amse
aix marseille
school of economics

Working Papers / Documents de travail

Do Large Departments Make Academics More Productive? Agglomeration and Peer Effects in Research

Clément Bosquet
Pierre-Philippe Combes

WP 2013 - Nr 26

Do large departments make academics more productive? Agglomeration and peer effects in research

Clément Bosquet[*†]
London School of Economics and Political Science (SERC) and
Aix-Marseille School of Economics

Pierre-Philippe Combes[*‡]
Aix-Marseille School of Economics

10 April 2013

Abstract: We study the effect of a large set of department characteristics on individual publication records. We control for many individual time-varying characteristics, individual fixed-effects and reverse causality. Department characteristics have an explanatory power that can be as high as that of individual characteristics. The departments that generate most externalities are those where academics are homogeneous in terms of publication performance and have diverse research fields, and, to a lesser extent, large departments, with more women, older academics, star academics and foreign co-authors. Department specialisation in a field also favours publication in that field. More students per academic does not penalise publication. At the individual level, women and older academics publish less, while the average publication quality increases with average number of authors per paper, individual field diversity, number of published papers and foreign co-authors.

Key words: research productivity determinants, economic geography, networks, economics of science, selection and endogeneity
JEL classification: R23, J24, I23

[*]We are very grateful to Philippe Donnay and Charles Laitong for excellent research assistance. We also thank Yann Bramoullé, Gilles Duranton, Laurent Gobillon, Jean-Marc Robin, Maurizio Iacopetta, Frédéric Robert-Nicoud, Elisabet Viladecans-Marsal, Cecilia García-Peñalosa, Alain Trannoy and participants in the First Workshop on Urban Economics (Barcelona University), the 25th EEA Annual Congress (Glasgow), the 59th AFSE Annual Congress (Paris), the 57th NARSC Annual Meetings (Denver), the 11th RIEF Doctoral Meeting (Nice) and the 10th Journées LAGV (Marseille) for useful suggestions. This study was made possible and financed by the French Ministry of Research and Higher Education. Pierre-Philippe Combes is a researcher at the CNRS, whose financial support is gratefully acknowledged.

[†]London School of Economics and Political Science (SERC), Houghton Street, London WC2A 2AE, United Kingdom, and Aix-Marseille University (Aix-Marseille School of Economics). (`c.bosquet@lse.ac.uk`; `http://sites.google.com/site/clementbosquet/`).

[‡]Aix-Marseille University (Aix-Marseille School of Economics), CNRS & EHESS, 2 Rue de la Charité, 13236 Marseille cedex 02, France (`ppcombes@univmed.fr`; `http://www.vcharite.univ-mrs.fr/pp/combes/`). Also affiliated with the Centre for Economic Policy Research.

1. Introduction

Every academic has an opinion about what makes a good department. Surprisingly enough, there are few hard studies quantifying this precisely, although possible implications for an optimal design of education and research policies are numerous. We focus here on the effect on individual publication records of both individual characteristics and a large set of department characteristics. We develop a careful strategy that controls for possible spatial selection of academics, reverse causality and missing variables. Clearly, both our identification strategy and the results we get for academic research are relevant more generally, for instance for all knowledge-intensive industries where individual abilities play a crucial role (as in R&D departments of many manufacturing industries, or in finance, law and health services).

We propose to answer three sets of questions. First, and at the most general level, what makes an individual productive, his own abilities or the firm in which he works? Applied to science, this translates into whether academics publish more because they have better abilities (gender, age, type of position or any other individual characteristics possibly unobserved) and a more rewarding publication strategy (research field, number and location of co-authors) or because they are located in departments that provide a better local environment with stronger externalities? Using an exhaustive panel of French economics departments and academics over 19 years (1990-2008) and their quality-adjusted publication records in EconLit, we find that both types of explanations are relevant. In particular, location is an important determinant of the individual quantity and quality of publications and represents at least half of the explanatory power of individual characteristics. The individual strategy of publishing in different fields of economics, with foreign co-authors, and with a high number of co-authors per paper is the most rewarding in terms of publication quality. This last result suggests the presence of increasing returns to scale at the co-author team level. The average quality of an academic's publications also increases with his number of publications, suggesting the presence of increasing returns to scale also at the individual level. Everything else equal (including the field of specialisation, all the aforementioned variables, and a department-time fixed effect), women and older academics (for a given type of position) publish less.

We then move to the dual question of the extent to which, again at the most general level, more productive firms simply attract more productive employees or generate more productive environments. That is, for academia, whether good departments (defined as those where the average quantity and quality of publications per academic is high) are those where highly-productive academics locate or those that generate more externalities? Even if we exhibit the presence of some spatial sorting of academics, the most productive academics being located in the departments that generate more externalities, we find that local externalities and the composition of departments matter equally when explaining the ranking of departments based on publications.

Finally, and most importantly for the optimal design of firms or institutions, what are the channels of local external effects? We enter the black box of department externalities and assess the relative magnitude of the channels through which they operate. Having fairly homogeneous academics in terms of publication records and a pretty diversified set of research fields (within economics) are the two characteristics that best explain department externalities. The presence of stars (researchers in the top 1% of academics in France) and department size, in terms of number of academics, constitute the second set of factors explaining department externalities, along with, although to a lower extent, the importance of co-authorship with US academics and with non-US foreign academics. Conversely, the geographical proximity to other French departments, weighted by their size, has little impact. All these effects are present as regards both the quantity and quality of publications. Importantly, they are stronger for the latter. We also observe significant positive externalities from the share of women or of older academics in the department, although these are not large determinants of the disparities between departments. We do not find any large reverse causality bias when estimations are instrumented (and are performed, due to instrument availability, at a slightly more aggregated geographical scale: the city). When the specification is extended to encompass the effect of teaching load, which requires us to reduce the time span due to data availability, we obtain, possibly contrary to some beliefs, that more students per academic in the department does not affect the quantity or quality of publications.

The paper first relates to the new surge of interest over the last ten years in the estimation of agglomeration economies (for reviews see Rosenthal and Strange, 2004, Melo, Graham, and Noland, 2009, Moretti, 2011). Assessing how much is gained by further spatial concentration of economic activities, by increasing regional specialisation or concentrating certain types of occupations, is indeed a crucial preliminary step to evaluate regional policies. A parallel can be made with universities or governments providing incentives to make academic departments larger or more specialised, for instance. Another recent strand of literature examines the effect of peer and network effects on various school or labour market outcomes (for reviews see Jackson, 2011, Sacerdote, 2011). Here, the focus is on the effect of the composition (by gender, ethnic or social origin) of a group or network on the individual outcomes of its members. Clearly, similar questions for departments arise as regards their optimal ratio of assistant professors to full professors for instance, of women, of elder academics, or of certain academics who are particularly talented or connected to co-authors in other institutions. For both agglomeration and peer effects, the access to new data sets, typically encompassing information at the individual level (firms, workers, students/pupils or academics as here) and the search for relevant econometric strategies has greatly widened identification possibilities and clarified the direction of causalities, a trend we also follow here.

A couple of recent papers to which we compare our results consider a sub-set of the effects identified here. Waldinger (2012) concludes there were no localised peer effects in Germany among physicists, mathematicians and chemists under the Nazi regime. Kim, Morse, and Zingales (2009) reach a similar conclusion, that being affiliated to one of the top 25 US universities no longer had an effect on the individual outcomes of academics in economics and finance in the 1990s, unlike the 1970s and 1980s. This is confirmed in mathematics by Dubois, Rochet, and Schlenker (2011), who show that the best departments do not necessarily stimulate positive externalities even if they are the most successful in hiring the most promising academics. Oyer (2006) shows that a top placement for new PhD economists has long-term benefits in terms of career but no benefit in terms of enhanced productivity, also supporting the view that top departments had no productivity spillovers (in the 1990s). Therefore, our conclusion that departments explain a large share of academics' individual productivity is somewhat discordant. It may be explained either by the different context under study, which would mean that European institutions currently generate more local externalities than modern-day US universities or German universities under the Nazi regime, or by the fact that our data set allows us to consider more local effects and to develop a more complete econometric analysis.

