size. For the remainder of the study, as a variable of interest, we use the estimated error term $\hat{u}_i$, which is by definition independent of all the explanatory variables describing the

organization of the company. We call it "fixed effect" and denote it as share_i. The latter corresponds to the average share of female or of young workers in the company, which is not correlated to any of the determinants of the share of female or young workers that appear in the estimated equation. It is a measure of the average (over time) residual share of female or young workers in the company.

3.1 Atypism

The first approach is that of atypism and consists in measuring the performance of companies located at the extremes of the distributions of the shares of female or young workers in the workforce. The intuition is that if atypism of workforce as regards gender has an impact on performance, we must be able to observe these effects clearly for atypical companies located at the extremes of the distributions of the share of women. The idea is to identify atypical firms from the netted out distribution of the share of female workers. We want to distinguish three groups of companies: an atypical group on the left (low residual proportions); an atypical group on the right (high residual proportions); a non-atypical group in the center.

In a first step, we seek to identify these groups to be able to study the characteristics of the companies composing them. To this end, we have chosen a statistical method which consists in truncating the netted-out distributions share for women in the company's workforce by choosing a threshold of 5% (2.5% on each side)[6].

In a second step we measure the labor productivity losses (or gains) related to atypical firms (firms belonging to the first 2.5% or the last 2.5% of the distribution). We estimate an equation at the company level within each sector considered for each category (female or young workers):

$$\ln(\overline{\text{lab\_prod}_i}) = \gamma_0 + \gamma_1 \text{low}_i + \gamma_2 \text{high}_i + \sum_{b=1}^{B} \beta_b \text{business}_{b,i} + \sum_{s=1}^{S} \delta_s \overline{\text{firm\_size}}_{s,i} + \sum_{r=1}^{R} \lambda_r \overline{\text{s\_region}}_{r,i} + \beta . \overline{\text{firm\_age}}_i + \varepsilon_i \quad (2)$$

The explained variable is the logarithm of the average level of labor productivity over the considered period; $\text{firm\_size}_{s,i}$ is a dummy variable that corresponds to the size group *s* of company *i* (on the basis of average workforce over the considered time period)*;* $\overline{\text{s\_region}}_{r,i}$ is the share of jobs in company *i* located in region *j*; $\overline{\text{firm\_age}}_i$ refers to the average age of company *i* over the period considered; low_i et $high_i$ are two dichotomous variables constructed from belonging to groups of atypical companies with a low or a high proportion of the considered worker category (women or young workers). The reference class is that of firms in "the norm".

3.2 Distance to the standard

The second approach that we have adopted measures the distance of each company from a reference situation corresponding to the maximum diversity. This baseline situation is assessed in two ways. The first is the industry average for the proportion of female or young workers. It has a "relative character". The second is the average proportion of female or young people in the labor force in the economy as a whole and to an "absolute character".

Implementing this approach requires only one estimation step. The average productivity of companies in a given industry or at a given level of aggregation is directly regressed on a

[6] In Challe *et al.* (2020), we also consider the 20% threshold (10% on each side). The results are available on request.

continuous indicator of distance to the norm, by controlling for the size of the company, its workforce by location and its seniority.

$$\ln(\overline{\text{lab\_prod}_i}) = \gamma_0 + \gamma_1(\text{share}_i - \text{share}_b).1_{\text{share}_i < \text{share}_b} + \gamma_2(\text{share}_i - \text{share}_b).1_{\text{share}_i \geq \text{share}_b} + \sum_{b=1}^{B} \delta_b \text{business}_{b,i} + \sum_{s=1}^{S} \delta_s \text{firm\_size}_{s,i} + \sum_{r=1}^{R} \lambda_r \overline{\text{s\_region}}_{r,i} + \beta \overline{\text{firm\_age}}_i + \varepsilon_i \quad (3)$$

where $share_b$ refers to the proportion of the job category in the "*b*" business sector to which company *i* belongs; the dummy variable $1_{share_i < share_b}$ is equal to one if $share_i < share_b$, zero else.

With regards to the distance to the absolute standard, the econometric specification retained is:

$$\ln(\overline{\text{lab\_prod}_i}) = \gamma_0 + \gamma_1 HHg_i + \sum_{b=1}^{B} \beta_b \text{business}_{b,i} + \sum_{s=1}^{S} \delta_s \text{firm\_size}_{s,i} + \sum_{r=1}^{R} \lambda_r \overline{\text{s\_region}}_{r,i} + \beta . \overline{\text{firm\_age}}_i + \varepsilon_i \quad (4)$$

where HHg_i denotes the generalized Herfindahl-Hirschmann index for firm *i*. The principle of this index is to bring the proportions obtained with the Herfindahl and Hirschmann indicator to values compatible with the proportions actually observed in the labor force and not to *1/K* with *K* is the number of modality of the variable (gender or age classes) (see Appendix A).

3.3. Non-linear measurement

We are also considering a third approach that is more local in scope. It enables us to assess the marginal impact of a diversity supplement on productivity while allowing this effect to vary along the distribution of companies in terms of gender diversity. As noted above, this measure is inspired by the indicators used by Chetty *et al.* (2014) in their study on intergenerational social mobility in the United States[7].

This method provides a common framework that makes it possible to estimate the impact of age or gender diversity on the company's performance, both on the distribution tails (atypism) or along the distribution of the proportions of young people or women employed (diversity). Second, it does not make any assumptions about the presence and form of nonlinearity since it is based on estimates by percentile of female or young workers.

The "fixed effect" of companies (for the proportion of female or young workers) is broken down into quartiles. In practice, for each quartile q_j ($j = 1, \ldots, 4$), we estimate the following equation:

$$\ln(\overline{\text{lab\_prod}_i}) = \gamma_0 + \gamma_1 \text{share}_i + \sum_{b=1}^{B} \beta_b \text{business}_{b,i} + \sum_{s=1}^{S} \delta_s \overline{\text{firm\_size}}_{s,i} + \sum_{r=1}^{R} \lambda_r \overline{\text{s\_region}}_{r,i} + \beta . \overline{\text{firm\_age}}_i + \varepsilon_i, \text{ for } i \in q_j \quad (5)$$

However, the potential nonlinearity detected during these regressions may be contingent on the chosen specification and therefore on the interpretation of the coefficient (proportion, semi-elasticity, for instance).

[7] See also Dahl M.W. and DeLeir T. (2008).

To reason in terms of semi-elasticity, the outcome variable is considered as a logarithm. However, estimating the relationship between atypism (or diversity) and company performance by taking the logarithm of productivity leads to the exclusion of companies with zero productivity. Moreover, it is not necessarily the difference between the proportion of workers between two companies that explains the difference in performance, but rather the fact that one company employs a higher proportion of women than another company. In other words, the relationship between atypicality or diversity and performance is not necessarily cardinal but could be rather ordinal.
Rank regressions then make it possible to estimate the link between the rank of the company in terms of share of a category of workers and the rank in terms of performance, without excluding firms with zero productivity. In addition, they make it possible to account for an ordinal relationship between the shares of female or young workers in a company's workforce and the company's performance. The considered equation is then:

$$\text{rang}\left[\text{lab\_prod}_i\right] = \gamma_0 + \gamma_1 rang\left[\text{share}_i\right] + \sum_{b=1}^{B} \beta_b \text{business}_{b,i} + \sum_{s=1}^{S} \delta_s \overline{\text{firm\_size}}_{s,i} + \sum_{r=1}^{R} \lambda_r \overline{\text{s\_region}}_{r,i} + \beta . \overline{\text{firm\_age}}_i + \varepsilon_i \text{ , for } i \in q_j \quad (6)$$

The estimated coefficient $\hat{\gamma}_1$ is plotted for each quartile (or rank quartile). For a company i belonging to the quartile (or rank quartile) q_j, $\hat{\gamma}_1$ measures within the quartile q_j the "effect" on productivity of increasing the proportion of the job category by one percentage point (or by one position when considering the rank regression). We can then see how this association is distorted when we move from one quartile (or rank quartile) to another. For example, if it is positive and decreasing with quartiles (or rank quartiles), the sequence of $\hat{\gamma}_1$, is symptomatic of a decrease in productivity gains as the share of the job category increases. Conversely, if it is negative and decreasing with quartiles, the sequence of $\hat{\gamma}_1$ is symptomatic of a decrease in productivity loss as the share of the job category decreases.

3.4. Association vs. causal effect?

Two estimation methods are systematically used. One is estimation through ordinary least squares; the other is through instrumental variables.
Ordinary least squares provide us with associations between age / gender diversity and productivity. We regress productivity on diversity while controlling for a set of variables to take account of technological and organizational choices, and job structure by qualification.
In contrast to ordinary least squares, the instrumental variables method allows – at least partially – to control for the endogeneity of the diversity. It is designed to isolate the effect of gender or age diversity (in terms of young workers employed) on productivity. To use this method, it is necessary to find one or more variables that correlate with the share of female or young workers without correlating to the error term of the performance equation. Therefore, a good instrument must be correlated to diversity without being correlated with the error term (exogeneity). Its choice is based primarily on the results of standard statistical tests of weak instruments (Stock and Yogo, 2005), in turn supported by theoretical and / or factual arguments. Therefore, the choice of instruments is an important step that should be discussed. We wish here to highlight the potential positive effects of complementarity on labor productivity. These complementarity effects suggest that greater diversity would have a positive effect on labor productivity. However, we have to face reverse causality between productivity and age / gender diversity, which complicates the evaluation.

To guard against this pitfall, we considered instruments for which we hoped to have good properties: both exogeneity and correlation with the proportion of women (of young worker) in the firm.

As an instrument, we systematically considered the share of female (resp. of young) workers among part-time workers. We also considered the share of female / young workers in the employment zone (resp. in the municipality) at the workplace, or in the employment zone (resp. in the municipality) at the place of residence.

With respect to the instruments mentioned above, we follow here the study of Parrotta *et al.* (2014) who considered shares in the employment zone. The first condition (exogeneity) seems to be verified by these three instruments, because the link between the performance of companies and the proportion of this category of employment in the employment area seems more difficult to establish (Parrotta *et al.*, 2014). The same is not true for the second condition: the relation between the proportion of women at the level of the municipality or the employment zone, and the proportion of women within the company. The proportion of women in a company depends closely on the proportion of women in the employment area or in the municipality (at the place of employment or at the place of residence). However, these instruments have been shown to be weak (Stock and Yogo, 2005). On the other hand, the relation between the performance of companies and the proportion of this category of employment in the employment pool seems more difficult to establish (Parrotta *et al.*, 2014). However, due to a frequent lack of variability, these instruments are often weak.

Reverse causality between age or gender diversity and productivity could be linked to the social aspect of Corporate Social Responsibility (CSR). This mainly concerns large companies, which are the most productive and also the most concerned about their image and their public relations. Beyond legal obligations, these most productive companies can thus have a proactive policy of diversity and increase the proportion of women or young people in the most visible positions (management teams, executive workers, boards of directors).[8] These positions are the most qualified and are mainly full-time, unlike the less visible jobs, which are respectively less qualified and much more frequently part-time[9]. Thus, we have also considered other instruments that are correlated more with the shares of female or young workers in the company and are compatible with the previous reverse causality. We have retained as instruments the proportion of female / young workers among part-time employees, which generally concerns low-skilled jobs that are less significant in the social balance sheet of these large companies and where gender or age (in terms of young workers) diversity will be less of an issue for the company's image.

What is the effect identified by the instrument - the share of female or young people among part-time employees in the company? Is it an average effect, or is it a local effect, *i.e.* on a particular group of firms with female or young workers?

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[8] In this regard, according to the 2011 survey on Enterprises and Sustainable Development (ENDD) conducted by INSEE, and over the period from 2009 to 2015, the changes compared to the proportions of women and young executives, in relation to those of the proportions of women and young non-executives are always more favorable in companies labeled "diversity" than those in non-labeled companies.

[9] According to data from INSEE (2019), part-time employment mainly concerns women, young people, and non-managers (employees, intermediary professions and manual workers). https://www.insee.fr/fr/statistiques/4501614?sommaire=4504425&q=emploi+%C3%A0%20temps+partiel

The instrument may only allow us to identify the effect of diversity for a sub-group of firms for which a change in the share of female (or young workers) employed part-time (instrument) implies an increase in the diversity of female (or young workers) which is a potentially endogenous variable. In this case, it is more a question of a local effect contingent on these particular firms (the "compliers" according to Angrist *et al.* (1996)).
In our case, when firms increase part-time employment, the "compliers" correspond to firms which recruit mainly women or mainly men on a part-time basis (polarized recruitment policy). In this case, they also change the share of women in the firm. On the other hand, if a firm recruits the same proportion of men and women part-time, the share of women will not be affected. We can see that the first type of company corresponds more to atypical companies, whereas the second type refers to companies that are more diversified in terms of their workforce composition (female, young workers).
As a consequence the effect measured with this instrument is rather specific to the group of companies with a polarized recruitment policy, *i.e.* "atypical" companies. The effect is then qualified as the local average treatment effect (LATE) and does not correspond to the average treatment effect (ATE) for the entire population of firms.

4. Data

4.1. Statistical sources

We use data from two different administrative sources available at INSEE (the French national institute of statistics) over 2002-2015. The first data source is the DADS (*Déclarations Annuelles de Données Sociales*), which is a matched employer-employee longitudinal data source, constructed from companies' reports to the French administration collecting the social contributions, URSSAF-ACOSS. The second source is another administrative source called FARE (*Fichiers Approchés des Résultats d'Esane*)-FICUS (*FiChiers Unifiés de Suse*), which gives us measures of sales, value-added and other economic outcomes for most French companies.
The DADS data source includes data on all workers employed in private and semi-public establishments. INSEE receives information from URSSAF-ACOSS in order to compile statistics on employment and wages in France. This file is exhaustive and has been available from 1995. In this article, we use this exhaustive data aggregated at the company level – for the years 2009 to 2015. For each year, we have a sample of approximately 1,300,000 firms. Individual wages, employment periods, age, sex, and the skill level of the workers are available. We compute proportions of female and young workers in each company.
The FARE dataset gives information at the firm level about the parent company to which subsidiaries belong. It results from a comparison between tax sources and the results of annual business surveys. This information is available for all firms that are subject to the two major tax regimes. These regimes cover virtually the entire productive system, representing roughly 95 percent of taxable companies in terms of sales. The data were kept for the period 2009-2015. For each year, we have a sample of approximately 2,500,000 companies. They mostly contain various economic indicators, such as value-added, capital investment, and profits. In particular, they allow us to measure the labor productivity, capital intensity and the labor share income of companies.

4.2. Size of samples of perennial businesses and industrial breakdowns

The preliminary stage consists in netting out the share of female or young workers. It assumes that companies' choices regarding age / gender employment structure – apart from technological considerations, distributions by qualification and company size – vary little over a short time period. This hypothesis requires a time dimension long enough to estimate the structural effects, but not too long to have a sample characterized by a homogeneous economic situation. Both DADS and FARE sources are available for the period from 2009 to 2015.

One drawback of considering all firms, even small ones, is the potential indivisibility of the employment categories in small firms. For instance, with a firm that has 2 employees, if both are male workers and are older than 30, they will be considered de facto as atypical (0% of women or young workers). We thus consider only companies with 20 employees at least.

Finally, we restrict our sample to non-farm private businesses. We thus exclude:

- Agriculture, hunting and forestry (AA), aquaculture and fishing (BA), where we do not have all the data prior to 2009.
- Public administrations (LA), because they do not belong to the business sector.
- Household activities (PA) or extra-territorial (QA) where we do not have all the information on labor in the DADS.
- The financial industries (JA) where labor productivity is not the most appropriate indicator to measure the company's performance.

In the end the 2009-2015 sample includes 56,620 businesses. Appendix B displays basic descriptive statistics for our sample.

Our estimates are made for the economy as a whole and at the level of each business sector, based on a breakdown into 6 main industries (NAF2003 nomenclature): manufacturing; construction; trade, hotels and restaurants; transport and communication; real estate, rental and business services; education, health and social assistance.

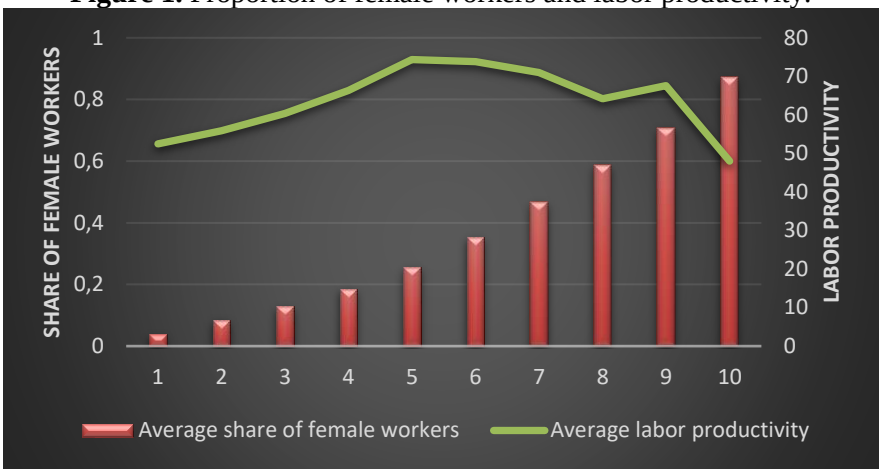
4.3. Descriptive statistics

In what follows, we represent labor productivity against the share of the given category of workers (female or young workers), on average over our 2009-2015 panel of firms.

Female workers

Figure 1 plots labor productivity against deciles of the proportion of women in the company's workforce. The productivity curve has an inverted *U* shape. It means that firms employing a small or large proportion of female workers are characterized by low labor productivity. By contrast, productivity is highest for companies whose proportion of female workers is located in the neighborhood of the average proportion of women in our sample of companies.

Figure 1. Proportion of female workers and labor productivity.



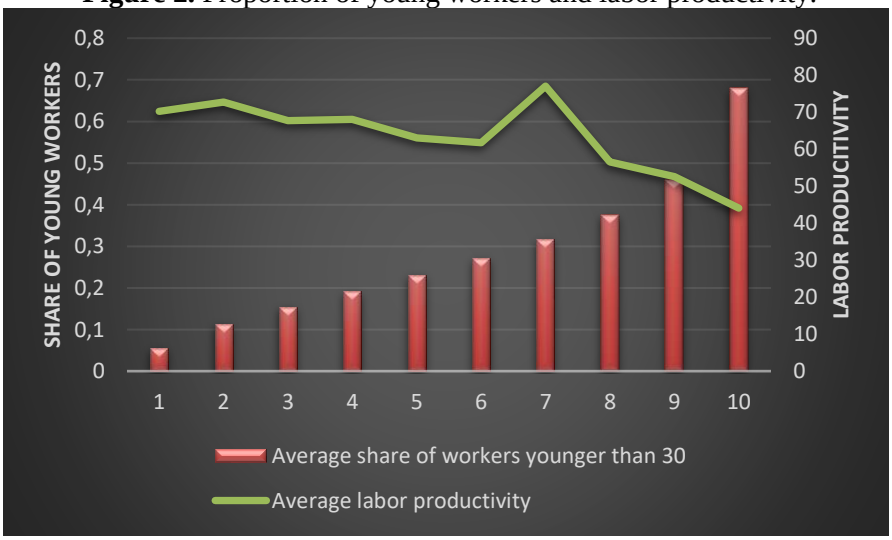
Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: X-axis: decile of proportion of female workers. Y-axis: proportion of female workers or labor productivity.

Young workers

Figure 2 represents the relation between the share of workers younger than 30, and labor productivity. As for women employed by firms, we see that there is a productivity peak at the 7th decile of the proportion of young employees.

In contrast to what is observed for women, it seems that productivity actually decreases with the share of young employees. This may be related to the fact that the firms with the highest proportions of young people are small and are characterized by lower capital intensity levels.

Figure 2. Proportion of young workers and labor productivity.



Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: X-axis: decile of proportion of young workers. Y-axis: share of young workers or labor productivity.

In the end, for both women and young workers, if we control for firm size and capital intensity, there appears to be an inverted U-shaped relationship between labor productivity in the firm and

the share of the worker category concerned. Therefore, companies with the lowest productivity are characterized by a small or large proportion of female or young workers. Companies in-between, with greater workforce diversity, are associated with higher labor productivity levels.

5. Results

Within the three approaches that we consider in analyzing the relation between diversity and labor productivity, ordinary least squares and instrumental variable estimates were produced.
For each of the two populations (female workers, young workers), the results are presented starting with the whole economy (the most aggregated sector of activity). We then distinguish 6 main industries manufacturing; construction; trade, hotels and restaurants; transport and communications; real estate, renting and business services; education, health and social assistance.

5.1. Atypism

Female workers
We want to identify two types of businesses with extreme values for netted out proportions of women: those with the lowest proportion of woman, and those with the highest proportion of women or equivalently atypical, to the left or right of the distribution of the share of women.
Considering the OLS estimates, for the economy as a whole (scope of firms with 20 or more employees – see Table 1[10]), employing a low or a high proportion of women is associated with lower productivity. Thus, the fact that a firm is among the 2.5% employing a low (respectively high) proportion of women is associated with a lower productivity of 21.6%[11] (respectively 22.3%).
We are now interested in the effect of atypism on labor productivity. The negative effect on productivity is obtained only on the left-hand side the distribution (10.5% on the left). It is not significant for firms employing the largest proportion of women.