We decompose individual productivity into three components: the probability to publish in a given period and field, the number of publications and the average quality of these publications. We study the determinants of these three dimensions separately. The literature usually considers only a number of publications adjusted for quality as dependent variable. We show that the effect of some variables does differ from one productivity dimension to another, which means that the optimal strategy for an individual or a department depends on which dimension is being targeted. Some departments may be constrained in terms of the characteristics they can directly influence. Thus, some may prefer to increase the proportion of published authors in the department, while others may on the contrary consider specialising more tasks, *i.e.*, allocating some people fully to teaching and administration and improving the quantity and quality of papers published by the others. Also, given their characteristics in terms of size and specialisation, some departments might find it more efficient to target the quantity of publications rather than their quality, or vice versa. All of this underlines the importance of characterising the most efficient local structure to improve departments' research productivity on each dimension separately. Moreover, we also perform our estimations on two different indexes, more or less selective, of publication quality. Typically, the (individual and department) determinants of publications in top journals might differ from those in field journals. Our use of all EconLit publications and a corresponding impact factor index for all the 1200 EconLit journals enables us to study such differences, whereas the literature usually restricts itself to a small number of journals (23 journals in Waldinger (2012), 41 in Kim *et al.* (2009), 68 in Dubois *et al.* (2011).

We take seriously the concern of a possible spatial sorting of talents that might influence the measurement of department effects. Such possible selection effects are mentioned in most papers on peer effects (Sacerdote, 2011) and are also central in recent assessments of agglomeration economies in market activities, as emphasised by Combes, Duranton, and Gobillon (2008*a*). We use individual data to tackle them properly. We run estimations on individual productivity considering both individual and department variables, and both department and individual fixed effects. We cannot use a natural experiment to remove endogenous selection to departments as Waldinger (2012) (who uses the dismissal of scientists in Nazi Germany) or Azoulay, Graff Zivin, and Wang (2010) (who uses the premature death of superstars academics) do to identify peer effects.[1] However, we do provide estimates of agglomeration economies net of the possible academic spatial sorting, whether based on observed or unobserved individual and department characteristics, which corresponds to a pretty general model. Moreover, and contrary to recent papers on peer effects in academia, we also propose some instrumental variable estimations that take into account possible reverse causality issues for some department characteristics. Not using a natural experiment also presents the advantage of providing more general results, and thus greater external validity. For instance, the co-authors of superstars, or the scientists dismissed by the Nazis, may not share the same characteristics as average current academics. Our data set is not only exhaustive on all academics present in France but it also presents the second important advantage of reporting non-publishing academics. Studies that only use bibliometric sources necessarily ignore this group. This means that the department characteristics of these studies, computed on publishers only, are affected by measurement error. For instance, department size is not the number of academics but the number of academics in the department who publish over the period studied (which is usually a short one). Last, we also have more individual characteristics, such as age, gender and position held, which can affect publication output and are usually absent from the data sets used in other studies. All of this can affect the results obtained and explain our new findings. We acknowledge that they remain estimated on

[1] This is also the strategy of Borjas and Doran (2012) who show that the inflow of Soviet mathematicians to the US after 1992 mainly substituted for local mathematicians, whose publications fell sharply while overall publications slightly increased. However, the effects of location within the US and of department characteristics are not simultaneously assessed.

French economists only.

The rest of the paper is organised as follows. Section 2 presents the theoretical framework, the studied variables and the econometric strategy, while data is detailed in Section 3. Results are presented in Sections 4, 5, and 6 for the determinants of individual publications, the variance analysis of departments' performances, and the determinants of departments' performances respectively. Section 7 presents some robustness checks and Section 8 concludes.

2. Theory and estimation

Publication output, individual and local effects

Let y_{ift} denote the publication output adjusted for quality (presented in Section 3) of academic i in field f at date t. The total output of academic i at date t is the sum of y_{ift} over all his fields, $y_{it} = \sum_f y_{ift}$. Since some academics share their time between many departments, let α_{idt} denote the share of academic i's output attributed to department d at date t.[2] Department d's output in field f at date t is given by $Y_{dft} = \sum_{i \in dt} \alpha_{idt}\, y_{ift}$ and its total output by $Y_{dt} = \sum_f Y_{dft} = \sum_{i \in dt} \alpha_{idt}\, y_{it}$.

We assume that y_{ift} is given by:

$$y_{ift} = e_{it}\, A_{d(i,t)ft} \;,$$

where e_{it} is the academic own efficiency at date t and $A_{d(i,t)ft}$ the efficiency in field f of department $d(i,t)$ to which academic i belongs at date t. For academics belonging to more than one department, one such specification is assumed for each department, A_{dft} being specific to each of them in this case, and the observation is weighted by α_{idt} in the estimation.

The observable part of department d's efficiency in field f at date t, A_{dft}, is then assumed to depend on two components, as follows:

$$A_{dft} = \text{Composition}_{dt}\ \text{Department Research Strategy}_{dft} \;.$$

Composition_{dt} corresponds to a vector of effects from the demographic structure of the department. This includes the logarithm of the department size ($\text{Size}_{dt} = \log\left(\sum_{i \in dt} \alpha_{idt}\right)$ the department full-time equivalent number of academics), the average age of academics, the proportion of women, and the proportions of the different types of positions in the department.

Department size plays the role of the total employment density variable considered in standard estimations of agglomeration economies. It reflects possible local externalities from the overall size of the local economy. The list of possible positive effects from department size is long. To give but a few examples, academics in larger departments may benefit from more numerous administrative or research assistance staff, from greater bargaining power within the university or at the national level, allowing them to get more research funds, or from a better overall visibility that makes network effects stronger, although some of these effects are captured by some of the $\text{Department Research Strategy}_{dft}$ variables. And we cannot exclude the possibility of congestion effects causing a negative impact of size.

For a given size, departments may have younger or older academics, more or less women, or a higher ratio of full professors to assistant professors, for instance. As suggested by Hellerstein, Neumark, and Troske (1999), these composition effects must be introduced into the specification in the form of their proportions in the total number of academics in the department. This allows us to assess whether local

[2] 90% of our academics have only one affiliation, in which case these shares α_{idt} are equal to 1.

externalities are stronger from different types of academics. For instance, older academics may provide the others with the benefit of their experience, women may generate more externalities than men, and similarly for the various types of positions. A literature in industrial organisation (see for instance Besley and Ghatak, 2008, Auriol, Friebel, and Lammers, 2012) studies the role of status incentives with implications for the optimal share of the different positions within the firms, which is another interpretation of such variables. The French academic system is rather complex in terms of possible academic status. On top of the distinction between lower and upper positions (assistant professor versus full professor), some academics have research obligations while others do not, and some are attached to the local university while others depend on national research institutes (CNRS, INRA, EHESS, etc.). Each type can generate more or less externalities since time devoted to research and incentives to cooperate locally both differ. This leads us to consider 13 different positions in the specification, which are detailed in Appendix D. Moreover, most academics in our data set are categorised as pure economists, but some of them are also attached to other domains (business, mathematics, etc.), information we also possess. Hence, we also introduce into the specification the department share of 'non-pure' economists, and we do this separately for university and CNRS academics, since the definition of an economist is not exactly the same for each.

The variables considered in the Research Strategy$_{dft}$ vector also allow us to identify different sources of department externalities. First, we evaluate through a specialisation variable - the share of department d's output in field f at date t - the effect of what economic geography calls 'localisation economies':

$$\text{Specialisation}_{dft} = \log \frac{Y_{dft}}{Y_{dt}} \,.$$

Marshall (1890) first developed the idea that the relative size of an industry within the local economy can generate stronger local externalities for this industry, for instance when it uses specific local public goods, specific inputs or labour types. The same intuition can be developed for a field in academic research, for instance because not all fields within economics are internationalised to the same extent, or because they do not need the same research mix in terms of research assistance, computer capacities, or access to data. Benefiting from a measure of publication at the field level allows us to test whether academics in departments that are specialised in a particular field publish more in that field.