[10] For all the estimated coefficients, only the associated p-values are reported. However, the corresponding standard deviations are available on request.
[11] The coefficient associated with a small proportion approximates the association. The exact calculation performed is as follows. Over the period 2009-2015, the logarithm of average productivity is 4.162. The associated coefficient being -0.244, we deduce for a firm belonging to the 2.5% of businesses employing the smallest proportion of women, a productivity-gap (compared to the average productivity) of exp(4.162-0.244)/ exp(4.162)-1=-0.2165, *i.e.* 21.65 percent less productivity. The same calculation can be made for the 2.5% of companies employing the largest proportion of women: exp(4.162-0.158)/ exp(4.162)-1=-0.1462, *i.e.* 14.62 percent lower productivity.

Table 1. Employing a low or a high proportion of female or young workers in relation to labor productivity. ***Overall economy.***

Indicator	2.5% of companies with the lowest proportions of considered workers [a]	2.5% of companies with the highest proportions of considered workers [b]
Estimator \ Population	Proportion of female workers: 36.67%.	
OLS	**-0.244*** **	**-0.158*** **
IV[c]	**-0.116*** **	**0.327*** **
Estimator \ Population	Proportion of young workers: 21.28%.	
OLS	**-0,162*** **	**-0,117*** **
IV[c]	**-0.490*** **	-0.043

Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
*Notes: [a,b]The firm employs a low (respectively a large) proportion of female (resp. young workers). [c]Considered instrument: proportion of female (resp. young) workers in part-time workers. [d]The atypism indicator is not considered to be endogenous (at a 5% level). [e]The given instrumental variable is considered to be weak (at a 5% level) – In our case there is no weak instrument-. *** (respectively ** and *) stands for significance at 1% (respectively 5 or 10%) level. In bold: the given coefficient is statistically significantly different from zero at a 5% level.*

The results depend on the industry under consideration. Appendix C shows a negative association between employing a small proportion of female workers and productivity only in the real estate, rental and business services industry. By contrast, atypism in terms of employing a large proportion of women is negatively correlated to labor productivity in three industries: manufacturing; trade, hotels and restaurants; and education, health and social assistance. As we instrument atypism, considering the share of women among part-time workers to take account of reverse causality, we find a negative impact of atypism (and employing a small share of women) only in the real estate, rental and business services industry. On the other hand, the effect of employing a large proportion of women is positive in the manufacturing, trade-hotels-restaurants, and transportation-communication industries.

Young workers

We focus now on young workers. Firms with the lowest or highest proportion of employees under age 30 are characterized by lower productivity. The fact that a firm is among the 2.5% of those employing a low (respectively high) proportion of young people is associated with a lower productivity of 15.0% (respectively 11.0%).

Considering the instrumental estimates using the share of under-30s among part-time employees as an instrument of workers younger than 30, we estimate the effect of such atypism. We obtain productivity losses only for firms employing a low proportion of under-30s (-38.7 percent over 2009-2015). In contrast, there is no effect of atypism on productivity for the 2.5 percent of firms employing the highest proportion of workers under 30.

As we distinguish according to the six main industries, we get the following results (Appendix D). First, a productivity loss is associated with firms employing a small proportion of workers younger than 30 in two main industries out of six (trade, hotels and restaurants; education, health and social assistance). This is also the case with firms employing a high proportion of young workers in all main industries except education, health and social assistance. Second, atypism in terms of employing both a small or a large share of young workers has a negative impact on productivity only in the trade-hotels and restaurants business sector. Employing a large proportion of people under 30 also has a negative effect in the manufacturing industry.

5.2. Distance to the norm

In this approach, we refer to the distance to a central tendency indicator applied to the proportion of a job category in a company. Gender diversity or of the proportion of young people employed by the firm is assessed according to two definitions: either with regard to the average proportion of female workers within the business sector (relative diversity) or with regard to the average proportion in the workforce of the overall economy (absolute diversity, using a generalized Herfindahl-Hirschmann index, like for instance in Garnero *et al.* (2014) or Parrotta *et al.* (2014)). Thus, the diversity indicators correspond to distances from the situation of relative or absolute diversity.

Relative diversity

Female workers

To quantify the relationship between relative gender diversity and productivity for the economy as a whole (Table 2), we compute the distance to the average share of women (36.7%) for firms with more than 20 employees. Thus, considering the OLS estimator, for a firm below this norm, a one-point increase in the share of female workers is associated with a productivity increase of +0.24%. This association is +0.23% if the company belongs to the group of companies located above the overall industry norm. These results show a symmetry between the two situations.

To estimate a causal effect of relative gender diversity on productivity, we use the instrumental variable method, considering the proportion of women among part-time workers as instrument. The estimate results in a negative impact of the relative diversity, for both cases (-0.12% for firms below the norm; -0.25% for firms above the norm).

Young workers

For the distance-to-the-norm approach, the coefficients again show the expected signs at the level of aggregation of the overall economy (Table 2). A one-point increase in the share of workers under-30, to get closer to the norm for the economy as a whole, is associated, over the period 2009-2015, with an increase in productivity of +0.12%, if the firm belongs to the group of firms that has less than the average proportion of employees under-30 of the economy as a whole. This association is +0.39% for companies with a proportion of employees above the norm.

Six main industries

By taking the results of the OLS estimates for gender diversity (Appendix E), three out of the six industries show a positive association between gender diversity and productivity if we consider firms employing a high proportion of women: trade, hotels and restaurants (coefficient: -0.095); transports and communications (-0.064); and real estate, rental and business services (-0.649). On the other hand, only the real estate, rental and business services industry exhibits a positive association for firms employing a low proportion of women[12]. Otherwise, the IV estimates show a positive impact of gender diversity only for the real estate, rental and business services industry, considering firms employing a share above the industry norm.

[12] For an increase (respectively a decrease) in the proportion of women by one point, an increase in productivity of +1% (respectively +0.62%) is achieved if the company belongs to the group of companies located below (respectively above) the norm for the economy as a whole, over the period 2009-2015.

Table 2. Gender and age diversity in firm's workforce and labor productivity**.**

Indicator	Relative diversity (Lower proportion[a] / higher proportion[a])	Absolute diversity (*HHg*[b])
Estimator \ Population	Proportion of female workers: 36.7%.	
OLS	**0.244***/-0.283*****	-0.008
IV[c]	**-0.122***/0.247*****	0.113*[d]
Estimator \ Population	Number of firms: 56,620. Proportion of young workers: 21.28%.	
OLS	**0.118***/-0.385*****	**0.133*****
IV[c]	**0.473***/-0.576*****	-0,096[e]

Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
*Notes: [a]Proportion lower (respectively larger) than that of overall economy. [b]Generalized Herfindahl-Hirschmann indicator (reference: proportion of female (resp. young workers) in the labor force of the overall economy). [c]Considered instrument: proportion of female (resp. of young) workers in part-time workers. [d]The diversity indicator is not considered to be endogenous (at a 5% level). [e]The given instrumental variable is considered to be weak (at a 5% level). *** (respectively ** and *) stands for significance at 1% (respectively 5 or 10%) level. In bold: the given coefficient is statistically significantly different from zero at a 5% level.*

Considering age diversity in terms of employing people younger than 30, we can see that the positive association between relative diversity (above or below the business sector norm) and productivity highlighted at the level of the economy as a whole is linked to three industries: manufacturing, trade-hotels-restaurants, and education-health-social assistance. In the construction industry, if the firm has a proportion of young workers above the industry norm, then reducing the share of young workers by 1 percentage point is associated with a productivity increase of 0.43 percent (Appendix F). As we look at the effect of relative diversity, we find a positive impact, but whose magnitude exceeds that of the association. For a company with a proportion of young people lower (respectively higher) than the norm for the economy as a whole, an increase (respectively a decrease) in the proportion of young workers results in an increase in productivity of 0.47% (respectively 0.58%). These impacts are mainly situated in 2 out of 5 of the main industries, namely the trade-hotels and restaurants, and education-health-social assistance business sectors.

Absolute diversity

Female workers

In the economy as a whole, considering the generalized Herfindahl-Hirschmann indicator (Table 2) with OLS estimates, no productivity gain is obtained from a 1 percentage point increase in the proportion of women, where the initial proportion is below the that of the economy as a whole (47.7%). On the other hand, when considering the instrumental variable estimator, we get a positive impact of gender diversity on labor productivity (0.113). At a 10 percent significance level, a 1 percentage point increase in the proportion of female workers leads to a 0.05 percent increase in productivity. Consequently, an increase in productivity is obtained through the absolute diversity index, but our relative diversity index shows a productivity decrease.

An increase in our indicator towards diversity (*ie.* the proportion of women in the entire labor force: 47.70 percent) is correlated with greater productivity for firms from the construction and real estate, rental and business services industries (Appendix E). Moreover, still considering the HH indicator, our IV estimates show a positive impact of gender diversity on productivity in 3 out of 6 of the main industries: construction; transport and communications; and real estate, rental / business services industries. This is mostly the case in the first two industries (construction; transport and communications), where the initial proportions of female workers (9.54% and 18.42%) are far from

the economy absolute norm, and where increasing gender diversity induces the largest productivity gains.

Young workers

Turning to workers under 30, we show a positive association between the generalized HH indicator and companies' labor productivity (Table 2). Thus, in our sample of companies' with 20 or more employees, where the proportion of workers under 30 years of age is 21.2 percent and thus slightly higher than the proportion for all firms, regardless of the number of employees (20.6 percent), a productivity increase of 0.03 percent is correlated with a decrease of 0.5 percent in the proportion of young workers. Our result at the level of the whole economy as a whole is attributed to 4 main sectors out of 6: manufacturing, construction, trade-hotels-restaurants, and education-health-social assistance (Appendix F).

If we focus on a causal effect of moving towards absolute diversity, no significant impact is found. However, if we distinguish between business sectors, we find a positive effect of absolute diversity on productivity in 3 sectors out of 6: trade-hotels and restaurants, construction, and education-health-social work. The effect is strongest in the latter two industries, where the average proportion of young people is initially high.

5.3 Non-linear approach

Our apparently conflicting findings for female workers in the previous sub-section may also stem from the fact we assume a linear effect of diversity considering our relative diversity indexes. This is not the case with the HH indicator. But HH assumes decreasing productivity gains as we move towards the norm. However, we do not test for this non-linearity.

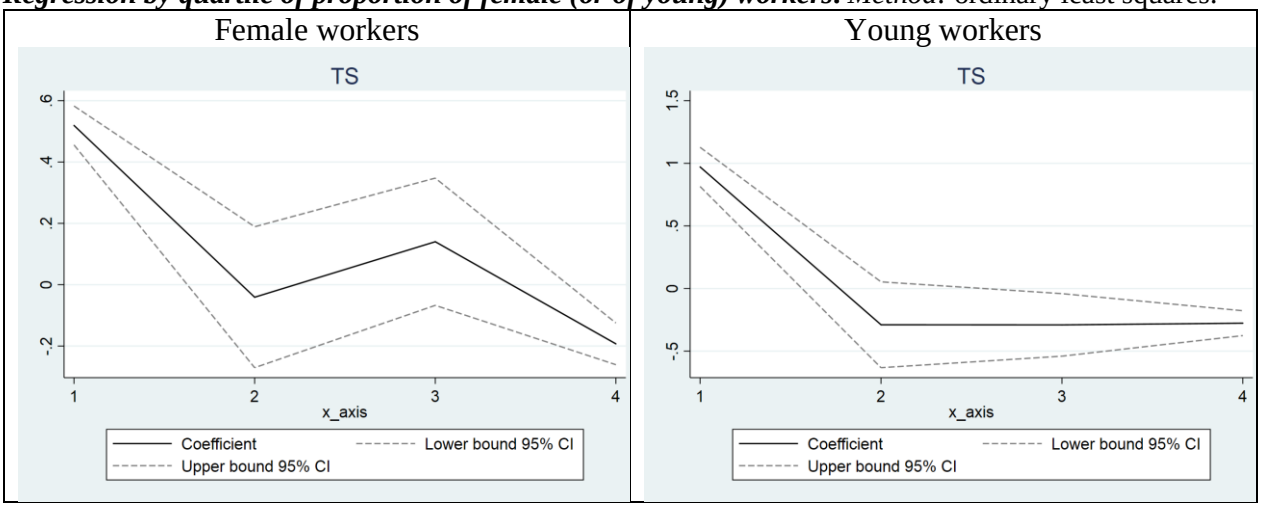
Another way of proceeding is thus to look at the extent to which gender or age diversity / atypism has non-linear effects, depending on the proportion of women initially employed in the company. In this perspective, we consider two types of regression. In a "classical" regression, for every quartile of the netted out proportion of female or young workers, we regress the logarithm of productivity on the netted out proportion of women and other explanatory variables. In a rank regression, we regress for each quartile the rank of productivity on the rank of the proportion of women and covariates. As in previous approaches, we perform ordinary least squares and then instrumental variables to assess the effect of gender diversity / atypism.

Associations

Overall economy

Considering the classical regression over the period 2009-2015 (Figure 3), the coefficient associated to the first quartile is positive and to the last one is negative. Thus, for the first quartile (leftmost part of the graph), an additional point in the share of women in the firm is correlated with a 0.55% increase in productivity. By contrast, for the last quartile, a productivity gain of 0.20% is correlated with a one-point decrease in the proportion of women. In the intermediate quartiles, there is no significantly different from zero.

Figure 3. Association between the proportion of female (or young) workers and labor productivity. ***Regression by quartile of proportion of female (or of young) workers*.** *Method:* ordinary least squares.

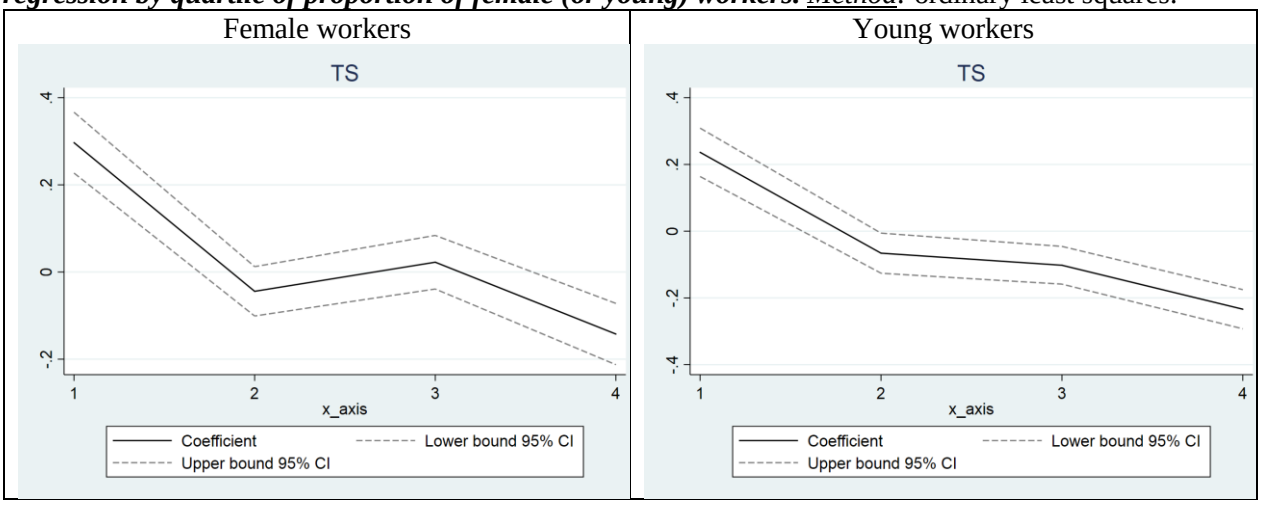


Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: straight line: coefficient estimate for the given quartile. Upper (respectively lower) dashed line: upper (respectively lower) bound of the confidence interval for the coefficient of the given quartile.

As we focus on young workers, and for firms employing the lowest proportion of young workers (first quartile), we find a positive association between productivity gains and an increase in the proportion of workers under 30 (Figure 3). Similarly, productivity gains are associated with a reduction in the share of young workers in firms employing a high proportion of workers younger than 30 (fourth quartile). Finally, when we consider age diversity (in terms of employing young people), for firms employing a proportion of young people close to the sectoral average, no productivity gains are correlated with a change in the proportion of young workers.

With respect to rank regressions, the same conclusions can be made (Figure 4). The association is positive on the first quartile but negative on the last quartile of the distribution of the share of women, for all samples. Gaining a position in the first quartile of the share of women is associated with an increase of nearly 0.30 position in the company's ranking in terms of productivity. On the other hand, in the last quartile, the association is negative: a decrease of one position in the firm's position in terms of women's share is correlated with an improvement of 0.15 in the company's ranking in terms of productivity. Finally, the productivity gain is zero in the middle of the distribution. The same kind of results hold for young workers, with an improvement of 0.25 (resp. 0.25) in the company's ranking in terms of productivity, while increasing (resp. decreasing) by one point in the distribution in the share of employed young workers, for firms located in the first (resp. the fourth) quartile.

Figure 4. Association between the proportion of female (or young) workers and labor productivity. ***Rank-regression by quartile of proportion of female (or young) workers.*** *Method:* ordinary least squares.



Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: straight line: coefficient estimate for the given rank quartile. Upper (respectively lower) dashed line: upper (respectively lower) bound of the confidence interval for the coefficient of the given rank quartile.

More generally, quartile rank regression coefficients are more accurately estimated than quartile value regressions. However, in all cases, the conclusions obtained for rank regressions are similar to those obtained using quartile value regressions. In particular, there are potential productivity gains for firms employing the lowest or highest proportions of women. For intermediate proportions of women, on the other hand, productivity remains unchanged if the proportion of women in the firm changes.

Overall:

- The distribution of the coefficients of the quartiles shows a strong non-linearity, with coefficients significantly different from 0 only for the first and last quartiles.
- The associations on the "extremes" are of opposite signs, reflecting a positive association between productivity and diversity. In a company characterized by a low (resp. high) proportion of women, an increase (resp. decrease) in this proportion is associated with productivity gains.
- The results of this approach are consistent with those obtained by the atypism or diversity approaches.
- Quartile rank regression coefficients are more accurately estimated than quartile regression coefficients.

Six main industries

Let us now look at what happens at the level of the six main business industries. Since the rank-regressions yield more accurate coefficients, and to facilitate the presentation, we display only the rank-regression estimates (Appendix G).

The association between the proportion of women and productivity appears positive in the 1st quartile in manufacturing, and in real estate, renting and business services industries. Thus, from the first quartile, an improvement of 1 position in the ranking of the business in terms of the proportion of employed women is correlated with an improvement of a 0.15 position (respectively 1.3 position point) in the ranking of the firm in terms of productivity in manufacturing (respectively

in real estate, rental/ business services). For these two business sectors, the association decreases as we consider a higher quartile. It becomes zero for the second, the third and the fourth quartiles. In manufacturing, it even becomes negative in the fourth quartile: a reduction of 2 position points in the company's ranking in terms of the proportion of female workers is correlated to an improvement of 1 position in the ranking of the same company in terms of productivity.
If we look at young workers, the results obtained for trade-hotels-restaurants and education-health-social assistance stand out most strongly. In these two industries, the association between the proportion of young workers and productivity is constantly decreasing. It is strong and positive in the first quartile (Appendix H) but shifts to zero from the second quartile onwards.[13]

Effects

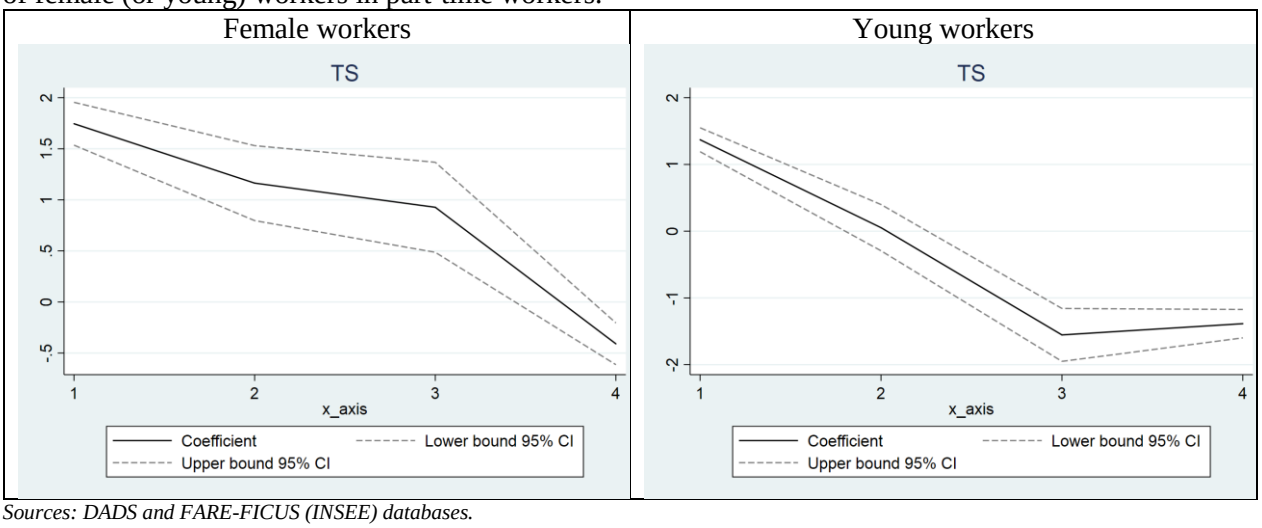
In order to measure the impact of atypism or gender diversity on productivity, the (residual) share of women in the company is instrumented. As an instrument, we still consider the proportion of female workers in part-time workers.