Conversely, it has been argued since Jacobs (1968) that the overall diversity of the local activity can be beneficial to local productivity, especially in research-intensive sectors. According to this viewpoint, diversity encourages the cross-fertilisation of ideas between industries, thus strengthening innovation and growth. A large literature has attempted to test this idea by introducing a diversity index into the estimated specifications, typically a Herfindahl index on the share of each industry in the local economy. We proceed similarly here with the share of each JEL code in the department publications. A problem arises because, by construction, such a crude diversity index is highly correlated with department size. This is because departments with few academics have many JEL codes without any publications. To remove this size effect, which is absent from standard economic geography studies because there are few locations without any activity in an industry, we subtract from the gross diversity index the value it would take if all academics in the department chose their JEL codes randomly. The diversity index net of size effect is written:

$$\text{Department Diversity}_{dt} = \log \left[\sum_f \left(\frac{Y_{dft}}{Y_{dt}} \right)^2 \right]^{-1} - \log \left[\sum_f \left(\frac{\tilde{Y}_{dft}}{\tilde{Y}_{dt}} \right)^2 \right]^{-1} ,$$

where $\sum_f \left(\frac{\tilde{Y_{dft}}}{\tilde{Y_{dt}}}\right)^2$ is the randomly-generated Herfindahl index built by simulations.[3]

The third research strategy effect concerns the physical proximity to other departments with which academics could interact or on the contrary compete. We capture this type of effect by an external research access variable, Research Access$_{dt}$. This tells us whether externalities also emerge between different but nearby departments, as economic geography has highlighted over the last decade for market activities. Research Access$_{dt}$ is the spatially-discounted sum of research outputs of all other departments:

$$\text{Research Access}_{dt} = \log \sum_{d' \neq d} \frac{Y_{d't}}{Dist_{dd'}} ,$$

where $Dist_{dd'}$ is the geographical distance between departments d and d'.[4]

Departments also differ in terms of the co-authorship patterns of their academics. Having academics connected to foreign academic institutions can generate positive externalities through network effects for instance, which has been emphasised recently both in market activities and for research (see Ductor, Fafchamps, Goyal, and van der Leij (2011) for a recent example in economics). We compute the share of department academics connected to (at least one) co-author who is located outside France but not in the USA (Non-USA openness$_{dt}$) and the same share for department academics connected to co-authors located in the USA (USA openness$_{dt}$).

There are debates in departments about whether or not hiring top academics is a good strategy for other academics. We test more generally the possible effect that department heterogeneity in terms of academics' publication records has on individual publication records. We complement this effect with a specific assessment of the role of stars, in the spirit of Azoulay *et al.* (2010). Department heterogeneity is measured by the within- department coefficient of variation of individual output:

$$\text{Heterogeneity}_{dt} = \log \frac{\text{Standard Deviation}(y_{it})}{\text{Average}(y_{it})} ,$$

where Standard Deviation(y_{it}) and Average(y_{it}) are the standard deviation and the average of individual publication outputs within department d at date t. We also introduce into the specification the proportion of academics in the department who are in the top centile of the most productive academics in France, Stars$_{dt}$.

We now turn to the description of individual variables. The observable part of the individual efficiency of academic i at date t, e_{it}, is also assumed to depend on two components, as follows:

$$e_{it} = \text{Individual Characteristics}_{it} \ \text{Individual Research Strategy}_{it} .$$

Importantly, the data set we use allows us to identify simultaneously the impact of individual characteristics – and therefore to control for the possible non-random selection of academics across departments – and the externality impact of these very characteristics. For instance, older academics might publish less individually while exerting a positive externality on the other academics of the department. Therefore Individual Characteristics$_{it}$ is the vector, at the individual level, of all the variables for which

[3]We first attribute random JEL codes to each publication assuming that the probability to publish in each JEL code follows a binomial law with a probability of success given by the share of output in each JEL code at the national level. Then, the department diversity index is recomputed using these new JEL codes. The randomly-generated Herfindahl index for the department is the average of 1,000 such procedures.

[4]Alternative specifications of the research access variable, with squared distance or square root of distance in the denominator have been tested and lead to qualitatively similar results as discussed in Section 6.

a possible externality at the department level is tested. This includes academic i's age and its square, gender, position held and dummy variables for being connected to (at least one) co-author abroad but not in the USA (Non-USA openness$_{it}$), in the USA (USA openness$_{it}$) and for being a star (here, being ranked among the top 1% of academics in France).

We also include a vector of variables that can be considered to reflect individual research strategy. To test for the presence of economies of scale within co-author teams, we introduce the average number of authors per article written by academic i at date t, Authors Number$_{it}$. This variable is central in many studies on the determinants of publication records that ignore the role of location but evaluate the returns to co-authorship following Sauer (1988). We also consider academic i's field diversity, Individual Diversity$_{it}$, to assess whether academics benefit from knowledge acquired in other fields to publish in field f. This tests the presence of complementarities between fields at the individual level:

$$\text{Individual Diversity}_{it} = \log \left[\sum_f \mathbb{1}(y_{ift} > 0) \right] ,$$

where $\mathbb{1}(y_{ift})$ is a dummy variable equal to 1 when academic i's production in field f is non-zero at date t.

Econometric specifications

To separate agglomeration and peer effects from individual characteristics, we follow the econometric strategy proposed by Combes *et al.* (2008*a*). This is a two-step procedure in which, in the first step, the logarithm of individual productivity in a given field (y_{ift}) is regressed on individual effects (and possibly an individual fixed effect), a department-time fixed effect (β_{dt}) and the department research strategy variables that depend on the field, which reduces here to Specialisation$_{dft}$:

$$\begin{aligned} \log y_{ift} \; = \; & \theta_i \, + \, \text{Individual Characteristics}_{it}\varphi \, + \, \text{Individual Research Strategy}_{it}\phi \, + \\ & \beta_{d(i,t)t} \, + \, \text{Specialisation}_{d(i,t)ft}\eta \, + \, \mu_{ft} \, + \, \varepsilon_{ift} \, , \end{aligned} \tag{1}$$

where θ_i and μ_{ft} are individual and field-time fixed effects, respectively, and ε_{ift} is the individual random productivity component assumed to be independent and identically distributed (i.i.d.) across individuals and periods.

The first step allows us to evaluate the respective explanatory power of individual characteristics, specialisation, and department-time fixed effects. The latter capture not only our observed department composition and research strategy effects but also any local effect that might be unobserved. The second step estimation allows us to identify separately the department composition and research strategy effects on the estimated department-time effect, net of individual effects and selection, $\hat{\beta}_{dt}$:

$$\hat{\beta}_{dt} \; = \; \text{Composition}_{dt}\gamma \, + \, \text{Department Research Strategy}_{dt}\lambda \, + \, \delta_t \, + \, v_{dt} \, , \tag{2}$$

where δ_t is a time fixed effect and v_{dt} is a random component at the department level assumed to be i.i.d. across departments and periods.

The main advantage of the two-step procedure is that it allows a more general specification than could be made by directly considering department variables next to individual effects in a single step and ignoring possible unobserved local effects. The second advantage is that the first step estimates the specialisation and individual characteristic effects independently of the specification chosen for the department composition and research strategy effects. Changing the specification of this second step, and for instance instrumenting it or not, does not affect estimates from the first step. The two-step procedure also allows us to consider both individual and aggregated random components, ε_{ift} and v_{dt}, which deals with the heteroscedasticity issues raised by Moulton (1990). Notice that the estimation of the second step dependent variable in the first step creates measurement error issues, which we deal with by using Feasible Generalised Least Squares (FGLS) in the second step.

The literature seems to agree on the fact that considering individual fixed effects in the first step allows the researchers to capture the role of unobserved individual effects that could otherwise bias the estimation of local or peer effects. For instance, Combes *et al.* (2008*a*) show that the impact of employment density on productivity is twice as low when individual fixed effects are introduced into the specification. However, to identify these effects separately from the location effects, one needs large data sets and enough mobility of individuals between locations. Gobillon (2004) shows that the exact identification conditions are difficult to check empirically, and it is never done in practice. Given the pretty low mobility of academics across departments and the much lower sample size by comparison with standard labour force surveys, it is difficult to be sure that individual and location effects are always properly identified. Notice also that information about age, gender and position are not often available in other studies from the literature, which makes it more important for them to control for individual fixed effects but heighten this concern. We present here the two sets of estimations, with and without individual fixed effects, and provide comments when conclusions differ between the two.

Introducing field-time fixed effects corresponds to an interpretation issue. If one assumes that differences in publication records between fields at the world level are only a matter of fashion and size of the field, and not of talents and true differences of productivity between academics and departments, then one should remove them by introducing field fixed effects and focusing on spatial variability independently of specialisation choices. Conversely, if one believes that a higher number of publications in a field at the world level truly corresponds to higher productivity, then field fixed effects should not be introduced into the specification. We adopt the former position here, and introduce field fixed effects. This is also the viewpoint adopted in empirical economic geography, which systematically considers industry fixed effects. It estimates the location effects once the composition effect due to the industrial structure is removed. Importantly, this does not prevent us from identifying the local externality role of specialisation.

Finally, we need to comment on possible endogeneity concerns. The only way to deal with them in the first step estimation consists in using natural experiments, as proposed by Azoulay *et al.* (2010) with the premature death of stars or by Waldinger (2012) with the dismissal of scientists by the Nazi government (or by Borjas and Doran (2012) with the inflow of Soviet mathematicians to the US after 1992, except that those effects are not local). Then one has to believe that the natural experiment is not correlated with any co-variate and, most importantly, that estimates obtained from the natural experiment would also hold in other circumstances. Alternatively, most of the literature does not deal with this possible endogeneity. We argue that considering both individual and department-time fixed effects should remove most if not all sources of endogeneity, as is the case when location choices are based on location characteristics only and not on individual temporary shocks. Since this seems to be a reasonable assumption for academics, and as a choice between two evils, we follow this strategy here.[5,6]

Endogeneity biases can be also present in the second step estimation. For instance Combes *et al.* (2008*a*) show that estimates of agglomeration economies decrease by around 20% when local variables are instrumented. Department composition and research strategy variables are endogenous when academics are mobile and have their department choices driven by the publication records of their members. Given the number of department characteristics we consider here, to instrument them all would be difficult and not make much sense, particularly with respect to possible weak instrument issues. Still, as a robustness check, we show that instrumental-variable estimates of models where each department characteristic is introduced into the specification on its own does not change any sign of our estimates and, if anything, only increases their magnitude. We are not aware of any other paper on agglomeration and peer effects in academia that proposes an instrumentation of department characteristics.

Decomposing overall productivity

Academic i's productivity can be decomposed as follows:

$$y_{ift} \equiv \mathbb{1}(\text{Quantity}_{ift} > 0) \times \text{Quantity}_{ift} \times \frac{y_{ift}}{\text{Quantity}_{ift}} \tag{3}$$

where Quantity_{ift} is the number of publications of academic i in field f at date t. The first component is a dummy variable equal to 1 when at least one of academic i's publications refers to JEL code f. The second component measures the publication quantity of active academic i in field f at date t. The last component corresponds to the average quality of publications of active academic i in field f at date t. One contribution we make consists in studying the determinants of each of these components of academics' publication records separately. For instance, we can state whether a department characteristic affects the probability to publish, the quantity or the quality of publications in the same direction, or if they are necessary substitutes for each other. This is important from a policy perspective. More precisely, we assume that specifications (1) and (2) hold for each component of the individual publication record in equation (3). For the first component, we estimate a logit model on the probability to publish. Then we use Tobit models to estimate the quantity and quality determinants conditionally on publishing.[7] Moreover, in order to evaluate possible returns to scale from the number of publications in terms of their average quality, the logarithm of quantity is introduced as an extra independent variable in the specification for quality. This also allows us to separate the direct effect of any variable on quality from its indirect effect operating through quantity, which can either reinforce each other or work in opposite directions.

Finally, first-step estimations need to weight individual observations for two reasons. First, an academic can belong to more than one department. For each academic, date and field, we have as many observations as the academic's number of affiliations and each has a weight α_{idt}. Second, the

[5]A third strategy would involve first specifying a model for the academic choice of department and then estimating our two-equation model conditionally on that choice. However, exclusion restrictions must then be satisfied, namely finding variables that explain the department choice but not the publication record. We cannot see any candidate for this, since even family characteristics for instance can explain the latter.

[6]We also run regressions net of openness (USA and non-USA) and stars that we consider to be the most endogenous variables of our analysis. Results are qualitatively similar and are available upon request.

[7]The inverse of Mills' ratio is calculated with a probit equation including both the individual variables and the department composition and research strategy variables. Unfortunately, it is difficult to satisfy exclusion restrictions, but this should at least allow us to control for the presence of some non-linearities in the model.

academic's output is split between all the publication's JEL codes and we have, for each academic, date and department, one observation for each field with weight $\frac{y_{ift}}{y_{it}}$. To take both effects into account, we weight by $\alpha_{idt}\frac{y_{ift}}{y_{it}}$ each observation in first step estimations.

3. Data

Measure of output

We measure the publication output of academic i in field f at date t as a weighted sum of his publications in field f listed in EconLit[8] over period τ. In most tables, τ corresponds to years $t+1$, $t+2$, $t+3$ and the output is a moving average over these three years. This choice is standard in the literature, adopted for instance recently by Ductor *et al.* (2011). It seems to correspond to the average reality of the profession in terms of the time needed to write papers and publication delays.[9] As a robustness check and because such a choice is both somewhat arbitrary and could result in the autocorrelation of residuals, we also present in Appendix I estimates where τ is reduced to year $t+2$. The first step results are very similar to those based on the three-year moving average. Most results of the second step are also robust to the period change: no effect changes sign and only a couple of them become non-significant, which we ascribe to the noise introduced by attributing each publication to one year only.

Each publication p is first weighted by the quality of the journal, $W(p)$, in which it is published. We use the Combes and Linnemer (2010) journal weighting scheme. Each journal weight is a weighted average of various recursive impact factors built from Thomson Reuters Web of Knowledge impact factors[10] and from Google Scholar citations.[11] For journals not listed in the Web of Knowledge, Combes and Linnemer (2010) use an econometric model to infer their weight. This leads to a ranking of all EconLit journals. Unfortunately, the ranking is constant over time and all publications of a journal get the same weight independently of their publication year. Then a function is applied to the ranking to obtain more or less selective weighting schemes. Here, we compare the determinants of publications using two of them, *CLm* in which selectivity is moderate (ranging from a weight of 100 for the Quarterly Journal of Economics through 55.1 for the Journal of Labor Economics, for instance, to a weight of 4 for the lowest journal) and *CLh* which is more selective (ranging from 100 for the Quarterly Journal of Economics to 0.0007 for the last journal, via 16.7 for the Journal of Labor Economics). We refer to these two schemes as the 'Quality' and 'Top quality' publication measures, respectively. They are given for the top 50 journals in Appendix A.

As is common practice in the literature, publication p is also weighted by its number of authors, $n(p)$. Since the publication output of a department is the sum of the outputs of its academics, we do not want a publication written by two members of the department to account for more (or less) than the same publication written by a single author. As mentioned above, we evaluate the presence of increasing, or decreasing, returns to scale within co-author teams by using the average number of authors as one of the independent variables.

[8]EconLit is the electronic bibliography of the American Economic Association (see `http://www.aeaweb.org/econlit/index.php`). It is one of the largest publication data sets, listing more than 560,000 articles published between 1969 and 2008 in more than 1200 journals.

[9]Note also that the list of the department's academics at date t is established in September of that year.

[10]`http://www.webofknowledge.com/`

[11]`http://scholar.google.com/`

The third (and most minor) dimension that the output measure takes into account is the number of pages of the article, $pa(p)$, relative to the average length of articles in the journal in the same year, $\overline{pa}$. This captures the idea that longer articles contain more ideas and innovations. A natural example comes from the differences between short and regular papers in the American Economic Review. Importantly, these weights are computed within each journal-year. This assumes that the editorial policy of the journal is consistent within a year, a 20% shorter article representing 20% less output, for instance. Conversely, differences in article length between journals, which can come either from different page and font sizes or from real contribution differences, are assumed to be directly and fully reflected in the journal's quality weight. In some sense, our choice is intermediate between fully ignoring the publication length and using the absolute number of pages as the literature sometimes does.

Finally, productivity is measured at the field level to enable us to study the effect of field specialisation and diversity and to control for between-field differences at the world level. We use JEL codes at the first digit level (letter) and we ignore the fields "Y - Miscellaneous Categories" and "Z - Other Special Topics". We also slightly modify the codes C and D by merging code C7 (Game Theory and Bargaining Theory) and C9 (Design of Experiments) with Microeconomics (code D), which we believe to be more coherent. This leaves us with 18 fields. The weight of publication p attributed to academic i is first divided by the publication's number of JEL codes, $j(p)$, and then multiplied by the publication's number of JEL codes corresponding to field f, $j_f(p)$.

To sum up, the publication output of academic i at date t in field f is given by:

$$y_{ift} = \frac{1}{\text{Card}(\tau)} \sum_{p\in\tau} \frac{W(p)}{n(p)} \frac{pa(p)}{\overline{pa}} \frac{j_f(p)}{j(p)}$$

where $\text{Card}(\tau)$ is the number of years in period τ.