Overall economy

With regard to regressions of productivity by quartile of the distribution of the netted out share of female workers, for the economy as a whole (Figure 5), the results are consistent with those obtained for OLS. Thus, a positive effect is obtained on the first quartile and a negative effect on the fourth quartile. However, for the second and third quartiles, there are still significant and positive effects, even if they are smaller than that of the first quartile because the association between the rank of the share of female workers and that of productivity is still decreasing. In particular, starting from the first quartile, an improvement of 1 position in the ranking of the share of female workers implies an improvement of 1.7 points in the ranking of the productivity. Conversely, if we start from the last quartile of the distribution of the share of women, decreasing by 1 position the ranking of the company in terms of the proportion of female workers improves the ranking of the firm in terms of productivity by 0.4 position.[14]

[13] Considering quartile regression instead of rank-regression by quartile, associations are negative from the second quartile onwards. However, these associations are small.
[14] The results are similar when considering IV regression by quartile.

Figure 5. Effect of proportion of female (or young) workers on labor productivity. Rank-regression by quartile of proportion of female (or young) workers. *Method:* instrumental variables. *Instrument*: proportion of female (or young) workers in part-time workers.



Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: straight line: coefficient estimate for the given rank quartile. Upper (respectively lower) dashed line: upper (respectively (respectively lower) bound of the confidence interval for the coefficient of the given rank quartile.

We are now interested in the effect of diversity in terms of employing young people. If we focus on the rank regressions which provides more accurate estimates, increasing the proportion of young employees increases productivity for firms in the first quartile (Figure 5). Similarly, for firms in the fourth quartile, reducing the share of young employees increases labor productivity. These gains are decreasing and significant except for the intermediate quartiles (the second quartile here). In particular, Figure 5 shows that, for firms in the top quartile in the share of employees under 30, an improvement of 1 position increases the position of the relevant firm by 1.3 positions. On the contrary, for a firm in the bottom quartile, a decrease of 1 position increases the firm's productivity position by 1.3 positions.

Six main industries

Using the rank quartile regressions, we still have three main findings for the industries under consideration (Appendix I).

First, there is a positive impact of the rank of the share of employed women on the productivity of firms in the first quartile of the share of female workers, for 4 out of the 6 main industries: manufacturing, construction, trade-hotels-restaurants, and real estate-rental-business services. This impact is greater in construction and manufacturing, where the average proportion of female workers is lower (9.54 and 28.82 percent respectively) than in the industry as a whole (43.70 percent) or in real estate-rental-business services (48.50). Second, a decreasing productivity gains as we move towards gender diversity. This finding – less clear than when using OLS – can be made for the real estate-rental-business services, the wholesale-hotel-restaurant and the construction industries. Third, the decrease in the proportion of women in fourth quartile companies increases labor productivity only in the real estate-rental-business services industry.

We now distinguish the non-linear effects of age diversity in terms of the proportion of young workers employed by the firm according to the six main business sectors (Appendix J).

First, for firms employing the lowest proportion of workers younger than 30 (first quartile rank), we find a positive effect on productivity of an improvement in the firm's position for the proportion of young workers in the firms concerned, in the following sectors: trade-hotel-restaurant, real estate-rental-business services, and education-health-social work. Second, for firms employing the largest proportion of young people (fourth quartile rank), the same result is obtained when the firm's position in terms of employment of employees under 30 is reduced by 1 rank in the same three industries. Third, the productivity gains from improving the firm's position in terms of the proportion of young employees, by shifting it towards the diversity position, are decreasing.
For both female and young workers we observe higher magnitude for the parameters - related to the share of women or young workers - in the IV estimates than in OLS ones. This is manly related to the fact that the IV estimates measure LATE for the firms belonging to the most atypical or to the less diversified group, *i.e.* the ones with highest potential gains to move toward diversity.

5.3 Discussion

So far we find two important results for both female and young workers: a positive impact of diversity on labor productivity and results mostly located in industries not fully polarized in terms of gender or age. How could these results be related to the theoretical literature?
Concerning the positive relation between diversity and labor productivity the underlying mechanism could be found in Alesina and La Ferrara (2005): the male and female employees and the young and elder workers could be view as complementary production factors. For instance the abilities of young workers in new technology could be complementary to the highest knowledge and network of elder workers (Grund and Westergaard-Nielsen, 2008; Leonard and Levine, 2003).
The fact that the positive relation between diversity and labor productivity is found in industries where the distribution of gender or young worker is not polarized, could be explain by Akerlof and Kranton (2000), who explain that in polarized firms the minority group could face harassment or no support from the majority group. This case prevents to get a positive relationship between diversity and labor productivity. This is what we found for instance Construction industry where the share of women is close to 10%, or Transportation industry with 17% of young workers which are industries where we do not find any significant positive relationship between diversity and labor productivity.

6. Conclusion

This article explores the links between diversity of firm’s workforce, in terms of gender or young workers, and productivity. To proceed, we use tax and accounting databases of firms, with exhaustive coverage over the fourteen years from 2009 to 2015. We consider econometric approaches that make it possible to move away from the reverse causality of performance towards gender or young worker diversity. Several important results can be highlighted.
The study carried out on the proportion of female or young workers yields a set of converging results for all the different approaches used to measure diversity.
First, gender or young workers diversity are associated with higher labor productivity. This association could be interpreted in terms of causal effect from gender / young workers diversity on labor productivity, considering IV estimates with “the share of women / young workers among the part-time workers” as instrument. This result is obtained with the three approaches: non-linear, atypism and diversity.

Second, the replication of the nonlinear approach on six main industries reveals that these results are valid to a greater or lesser degree for the different business sectors. For women, we see that the effects obtained at the aggregate level are not confirmed for education, health and social assistance, which are those where the proportion of women is highest. On the other hand, they are confirmed in real estate-rental-business services, manufacturing, and trade-hotels-restaurants. Likewise, still considering the non-linear diversity approach, concerning the employment of young people under 30, we find the same effects for the economy as a whole for a targeted number of business sectors: manufacturing, trade-hotels-restaurants, and real estate-rental-business services, and even sometimes education-health-social assistance.

Although we have used different approaches to highlight regularities in the relations between the gender and young workers diversity of the workforce and the firm's labor productivity, several limitations of the work carried out are worth noting. We use administrative data sources that are exhaustive and cover all firms with more than 20 workers in France. The high number of firms (56 000) allows us to highlight accurate effects. However, the variables in our databases do not allow us to control for all of the determinants of labor productivity and in particular those related to gender and young workers diversity. In particular, these data do not provide information on the organization of work in a company; they do not provide information about the size and composition by gender and age at the work team level. It is clear that the age/gender distribution of work groups within the company can play a role in the relation between women and young workers diversity and labor productivity.

More generally, we are not in a position to interpret the individual, organizational or contextual causes of the relation we have been able to identify. Several mechanisms are proposed by the theoretical and applied literature on the links between women and young workers diversity and firm labor productivity, and our data do not enable us to identify the nature of the mechanisms at work. For example, experimental studies indicate that men are more individualistic and value competitive contexts more, which is a potential key to interpreting the links between the proportion of women in teams, their decisions, and their performance (Azmat and Petrongolo, 2014), although this cannot be confirmed here.

Despite these limitations, it seems to us that this study produces sufficiently robust findings to inspire public policy actions in favor of gender and young workers diversity. It indicates that actions in favor of professional equality and gender or young worker diversity in firms do not only respond to the ethical issues of compliance with the principle of equality. The performance of some companies can be greatly improved by actions that promote gender or young workers diversity. Moreover, we show that the most effective action in this area is probably not a general and uniform action for all companies, but an action targeted at a small number of companies in a small number of business sectors of activity that can be identified precisely.

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Appendix A: Distance to absolute diversity: the generalized Herfindahl-Hirschmann index.

The Herfindahl-Hirschmann index (*HH*) is built to characterize the distribution of *K* characteristics in a given population: when the population is polarized the index is equal to 0, and when the population is distributed with identical proportions (*1/K*), the index reaches its maximum value.

$$HH\left(s_1,\ldots,s_K\right)=1-\sum_{k=1}^{K}s_k^2$$

Where s_k refers to the share of worker. This indicator is well designed to describe degree of gender diversity. In this case the maximum value of the *HH* index is obtained for a share of woman equal to 50% (*1/K* with *K=2*), which is also the proportion of women approximately observed in the population. More generally, this indicator is meaningful when the overall population is split in *K* modalities of identical sizes.

Let's take the example of the share of young workers in company *i* ($s_{y,i}$). Let's consider the complement share $s_{ny,i}$ the share of workers who are not young people. *HH* index is then equal to:

$$HH\left(s_{y,i},s_{ny,i}\right)=1-s_{y,i}^2-s_{ny,i}^2$$

$$\Leftrightarrow HH\left(s_y\right)=1-s_{y,i}^2-\left(1-s_{y,i}\right)^2=1-s_{y,i}^2-1+2.s_{y,i}-s_{y,i}^2=2s_{y,i}-2s_{y,i}^2$$

The maximum value of this index is obtained for a share of young workers in the company of 50%, which is much higher than the share of young people in the workforce (20%).

We therefore prefer a new index, to be called generalized HH (*HHg*). The principle is to reduce the proportions obtained with the Herfindahl and Hirschmann indicator to values compatible with the proportions actually observed in the population.

If we take the previous example of young workers, we know that their share in the total labor force is: $\omega_y=20\%$.

If we note $s_{y,i}^r$ the ratio of the share of young workers in the company *i* to the share of the young workers in the workforce, we can also define the complementary share ratio $s_{ny,i}^r$.