Academics and universities

The French Ministry of Education and Research, CNRS and INRA[12] provided us with the list of academics in economics in France for the period 1990 to 2008. Each academic is affiliated to at least one university department or to a CNRS or INRA research centre. We merge together these affiliations at the university level to obtain what we call a "department". This is either an economics department, if that is the only body to which economists are affiliated in a university (which is the majority of the cases), or the aggregation of all departments or research centres containing economists in the university. We believe that this notion of slightly aggregated economics departments better matches the French reality of academic research than a more detailed approach. Robustness checks using detailed affiliations lead to fully consistent results, which are available upon request.

The French system allows for multiple affiliations and around 10% of academics belong to 2 or 3 departments. In this case, we give an equal weight (parameter α_{idt} in above definitions) to each department. For a few cases of academics who have positions both in France and abroad, we use their CV to evaluate the share that should be attributed to the French department. Last, we want the analysis to focus only on academics that can really be considered as forming a local group of academics working together. Therefore we only keep departments larger than 4 full-time equivalent academics, excluding economists that are isolated in universities without a real economics department. We have performed a

[12] Ministère de l'Enseignement Supérieur et de la Recherche - Direction Générale de la Recherche et de l'Innovation, Centre National de la Recherche Scientifique, and Institut National de la Recherche Agronomique, respectively.

variant keeping only departments larger than 9 full-time equivalent academics and obtained very similar results, which are available upon request.

The data set includes a number of individual characteristics such as gender, age and position. We merge this with EconLit by surname and initials. First names are too badly recorded in EconLit to be used in full. Keeping only the initials very slightly increases the number of academics with identical names; we deal with their publication records manually. For each academic and for each year between 1990 and 2008, we obtain a data set with his individual characteristics, departments of affiliation, and publication record with weighted outputs.

Descriptive statistics

Table 1 presents the number of academics (equivalent full time) and departments per year, from 1990 to 2005. Using a three-year moving average for the publication output prevents us from considering the years 2006, 2007, and 2008. Both the number of academics and the number of departments are monotonically increasing over time, from 1,753 academics and 69 departments in 1990 to 2,914 academics and 81 departments in 2005. Over the 16 years of our panel, this leads to 38,742 academic-year observations and 1,267 department-year observations.

Table 1: numbers of academics and departments per year

Year	Number of academics	Number of departments	Average department size
1990	1753	69	25.4
1991	1853	71	26.1
1992	1933	74	26.1
1993	2038	77	26.5
1994	2175	80	27.2
1995	2292	79	29.0
1996	2365	80	29.6
1997	2423	81	29.9
1998	2530	83	30.5
1999	2680	82	32.7
2000	2724	83	32.8
2001	2744	82	33.5
2002	2752	82	33.6
2003	2764	81	34.1
2004	2803	82	34.2
2005	2914	81	36.0
Total	38742	1267	30.6

Table 2 panel (a) presents descriptive statistics for all academics. The average academic is 45.6 years old and 25% are women. We do not present the share of each of the thirteen positions distinguished, but we create two aggregate variables that characterise them. The line 'Teaching' reports that 83% of academic-year observations have statutory teaching loads. The line 'Upper position' reports that 35% of academic-year observations correspond to an upper position, *i.e.*, equivalent to full professor as opposed to assistant professor.

Table 2: descriptive statistics

	Mean	Standard deviation	1st decile	Median	Last decile
Panel (a): All academics					
Age	45.6	9.1	32	46	58
Women	0.25	0.41	0	0	1
Upper position	0.35	0.45	0	0	1
Teaching	0.83	0.35	0	1	1
Publisher	0.33	0.44	0	0	1
Quantity	0.17	0.36	0	0	0.57
Quality	4.3	10.2	0	0	12.1
Top quality	0.80	5.31	0	0	0.22
Panel (b): Publishers					
Age	42.7	9.0	31	41	56
Women	0.22	0.38	0	0	1
Upper position	0.49	0.46	0	0	1
Teaching	0.75	0.40	0	1	1
Quantity	0.52	0.46	0.17	0.33	1.06
Quality	13.2	14.3	4.0	7.9	29.4
Top quality	2.44	8.91	0.01	0.04	4.94
Authors number	1.9	0.7	1	2	3
Non-USA openness	0.1	0.3	0	0	1.0
USA openness	0.07	0.24	0	0	0
Individual diversity	2.6	1.6	1	2	5
Panel (c): Departments					
Publishers	0.34	0.20	0.11	0.30	0.62
Quantity	5.46	8.20	0.44	2.75	12.62
Quantity per academic	0.18	0.18	0.04	0.13	0.37
Quality	11.80	8.10	5.67	9.18	20.85
Top quality	1.93	4.44	0.02	0.27	5.06
Specialisation	0.28	0.20	0.12	0.20	0.50
Size	31.6	34.6	7.5	18.0	82.0
Women	0.24	0.12	0.10	0.24	0.39
Age	45.0	3.5	40.6	45.0	49.3
Upper position	0.34	0.19	0.13	0.31	0.64
Teaching	0.79	0.34	0	0.97	1
Department diversity	-0.52	0.46	-1.18	-0.42	-0.01
Research Access	11.4	17.6	0.8	2.8	37.9
Non-USA openness	0.04	0.07	0	0.01	0.14
USA openness	0.02	0.06	0	0	0.07
Heterogeneity	2.1	0.8	1.2	1.9	3.1
Stars	0.01	0.05	0	0	0.02

Variables are defined in Section 2. To match what is done in the econometric section, publication variables are first computed as three-year moving averages before descriptive statistics are computed. The number of observations for panels (a), (b) and (c) are 38,577, 12,591, and 1209 respectively. 165 individuals that have missing values for some variables are excluded from the sample. Descriptive statistics at the department level (panel (c)) are calculated on the sub-sample of departments in which there is at least one published author and hence, for which all variables are defined. That is why average department size is slightly higher than in Table 1.

Not all academics publish over the three-year period. The line 'Publisher' in Table 2 panel (a) reports that one third of them have published at least one article over the three-year period, possibly co-authored and in any field. This is one of the figures that changed quite substantially over the period, rising from 0.17 in 1990 to 0.42 in 2005. Panel (b) in Table 2 provides descriptive statistics on the sub-group of academics who have published at least one article over the three years. They are almost three years younger, slightly less likely to be women, and more likely to hold non-teaching and upper positions.

The line 'Quantity' in Table 2 panel (a) reveals that the average academic publishes 0.17 papers equivalent alone per year, which is one paper with one co-author every three years. This is little, but partly due to the fact that many academics do not publish any papers at all. Conditional on having at least one publication over the three-year period, we read in Table 2 panel (b) that the average number of publications is three times higher, corresponding to, for instance, one publication alone and one publication with a co-author every three years. As regards quality, we also confirm the large disparities existing among academics, a well-documented fact since Lotka (1926). The median publication is worth the equivalent of one publication in the 150th journal per year but the median journal is lower, around the 350th journal. By contrast, the top decile average quality publication corresponds to one publication in the 50th journal per year or one publication in a top 5 journal every three years. The average quality of publications of academics in France appears to be better in terms of the top quality index, since the mean is now around the 50th journal, the median around the 100th, and the top decile around the 30th journal. 10% of the publishers have at least one co-author abroad but not in the USA, and 7% have at least one co-author in the USA. The average number of authors per paper is 1.9 and, more precisely, 44.7%, 38.0% and 14.8% of the publications have one, two, and three authors respectively. Only 2.5% of the publications have strictly more than three authors.