Then we have: $s_{y,i}^r=\frac{s_{y,i}}{\omega_y}=\frac{s_{y,i}}{0.2}$, and $s_{ny,i}^r=\frac{s_{ny,i}}{\omega_{ny}}=\frac{s_{ny,i}}{0.8}$

And: $\sum_{j=\{y,ny\}}s_j^r=\sum_{j=\{y,ny\}}\frac{s_j}{\omega_j}=\frac{s_{y,i}}{0.2}+\frac{s_{ny,i}}{0.8}=\frac{s_{y,i}}{0.2}+\frac{1-s_{y,i}}{0.8}=\frac{0.8s_{y,i}+0.2-0.2s_{y,i}}{0.16}=\frac{0.6s_{y,i}+0.2}{0.16}$

We then deduce the normalized shares $\tilde{s}_{y,i}$:

$$\tilde{s}_{y,i}=\frac{s_{y,i}^r}{s_{y,i}^r+s_{ny,i}^r}=\frac{s_{y,i}}{0.2}.\frac{0.16}{0.6s_{y,i}+0.2}=\frac{0.8s_{y,i}}{0.6s_{y,i}+0.2}$$

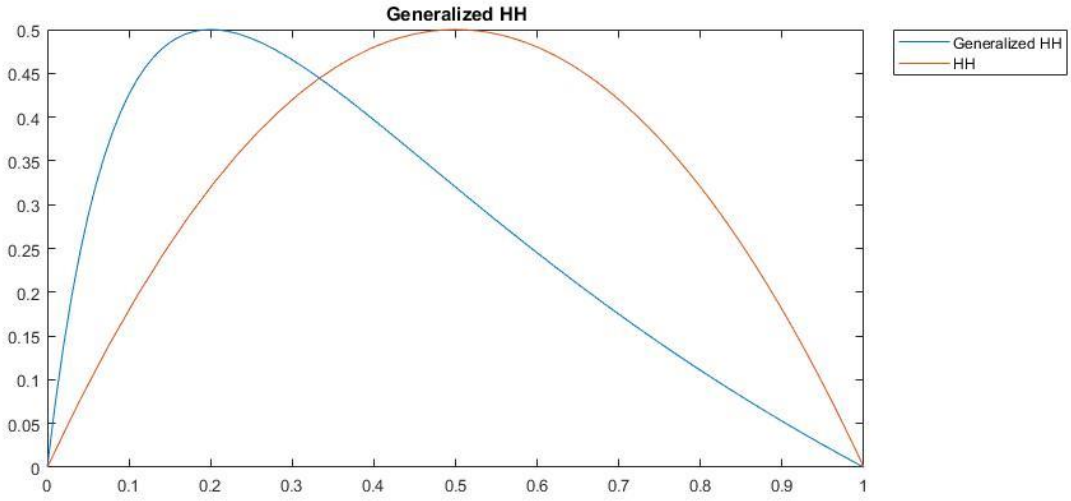
and $\tilde{s}_{ny,i}=\frac{s_{ny,i}^r}{s_{y,i}^r+s_{ny,i}^r}=\frac{1-s_{y,i}}{0.8}.\frac{0.16}{0.6s_{y,i}+0.2}=\frac{0.2\left(1-s_{y,i}\right)}{0.6s_{y,i}+0.2}$

where $\tilde{s}_{y,i}+\tilde{s}_{ny,i}=1.$

We thus find an equivalent formula of the traditional HH's index:

$$HH_g\left(\tilde{s}_{y,i},\tilde{s}_{ny,i}\right)=1-\tilde{s}_{y,i}^2-\tilde{s}_{ny,i}^2$$

$$HH_g\left(\tilde{s}_{y,i}\right)=1-\tilde{s}_{y,i}^2-\left(1-\tilde{s}_{y,i}\right)^2$$



The maximum value of the HH_g index is equal to the optimal share of young worker observed in the workforce. In this case the maximum diversity is equal to 20%.

Appendix B: Descriptive statistics at the company level.

Variable	**Mean**	**Standard deviation**
Labor productivity (€, thousands):	63,357	458,172
Total business workforce (number of workers):	130.3	1,010.3
Labor force composition (percent of business workforce):		
Proportion of female workers	36.67	26.64
Proportion of workers younger than 30	26.14	16.88
Proportion of female younger than 30	10.48	12.29
Proportion of workers older than 49	22.20	12.42
Proportion of female older than 49	7.58	8.17
Other features of firm workforce (percent of business workforce):		
Proportion of blue-collar workers	39.29	33.25
Proportion of employees	29.02	30.08
Proportion of intermediate workers	16.90	16.24
Proportion of executives	13.77	19.17
Proportion of full-time workers	83.50	19.73
Firm class size (percent of businesses):		
20<=workforce size<50	55.21	49.73
50<=workforce size <100	23.04	42.11
100<=workforce size <250	13.70	34.39
250<=workforce size <500	4.56	20.87
500<=workforce size <1000	2.01	14.04
1000<=workforce size <2000	0.87	9.29
2000<=workforce size <5000	0.43	6.54
Workforce size >=5000	0.17	4.13
Proportion of the business workforce, by region (percent of the company's workforce):		
11-Paris region	21.43	39.04
24-Centre-Val de Loire	3.96	18.45
27-Burgandy	4.49	19.84
28-Normandy	5.21	21.17
32-Hauts-de-France	8.39	26.61
44-Grand Est	8.37	26.72
52-Pays de la Loire	6.71	23.82
53-Brittany	5.02	20.99
75-Nouvelle-Aquitaine	8.54	26.80
76-Occitanie	7.38	24.88
84-Auvergne-Rhône-Alpes	13.60	32.83
93-Provence-Alpes-Côte d'Azur	6.42	23.23
94-Corsica	0.47	6.77

Appendix B (continued): Descriptive statistics at the company level.

Variable	Mean	Standard deviation
Business' age (years):	26.8	18.95
Other activity indicators of the business:		
Turnover (€, thousands)	35,815	294,125
Value added (€, thousands)	9,560	103,919
Capital intensity ratio (€ per head, thousands)	92,778	560,008
Proportion of wages in value added (percent)	78.664	5.54
Business sectors (percent of firm's workforce):		
A-AA-Agriculture, hunting, forestry	-	-
B-BA-Fishing and aquaculture	-	-
C-Extraction industries		
CA-Extraction of energy products	0.01	0.95
CB-Extraction of non-energy products	0.37	6.08
D-Manufacturing industries		
DA-Agriculture and food industries	3.71	18.91
DB- Textile and clothing industries	1.54	12.30
DC-Leather sector and footwear industries	0.26	5.07
DD-Manufacture of wood, and wood products	0.75	8.61
DE-Pulp, paper products; publishing and printing	2.57	15.83
DF-Coking, refined petroleum, and nuclear fuel	0.04	1.93
DG-Chemical and pharmaceutical industries	1.37	11.64
DH-Rubber and plastic industries	1.67	12.83
DI-Manufacturing of other non-metallic mineral products	0.92	9.51
DJ-Metallurgy and manufacture of metal products	4.80	21.37
DK-Manufacturing of machinery and equipment	3.48	18.33
DL-Manufacturing of electrical and electronic goods	1.62	12.64
DM-Transportation equipment manufacturing	1.08	10.36
DN-Other manufacturing industries	0.69	8.28
EA-Electricity, gas, and water supply	0.19	4.34
FA-Construction	11.97	32.47
GA-Wholesale and retail trade, repair of personal and household goods	22.58	41.81
HA-Hotels and restaurants	5.60	22.99
IA-Transportation and communications	8.07	27.23
JA-Financial industries	-	-
KA-Real estate, renting and business activities	17.19	37.73
LA-Public administrations	-	-
MA-Education	0.98	9.87
NA-Health and social work	5.36	22.52
OA-Community, social and personal services	3.17	17.51
PA-Activities of housholds	-	-
QA-Activities of non-governmental organizations	-	-

Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: [;]: 95% confidence interval.

Appendix C: Employing a low or a high proportion of female workers and labor productivity.

Six main industries

Indicator / Estimator	2.5% of companies with the lowest proportions of female workers [a]	2.5% of companies with the highest proportions of female workers [b]
Manufacturing	Number of firms: 13,460. Proportion of female workers: 28.82%.	
OLS	-0.017	**-0.191*** **
IV[c]	**0.397*** **	**0.436** **
Construction	Number of firms: 6,572. Proportion of female workers: 9.54%.	
OLS	**0.131*** **	**0.117*** **
IV	0.324[de]	-12.008[d]
Trade, hotels and restaurants	Number of firms: 15,285. Proportion of female workers: 43.70%.	
OLS	0.027	**-0.168*** **
IV	**0.749*** **	**0.789*** **
Transport and communications	Number of firms: 4,420. Proportion of female workers: 18.42%.	
OLS	0.182***	-0.004
IV	**0.715*** **	**1.034** **
Real estate, rental and business services	Number of firms: 9,272. Proportion of female workers: 48.50%.	
OLS	**-0.760*** **	-0.075
IV	**-0.614*** **	0.396*
Education, health and social assistance	Number of firms: 5,250. Proportion of female workers: 64.94%.	
OLS	0.100	**-0.336*** **
IV	**0.579*** **	-0.055

Sources: DADS and FARE-FICUS (INSEE) databases.

Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.

*Notes: [a,b]The firm employs a low (respectively a large) proportion of female workers. [c]Considered instrument: proportion of female workers in part-time workers. [d]The atypism indicator is not considered to be endogenous (at a 5% level). [e]The given instrumental variable is considered to be weak (at a 5% level). *** (respectively ** and *) stands for significance at 1% (respectively 5 or 10%) level. In bold: the given coefficient is statistically significantly different from zero at a 5% level.*

Appendix D. Employing a low or a high proportion of young workers. ***Six main industries.***

Indicator / Estimator	2.5% of companies with the lowest proportions of young workers [a]	2.5% of companies with the highest proportions of young workers [b]
Manufacturing	Number of firms: 13,460. Proportion of young workers: 18.51%.	
OLS	0.028	**-0.160*** **
IV	0.109	**-0.269*** **
Construction	Number of firms: 6,572. Proportion of young workers: 27.04%.	
OLS	**0.051** **	**-0.122*** **
IV	-0.323[f]	-0.255*[f]
Trade, hotels and restaurants	Number of firms: 15,285. Proportion of young workers: 36.10%.	
OLS	**-0.464*** **	**-0.143** **
IV	**-1.048*** **	**-1.910*** **
Transports and communications	Number of firms: 4,420. Proportion of young workers: 16.97%.	
OLS	**0.077***	**-0.105** **
IV	**0.528** **	0.022
Real estate, rental and business services	Number of firms: 9,272. Proportion of young workers: 25.00%.	
OLS	**0.510*** **	**-0.140*** **
IV	**1.336*** **	0.265*
Education, health and social assistance	Number of firms: 5,250. Proportion of young workers: 26.06%.	
OLS	**-0.687*** **	0.022
IV	**-0.971*** **	**0.238** **

Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
*Notes: [a,b] The firm employs a low (respectively a large) proportion of young workers. [c] Considered instrument: proportion of young workers in part-time workers. [d] The atypism indicator is not considered to be endogenous (at a 5% level). [e] The given instrumental variable is considered to be weak (at a 5% level). *** (respectively ** and *) stands for significance at 1% (respectively 5 or 10%) level. In bold: the given coefficient is statistically significantly different from zero at a 5% level.*

Appendix E. Gender diversity in firm's workforce and labor productivity. ***Six main industries.***

Indicator / Estimator	Relative diversity (Lower proportion[a] / higher proportion[a])	Absolute diversity (*HHg*[b])
Manufacturing	Number of firms: 13,460. Proportion of female workers: 28.82%.	
OLS	**-0.001*****/-0.369	**-0.091*****
IV[c]	**-0.563*****/0.406*****	-0.070[d]
Construction	Number of firms: 6,572. Proportion of female workers: 9.54%.	
OLS	**-0.920*****/0.356*****	**0.161*****
IV	**-1.738*****/3.069*****	**1.721*****
Trade, hotels and restaurants	Number of firms: 15,285. Proportion of female workers: 43.70%.	
OLS	**-0.139*****/-0.095*****	**-0.170*****
IV	**-1.418*****/1.181*****	**-0.971*****
Transports and communications	Number of firms: 4,420. Proportion of female workers: 18.42%.	
OLS	-0.440/**-0.064*****	**-0.189*****
IV	**-1.806*****/1.573*****	**1.086*****
Real estate, rental and business services	Number of firms: 9,272. Proportion of female workers: 48.50%.	
OLS	**1.006*****/-0.649*****	**0.600*****
IV	0.536/**-0.017*****	**0.324****
Education, health and social assistance	Number of firms: 5,250. Proportion of female workers: 64.94%.	
OLS	**-0.113*****/-0.331*	0.019
IV	**-0.588*****/0.660*****	13.951[e]

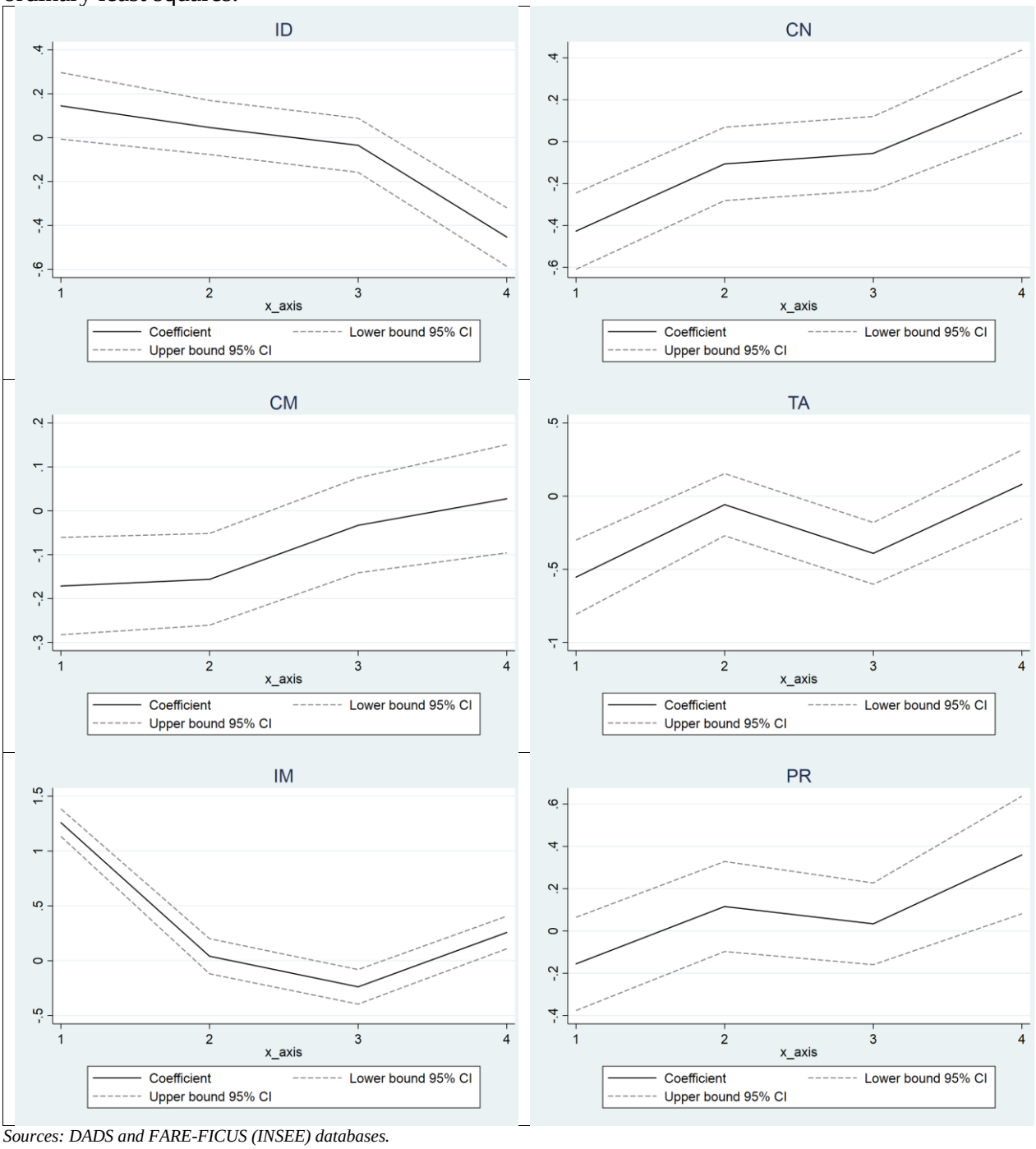
Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
*Notes: [a]Proportion lower (respectively larger) than that of overall economy. [b]Generalized Herfindahl-Hirschmann indicator (reference: proportion of female workers in the labor force of the overall economy). [c]Considered instrument: proportion of female workers in part-time workers. [d]The diversity indicator is not considered to be endogenous (at a 5% level). [e]The given instrumental variable is considered to be weak (at a 5% level). *** (respectively ** and *) stands for significance at 1% (respectively 5 or 10%) level. In bold: the given coefficient is statistically significantly different from zero at a 5% level.*

Appendix F. Age diversity in firm's workforce in terms of employed young workers and labor productivity. ***Six main industries.***

Indicator / Estimator	Relative diversity (Lower proportion[a] / higher proportion[a])	Absolute diversity (*HHg*[b])
Manufacturing	Number of firms: 13,460. Proportion of young workers: 18.51%.	
OLS	**0.155***/-0.372****	**0.066*****
IV	-0.172*/-0.293	0.033[f]
Construction	Number of firms: 6,572. Proportion of young workers: 27.04%.	
OLS	**-0.196***/-0.431*****	**0.214*****
IV	-0.129/-0.373	**1.170*****
Trade, hotels and restaurants	Number of firms: 15,285. Proportion of young workers: 36.10%.	
OLS	**0.323***/-0.441*****	**0,285*****
IV	**0.480***/-0.571*****	**0.351*****
Transports and communications	Number of firms: 4,420. Proportion of young workers: 16.97%.	
OLS	**-0.566***/-0.258*****	**-0.154*****
IV	-1.507/**0.309*****	**-0.943*****
Real estate, rental and business services	Number of firms: 9,272. Proportion of young workers: 25.00%.	
OLS	**-2.301***/0.241*****	**-0.531*****
IV	**-3.422***/1.137*****	**-0.706*****
Education, health and social assistance	Number of firms: 5,250. Proportion of young workers: 26.06%.	
OLS	**0.848***/-0.382*****	**0.494*****
IV	0.544*/**-0.381****	**0.957*****

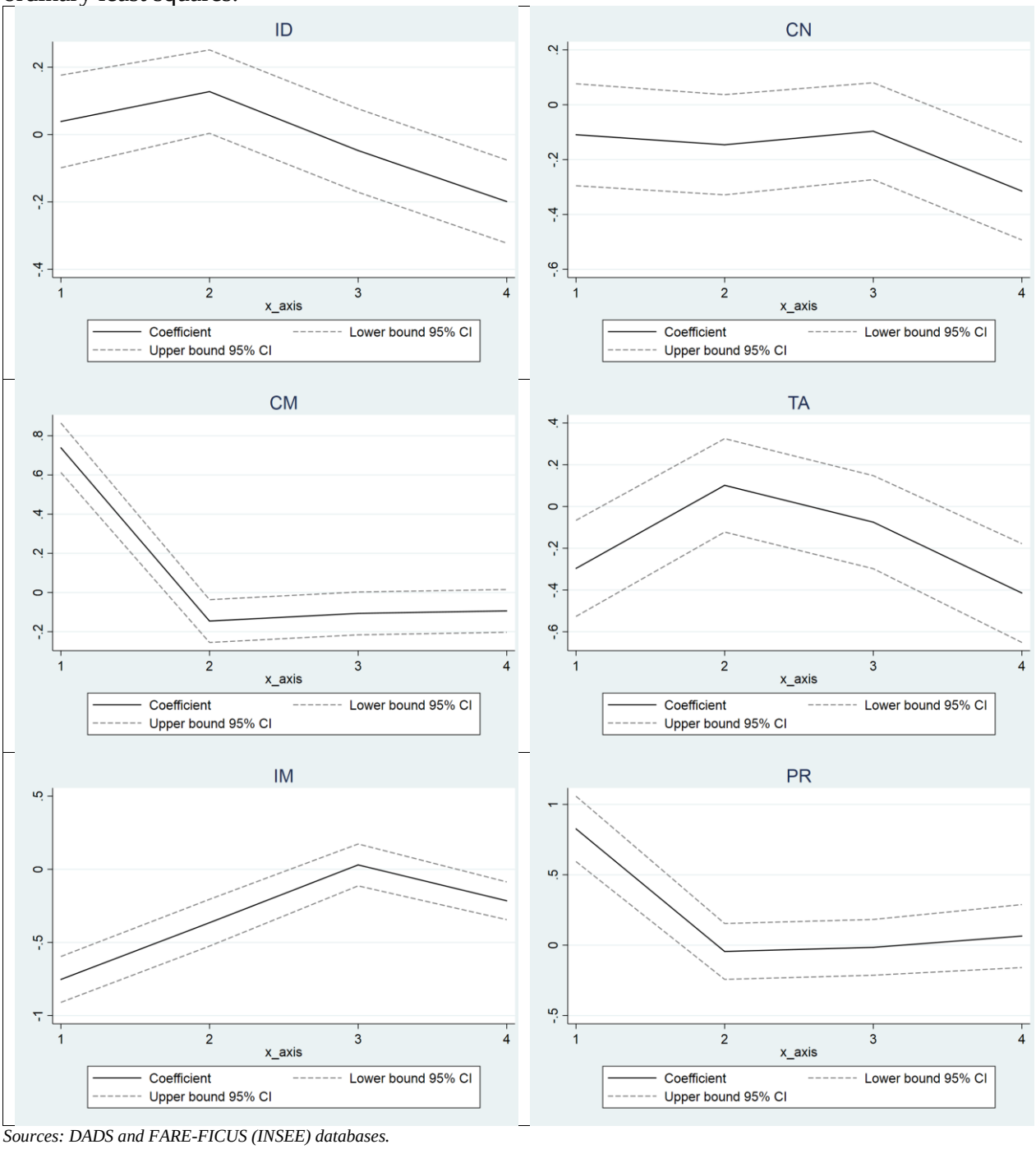
Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
*Notes: [a]Proportion lower (respectively larger) than that of overall economy. [b]Generalized Herfindahl-Hirschmann indicator (reference: proportion of young workers in the labor force of the overall economy). [c]Considered instrument: proportion of young workers in part-time workers. [d]The atypism indicator is not considered to be endogenous (at a 5% level). [e]The given instrumental variable is considered to be weak (at a 5% level). *** (respectively ** and *) stands for significance at 1% (respectively 5 or 10%) level. In bold: the given coefficient is statistically significantly different from zero at a 5% level.*