Regressions are performed at the field level. Since there are 18 possible fields, the 38,577 academic-year observations translate into 694,386 field-academic-year observations, which is then increased by the fact that some observations are duplicated for academics with multiple affiliations (as explained in Section 2). As a result, the number of observations we have in the first step estimation for the probability to publish is 771,426. However, both because some academics do not publish at all, and, more importantly, because none publishes in all fields, many of these observations correspond to zero publications (in a given field). There are 'only' 38,984 non-zero observations, which are the observations for the first step quantity and quality estimations. The line 'Individual Diversity' in Table 2 panel (b) reveals that the average number of fields per academic over a three-year period is 2.6 and the very diversified academic at the top decile has five fields. At the national level, "Microeconomics" is largely the most represented field in France with 16.8% of the number of publications. This is larger than its share for EconLit as a whole, which is 10.2%. Then, there are ten fields each representing more than 4%.[13]

Panel (c) in Table 2 reports descriptive statistics at the department level. The average department has 31.6 academics who are 45 years old on average, 24% are women, 34% have upper positions, and 34% are publishers. The figures are comparable to the averages over all academics. Importantly, they all present quite a lot of variations between departments, which is also observed for publication output. The average department has 5.5 publications per year, 0.18 per academic, and the average quality indexes are in the same ranges as for individual academics. Specialisation of the median department means that a JEL code actually active in the department represents 20% of the department publications, or that there are only 5 active JEL codes in the department. Departments are therefore fairly specialised, given that there are 18 different possible JEL codes. In the very specialised department at the top decile of specialisation, each JEL code represents half of the publications; that is to say, there are only two

[13]Industrial Organization (9.5% vs 8.8% for EconLit as a whole), Development/Growth (8.8 vs 10.0%), Finance (8.8 vs 10.9%), Macro/Monetary Economics (8.2 vs 7.2%), Labour/Demography (8.2 vs 8.3%), International Economics (7.6 vs 7.8%), Agricultural/Environmental Economics (5.6 vs 7.0%), Economics History, Thoughts and Methodology (5.4 vs 2.2%), Public Economics (4.2 vs 4.3%), Urban and Regional Economics (4.2 vs 5.0%).

JEL codes represented within the department. This is confirmed by the diversity index, which almost always takes negative values even at the top decile, meaning that departments are less diversified than they would be with random JEL code choices.

Table 3: simple correlations at the department level

	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Quantity (1)	0.92	0.75	0.08	-0.07	-0.08	0.48	-0.36	0.59	0.32	0.55	0.48	-0.78	0.42
Quality (2)	1	0.92	0.11	-0.08	-0.09	0.52	-0.43	0.52	0.37	0.63	0.59	-0.69	0.54
Top quality (3)		1	0.21	-0.07	-0.06	0.48	-0.38	0.43	0.36	0.57	0.55	-0.51	0.49
Size (4)			1	-0.02	0.19	0.06	0.15	0.16	-0.09	0.03	-0.04	0.16	-0.09
Women (5)				1	-0.08	-0.28	0.16	0	0.23	-0.07	-0.07	-0.02	-0.15
Age (6)					1	0.26	0.03	0.03	0.23	-0.15	-0.11	0.19	-0.14
Upper position (7)						1	-0.58	0.15	0.40	0.38	0.43	-0.37	0.40
Teaching (8)							1	-0.05	-0.36	-0.37	-0.46	0.41	-0.36
Diversity (9)								1	0.19	0.25	0.18	-0.50	0.15
Research Access (10)									1	0.30	0.34	-0.31	0.30
Non-USA Openness (11)										1	0.61	-0.45	0.51
USA Openness (12)											1	-0.39	0.72
Heterogeneity (13)												1	-0.29
Stars (14)													1

Variables are defined in Section 2. Specialisation defined at the JEL code level is first averaged by department (weighted by the share of the JEL code in the department) before statistics are computed.

Finally, Table 3 presents the simple correlations between the variables at the department level. First, quantity and quality are largely positively correlated even for the top quality index. Those departments that publish more also produce higher quality publications and no trade-off seems to take place between the two. This is in keeping with what Combes and Linnemer (2003) find at the European level. Academics are also on average more productive in departments where the share of upper positions is higher and the share of teaching positions lower, and where field diversity and research access are high. Correlations are also positive but lower with the share of academics having co-authors abroad and in the USA (openness variables), and again large for the presence of stars and heterogeneity, which are positively and negatively correlated with quantity and quality respectively. The correlation of size with quantity is not very strong but it increases for quality, and even more for top quality. We must now investigate whether these correlations are driven by the fact that upper position researchers, or researchers with high abilities more generally, are over-represented in some departments through selection effects and/or by the fact that some academics or department characteristics generate more externalities. This is the purpose of the econometric analysis developed in the next sections.

4. Productive individuals: abilities and research strategy versus location

This section studies the determinants of individual productivity and assesses the relative weight of individual and department effects. We regress individual productivity in a specific field on individual characteristics that relate to both individual abilities and individual research strategy (including field-time fixed effects), department specialisation and department-time fixed effects. Columns (1) and (2) ('Publishing') in Table 4 concern a Logit model where the dependent variable is 1 if academic i produces in field f at date t and 0 otherwise. Columns (3) and (4) ('Quantity') concern the number of publications, and Columns (5) and (6) ('Quality') and Columns (7) and (8) ('Top quality') concern the average publication quality using regular and top journal quality indexes respectively. For each output measure, the first column does not include the department variables (specialisation and the department-time fixed effect), which are included in the next column specification. Table 14 in Appendix B reproduces Table 4 including individual fixed effects.[14]

Table 4: determinants of individual publications

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Women	-0.368^a	-0.373^a	-0.090^a	-0.376^a	0.043^a	-0.297^a	0.102^b	-1.024^a
	(0.022)	(0.015)	(0.013)	(0.035)	(0.014)	(0.036)	(0.041)	(0.093)
Age	-0.104^a	-0.090^a	-0.030^a	-0.107^a	0.002	-0.084^a	-0.010	-0.292^a
	(0.010)	(0.006)	(0.005)	(0.010)	(0.005)	(0.010)	(0.015)	(0.026)
Age square	0.000^a	0.000^a	0.000^a	0.001^a	-0.000	0.000^a	0.000	0.001^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Authors number			-0.917^a	-0.868^a	0.292^a	0.279^a	1.050^a	0.989^a
			(0.014)	(0.010)	(0.018)	(0.011)	(0.047)	(0.029)
Non-USA Openness			0.362^a	0.319^a	0.253^a	0.242^a	0.889^a	0.854^a
			(0.014)	(0.010)	(0.018)	(0.011)	(0.052)	(0.028)
USA Openness			0.338^a	0.322^a	0.408^a	0.377^a	1.243^a	1.129^a
			(0.021)	(0.014)	(0.025)	(0.014)	(0.073)	(0.038)
Star			0.492^a	0.413^a	0.877^a	0.772^a	2.504^a	2.156^a
			(0.032)	(0.023)	(0.045)	(0.023)	(0.123)	(0.061)
Diversity			-0.131^a	-0.060^a	-0.002	-0.007	0.087^a	0.074^a
			(0.011)	(0.007)	(0.010)	(0.007)	(0.027)	(0.017)
Specialisation				0.368^a		0.007		0.024^c
				(0.005)		(0.005)		(0.013)
Quantity					0.087^a	0.075^a	0.491^a	0.442^a
					(0.007)	(0.005)	(0.019)	(0.014)
Selection			-0.180^a	1.861^a	-0.565^a	1.662^a	-1.743^a	5.600^a
			(0.036)	(0.232)	(0.047)	(0.234)	(0.142)	(0.614)
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jel Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department Time FE	No	Yes	No	Yes	No	Yes	No	Yes
R^2			0.28	0.43	0.33	0.40	0.43	0.50
Observations	771426	760122	38984	38984	38984	38984	38984	38984

Standard error between brackets. ^{a}, ^{b}, ^{c}: significant at the 1%, 5% and 10% levels respectively. 'Publishing': Logit model for the probability of having at least one publication. 'Quantity', 'Quality', and 'Top quality': Heckman two-step Generalized Tobit models. The first step consists in a Probit model for the probability of publishing. The variable 'Selection' in the second step is the inverse of Mills' ratio from the Probit equation. Variables are defined in Section 2.

Before turning to the effect of each variable, let us start with some variance analysis. A first conclusion is that the model better explains the average quality of publications than the number of publications, even more so when a top quality index is considered and when individual fixed effects are introduced. The publication quality relates more to individual and department characteristics than does the number of publications, for which the random component is larger. This would probably make sense to all academics, since publishing in good journals needs more specific skills, captured by the model, than just publishing.

[14]The effects of women and age are no longer displayed in Appendix B, since it is not possible to identify them separately from individual and year fixed effects, respectively, in the within dimension of a panel.

Importantly, there is a large increase of the R^2 when department effects are introduced, by almost 60% for the quantity published, 22% for the publication quality and 16% for top quality (as regards estimations without individual fixed effects). This is confirmed by the more detailed variance analysis provided in Table 5. First, the 'Stand. error' columns report the standard error of the effect of a variable or of a group of variables for the quantity estimation presented in Table 4 column (4) and for the same regression including individual fixed effects presented in Table 14 column (4) in Appendix B. The higher it is relative to the standard error of the dependent variable to be explained (reported in the first line), the larger the explanatory power of this variable or group of variables. However, and most importantly, a variable or group of variables has a large explanatory power when its effect is largely correlated with the dependent variable. This is reported in the 'Correlation' columns.[15] We observe that the standard error of individual effects is slightly larger than the standard error of department effects. By contrast, the correlation of the latter with the dependent variable is slightly higher. Both results point to the fact that the two groups of variables have a relatively similar explanatory power of the individual number of publications, at least when individual fixed effects are not considered.