Appendix G. Association between the proportion of female workers and labor productivity. Rank-regression by quartile of proportion of female workers. ***Six main industries.*** *Method:* ordinary least squares.



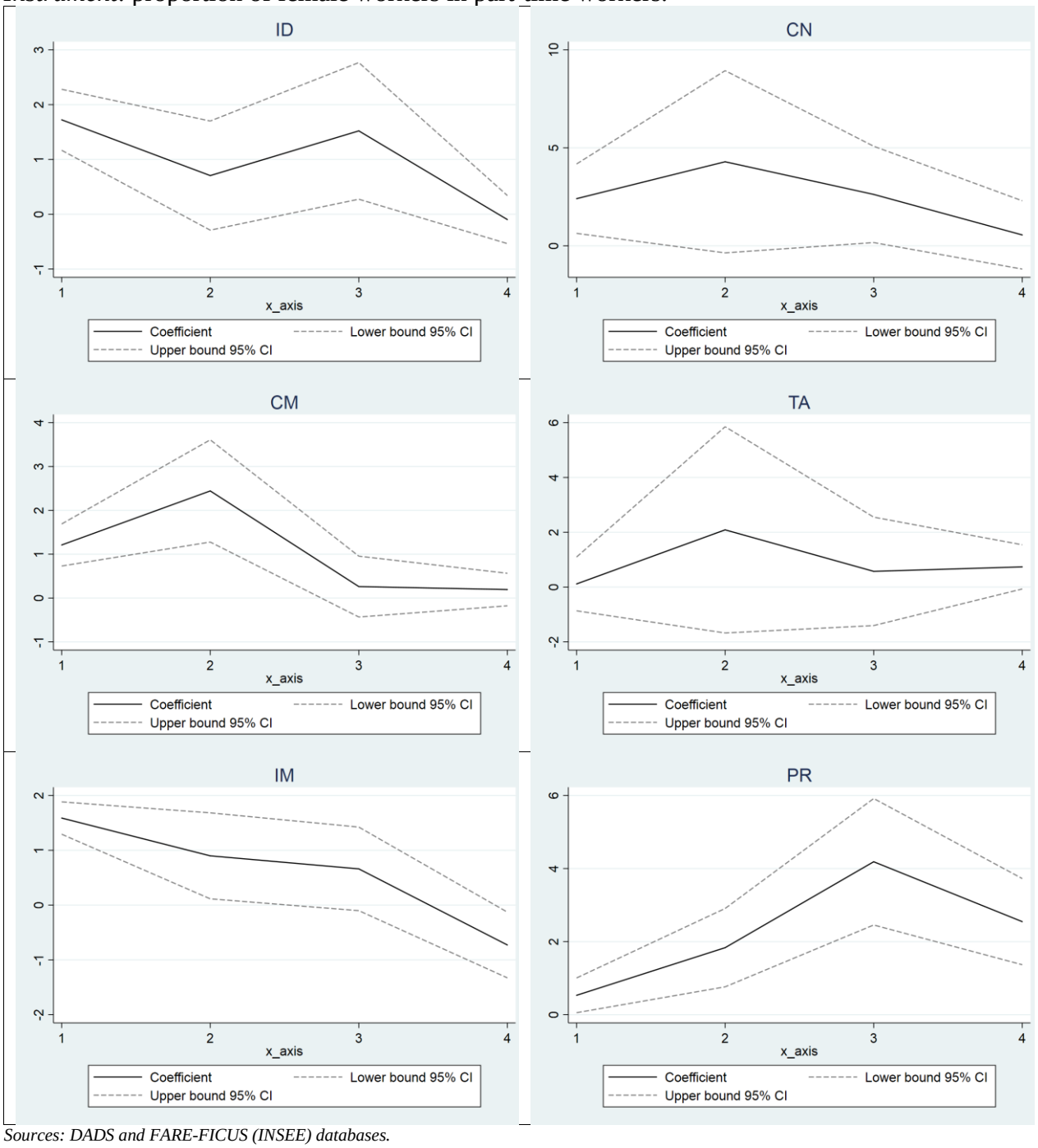
Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: straight line: coefficient estimate for the given rank quartile. Upper (respectively lower) dashed line: upper (respectively lower) bound of the confidence interval for the coefficient of the given rank quartile.

Appendix H. Association between the proportion of young workers and labor productivity. Rank-regression by quartile of proportion of young workers. ***Six main industries.*** *Method:* ordinary least squares.



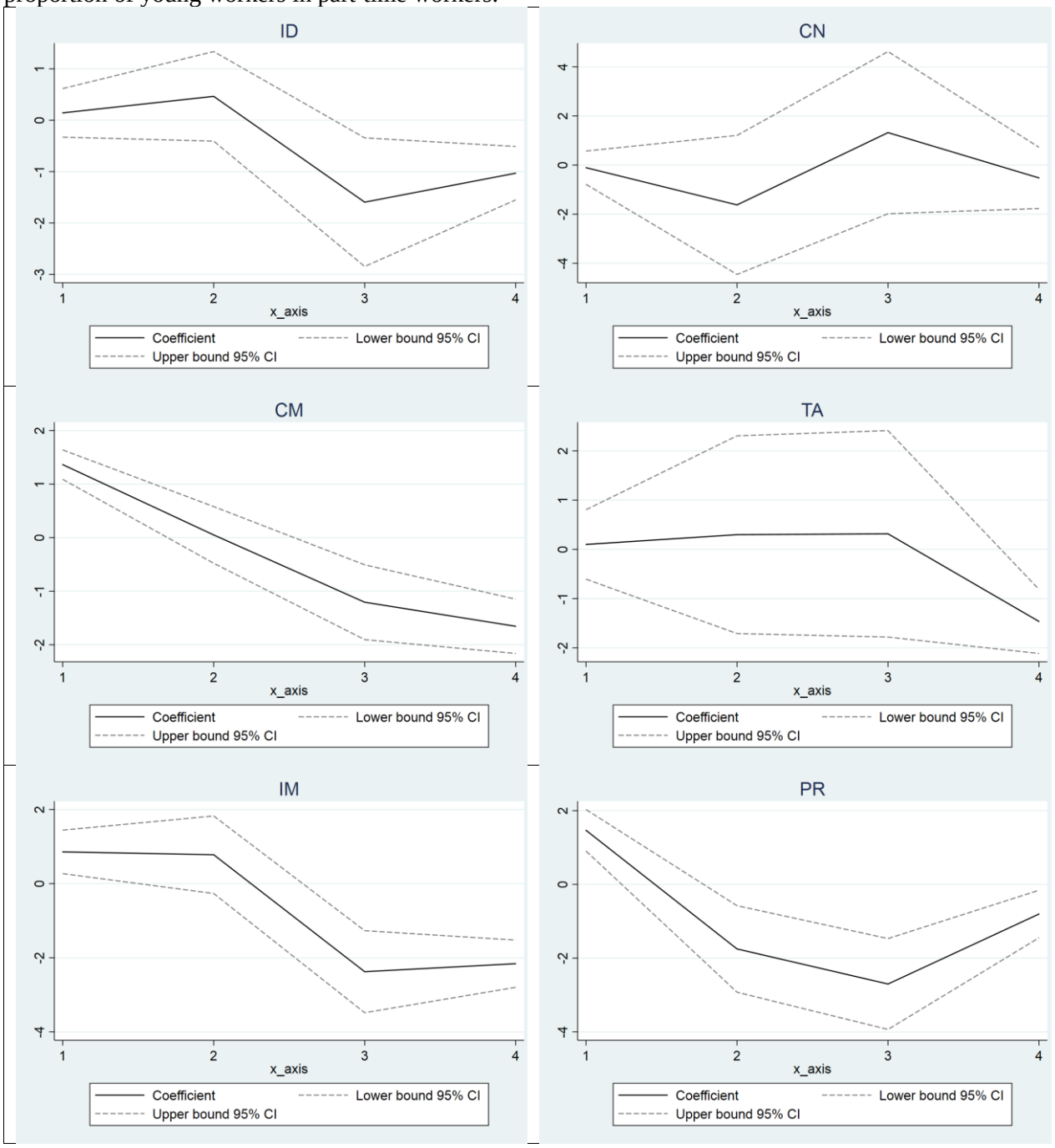
Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: straight line: coefficient estimate for the given rank quartile. Upper (respectively lower) dashed line: upper (respectively lower) bound of the confidence interval for the coefficient of the given rank quartile.

Appendix I. Effect of proportion of female workers on labor productivity. Rank-regression by quartile of proportion of female workers. ***Six main industries.*** *Method:* instrumental variables. *Instrument*: proportion of female workers in part-time workers.



Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
Notes: straight line: coefficient estimate for the given rank quartile. Upper (respectively lower) dashed line: upper (respectively lower) bound of the confidence interval for the coefficient of the given rank quartile.

Appendix J. Effect of proportion of young workers on labor productivity. Rank-regression by quartile of proportion of young workers. ***Six main industries.*** *Method:* instrumental variables. *Instrument*: proportion of young workers in part-time workers.



Sources: DADS and FARE-FICUS (INSEE) databases.
Scope: sample of 56,620 perennial companies with 20 employees and more from the non-agricultural and non-financial private business sectors (excluding extra-territorial activities) over the period 2009-2015.
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