This shows that for such a type of analysis, whether or not an individual fixed effect is considered in the specifications is crucial. First, the explanatory power of the model largely increases when individual fixed effects are introduced. Compared with the model without individual fixed effects, the explanatory power almost doubles in the regressions without department effects, and it is still 50 to 80% higher than when department effects are included (see Table 14 in Appendix B). The explanatory power of the model is now comparable, even if a bit lower, to what is obtained in standard individual wage or productivity equations, with R^2 between 0.60 for quantity and 0.73 for top quality. Second, from the right-hand side of Table 5, we can see that the standard error of individual effects is now twice as large as that of department effects, while the correlation with the dependent variable is also larger for the former. This means that some unobserved individual effects do significantly influence the number of publications, which increases the explanatory power of individual effects relative to department effects.

Tables 15 and 16 in Appendix C reproduce the variance analysis for publication quality and top quality respectively. We first observe that individual effects explain more quality than quantity. Even when individual fixed effects are not included, the explanatory power of individual effects is larger than that of department effects. At the extreme, department effects have a standard error and correlation with the dependent variable around three times lower than those of individual effects.

To sum up, and keeping in mind the observation in Section 2 that individual fixed effects cannot always be properly identified separately from department effects if there is not enough mobility between departments – which could be the case here –, the lower bound for the explanatory power of department effects is around half of the explanatory power of individual effects. However, at the upper bound, without individual fixed effects but still with a set of individual observable characteristics, department effects could explain as much as individual effects, even more so for the number of publications than for their average quality. This means that agglomeration and peer effects do matter for the individual productivity of academics. Interestingly, the lower bound is of a similar magnitude to what Combes *et al.* (2008*a*) find for market activities in the same country, France. Relative to location effects, individual effects do not appear to play a larger role and may play a smaller one in scientific research, compared

[15]The variance analysis is computed on variables centered with respect to their annual means and therefore performed in the within time dimension, to focus on spatial variations. See Abowd, Kramarz, and Margolis (1999) for details on this type of variance analysis.

with other activities. This contrasts with the findings of the literature. Waldinger (2012) does not find any peer effects among physicists, chemists and mathematicians in Nazi Germany, and this is also the conclusion of Dubois *et al.* (2011) for modern-day mathematicians. Kim *et al.* (2009) find that the effect of being in a top 25 economics and finance department gradually disappears between the 1970s and the 1990s in the USA. These authors comment the fact that department effects are or are not significant, but they do not discuss their global explanatory power, which we do here. This is not exactly the same point of view, and we believe our approach to be more relevant to assessing the share of individual productivity explained by location. Another possible explanation of the difference between these results is that individual fixed effects are not always properly identified. Unfortunately, as discussed in Section 2, the fact that mobility is high enough to identify both individual and location fixed effects is difficult to test formally. A last explanation could be that research habits differ between a European country like France and the USA, both in terms of research technology (e.g., the intensity of internet use for collaborations) and in terms of institutional design. For instance, the possibility of individuals capturing their publication performance is considered to be lower in most European countries where wages and positions are much less closely tied to publication records.[16] All of these factors could affect the relative role of individual and department characteristics.

Table 5: variance analysis of the individual publication quantity

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quantity	0.456	1.000		0.456	1.000	
Individual effects	0.439	0.335	0.100	0.497	0.484	0.029
Individual fixed effect	-	-	-	0.432	0.292	-0.026
Gender	0.086	0.094	0.014	-	-	-
Age	0.295	0.023	-0.053	0.197	-0.012	0.030
Position fixed effect	0.315	0.091	0.126	0.197	0.097	0.054
Authors number	0.187	0.353	-0.025	0.184	0.353	-0.018
Non-USA openness	0.063	0.110	0.106	0.034	0.110	0.088
USA openness	0.047	0.118	0.116	0.029	0.118	0.098
Star	0.038	0.168	0.157	0.027	0.168	0.135
Individual diversity	0.019	0.046	-0.162	0.030	0.046	-0.156
Jel fixed effect	0.201	0.087	0.042	0.272	0.073	0.029
Department effects	0.269	0.372	0.743	0.250	0.333	0.735
Department fixed effect	0.246	0.155	1.000	0.226	0.112	1.000
Specialisation	0.186	0.333	-0.248	0.175	0.333	-0.240
Selection	0.436	-0.134	-0.396	0.441	-0.124	-0.334
Residuals	0.349	0.766	0	0.291	0.640	0

The table presents the variance analysis of the estimation reported in Table 4 column (4) and of the same regression including individual fixed effects reported in Table 14 column (4) in Appendix B. All variables are first centred with respect to their annual mean. The 'Stand. error' columns report the standard error of the effect of a variable or a group of variables. For the first line, it reports the standard error of the dependent variable. The 'Correlation' columns report the correlation between the effect of a variable or a group of variables and the dependent variable. The 'Sorting' columns report the correlation between the effect of a variable or of a group of variables and the department fixed effect.

Another crucial result emphasised by Combes *et al.* (2008*a*) regards the sorting of workers across space. More able workers locate in more favorable locations, where location effects reflecting localised externalities are the largest. From the econometric point of view, it is important to assess whether

[16] Combes, Linnemer, and Visser (2008*b*) document this for France.

department effects would be biased if individual effects were ignored. From the policy point of view, it is interesting to know whether more productive academics are attracted by the departments that generate more externalities, or if they locate randomly across departments. The 'Sorting' columns in Table 5 for publication quantity, and in Tables 15 and 16 in Appendix C for the average quality and top quality of publications, report the correlation between the effect of a variable or group of variables and the department fixed effects. It is typically found to be positive for individual effects, which means that workers with individual characteristics that make them publish more and with a higher quality are located in the departments that provide larger external effects. The correlation of all individual effects together, at 0.1, is significantly lower than what Combes *et al.* (2008*a*) find for market activities in France. However, it is larger for publication quality, and even larger for top quality publications. Due to the presence of such a correlation, Combes *et al.* (2008*a*) show that not considering individual effects can largely bias the estimation of department effects, which we will also illustrate below. Interestingly, we find that the spatial sorting of academics is larger on observed characteristics than on unobserved ones, since the correlations are smaller when individual fixed effects are considered (right-hand side of the tables). However, the gap between the two reduces for quality, and especially top quality, meaning that unobserved characteristics matter relatively more when the quality of publications increases. Unfortunately, none of the papers assessing the magnitude of peer effects in science compute such correlations between individual and department effects, which would have allowed us to compare our conclusions with those in other fields or for other periods.

We finally turn to the role of each variable. From Table 4, women and older academics appear to publish less, at least when department effects are considered. This is consistent with previous findings in the literature, even more so since we control here for the type of position held. Once a given position is achieved, for instance becoming a full professor, the number and quality of publications decreases with age. Part of the effect might also result from a cohort effect (previous generations had weaker incentives to publish than younger academics).

As detailed in Table 17 in Appendix D, expected results are obtained for the impact of the various positions. The higher the rank (professor, research professor, and even more so INSEE or *Ponts-et-Chaussées* Engineers as opposed to assistant professors or research fellows) and the more time allocated to research (research versus teaching positions), the larger the published quantity and quality, which is also the case for the academics purely in economics. Therefore, even if part of promotions in France is not related to publications, as observed by Combes *et al.* (2008*b*), those who get better positions do publish more on average. Note that our purpose here is not to give a causal interpretation to such variables but to control at best for individual abilities when estimating the role of departments.

Interestingly, we control not only for some of the standard 'ability' variables considered in wage or productivity equations, like gender, age or position (which plays the role of occupation), but also for variables related to what we call the individual 'research strategy'. The variable that has the largest correlation with the dependent variable is the academic's average number of co-authors per publication. Its impact on published quantity is largely negative. Having more co-authors decreases the number of published papers, which means that attributing only part of the publication to each co-author corresponds to a stronger effect than the one of producing more papers with more co-authors. In other words, the quantity published is subject to decreasing returns to scale in terms of the number of authors; academics would publish more papers if they worked alone. However, the average number of co-authors has a large positive effect on the average publication quality, which is even larger for top quality. Therefore, a larger number of co-authors decreases the number of publications equivalent written alone but increases their quality. There is a trade-off between the two, and only an analysis such as this can identify the two separately. For instance, an academic who has on average two co-authors instead of only one (per publication) has 30% less publications but their average quality is 12% higher and their average top quality is 49.3% higher.[17] This is drawn from the estimations without individual fixed effects, but the estimations including individual fixed effects give results of very similar magnitude.

Combining the two effects, having two co-authors instead of one decreases the quality-weighted volume of publications (a measure frequently found in the literature, consisting here in multiplying the quantity by the average quality) by around 21.6% but increases the top quality-weighted volume of publications by around 4.5%. Therefore, one should not expect to publish more, even in decent journals, thanks to co-authoring, but possibly to reach the top journals. Notice that the number of co-authors also has an indirect negative effect on average quality through quantity, since quantity has a positive impact on average quality (which is commented below). However, this indirect negative effect is not large enough to offset the positive direct effect on average quality. The total effect of co-authorship on quality is 0.214 and on top quality 0.605.[18] The article by Sauer (1988), which is one of the earliest contributions on the impact of co-authorship on publication, finds almost no effect, and two other studies, also on economists, Hollis (2001) and Medoff (2003), conclude to a negative effect of co-authorship on publication quality. Dubois *et al.* (2011) identify an overall negative effect of co-authorship for mathematicians on their citation-weighted publication index, but the effect turns positive when co-author specialisation is taken into account. The difference between these results and our own may be due to the fact that they do not precisely distinguish the quantity and quality effects, which work in opposite directions, as we have shown. Ductor (2011) obtains results that are consistent with ours, finding a negative effect of co-authorship for economists between 1971 and 1999 that turns positive when unobserved heterogeneity and endogenous co-authorship formation are taken into account.[19]

We also find that having a higher diversity of research fields does not really help academics to publish more, but it does increase their average publication quality, and again the effect is larger for top quality. This suggests the presence of some complementarities between research in different fields at the individual level. Dubois *et al.* (2011) also find a positive effect of field diversity for mathematicians.

Finally, our estimations of quality control for quantity, *i.e.*, the individual number of publications. This allows us to test for the presence of increasing returns to scale for quality at the individual level now (as opposed to the co-author team level assessed through the number of co-authors). This is usually omitted in the literature. Table 4 reveals that there are indeed increasing returns to the number of publications for average quality, and even more so for top quality publications. The more academics publish, the higher the average quality of their publications. An academic with twice as many publications has an average publication quality higher by 5.3% and a top publication quality higher by 35.8%.[20]

Notice that all these results hold within JEL codes, since we control for JEL code fixed effects. JEL codes appear to have a pretty large explanatory power, especially as regards publication quality. This reflects the fact that all fields are not equal in terms of publication opportunities. To the best of our knowledge, nobody has yet been able to assess whether this is due to a pure 'fashion' effect (some

[17] $1.5^{-0.868} - 1$, $1.5^{0.279} - 1$ and $1.5^{0.989} - 1$, respectively.

[18] $-0.868 \times 0.075 + 0.279$ and $-0.868 \times 0.442 + 0.989$, respectively.

[19] See Section 2 for a discussion about endogeneity concerns in the first step estimation.

[20] $2^{0.075} - 1$ and $2^{0.442} - 1$ respectively.

topics are more fashionable, which makes them easier to publish) or to some selection effects (more able academics self-select in certain fields or those fields attract more able academics). However, it is not the purpose of the present article to tackle this difficult question. Still, in terms of interpretation, department effects are estimated here net of the direct role of academic composition in terms of research fields.

5. Productive departments: sorting versus externalities

The previous section studies how much location matters for the individual productivity of academics. We now move to the dual question of the extent to which department composition in terms of individual characteristics explains department performance, compared with the presence of local externalities. To this end, we repeat the previous variance analysis, but only after aggregating variables by department. Table 6 presents the results for quality while Tables 18 and 19 in Appendix E present the results for quantity and top quality respectively.

Table 6: variance analysis of average publication quality at the department level

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quality	0.426	1.000		0.426	1.000	
Individual effects	0.494	0.532	0.225	0.536	0.721	0.060
Individual fixed effect	-	-	-	0.390	0.701	0.016
Gender	0.059	0.054	0.005	-	-	-
Age	0.266	0.076	-0.119	0.013	-0.061	0.028
Position fixed effect	0.300	0.324	0.264	0.124	0.103	-0.047
Authors number	0.068	0.358	0.096	0.061	0.358	0.134
Non-USA openness	0.040	0.414	0.184	0.010	0.414	0.099
USA openness	0.038	0.484	0.315	0.018	0.484	0.240
Star	0.058	0.514	0.348	0.044	0.514	0.222
Individual diversity	0.002	-0.239	-0.383	0.001	0.239	0.335
Jel fixed effect	0.216	0.246	0.083	0.205	0.209	0.036
Department effects	0.524	0.712	1.000	0.381	0.495	1.000
Department fixed effect	0.526	0.711	1.000	0.382	0.494	1.000
Specialisation	0.004	-0.110	-0.426	0.005	-0.110	-0.335
Quantity	0.028	0.118	0.093	0.021	0.118	-0.038
Selection	0.528	-0.404	-0.635	0.386	-0.391	-0.522
Residuals	0.001	-0.007	0	0.001	-0.013	0

The table presents the variance analysis of the estimation reported in Table 4 column (6) and of the same regression including individual fixed effects, reported in Table 14 column (6) in Appendix B, once they are averaged by department. For the meaning of the figures reported, see the note to Table 5.

Both Kim *et al.* (2009) for economics and business and Dubois *et al.* (2011) for mathematics argue that what makes a good department nowadays is primarily the bringing together of academics with good individual characteristics. This is not what we find here. Even according to the specification that includes individual fixed effects, in the right-hand side of Table 6, the standard error of individual effects is only slightly higher than the standard error of department effects. Still, the correlation with average department quality of publication is twice as high for the former. When individual fixed effects are not controlled for, both the standard error of department effects and their correlation with the dependent variable are now higher than those for individual effects. Therefore, at best, the characteristics of academics explain slightly more the publication quality disparities between departments than the external effects at play in these departments. From Tables 18 and 19 in Appendix B, the same conclusion is obtained for quantity and top quality, to slightly larger and smaller extents respectively. Again, this means that agglomeration and peer effects are quite strong and therefore important in explaining the ranking of academic institutions.

Among individual characteristics that explain department disparities, research fields present in the department play a large role since JEL code fixed effects have a standard error of 0.216 and a correlation with the dependent variable at 0.246. Having a larger share of high rank positions is the only group that has a larger explanatory power. Importantly for policy implications, the share of each position type is to a large extent not a department decision in France but results from individual location choices for research position, and from the Ministry of Higher Education decisions for position involving teaching. It also appears that the higher publication quality in some departments is due to the fact that they have more people with a higher average number of co-authors. Having academics with co-authors abroad or being a star is also quite correlated with the average department publication quality, but the explanatory power of these variables is reduced by their pretty low variability across departments. Individual diversity does not vary so much between departments and its effect is not strongly correlated with the average department quality, although its elasticity is largely positive. Differences in gender and age composition do not really matter for disparities between departments. As presented in Appendix E, such conclusions are broadly confirmed for quantity and top quality, with some variables sometimes having a slightly stronger or weaker explanatory power.

We can also study the impact of individual spatial sorting on department disparities. For market activities in France, Combes *et al.* (2008*a*) find that the correlation between individual and department fixed effects is strong, at 0.29. Disparities between individual characteristics and in terms of local externalities therefore cumulate and generate pretty large productivity disparities between locations. Individual and department effects disparities are less systematically related to each other here since the correlation between both is only 0.06, as shown in the right-hand side of Table 6. Interestingly, sorting on individual observed characteristics, which is reported in the left-hand side of Table 6, is larger, at 0.225. This means that unobserved individual characteristics, which significantly increase the explanatory power of the model (the correlation of individual effects with the dependent variable is 0.72, compared with 0.53 without individual fixed effects), are distributed more independently from department effects than observed characteristics.

Kim *et al.* (2009) argue that the declining role of economics and finance department externalities is a recent trend that gradually emerged in the eighties and nineties, by comparison with the seventies. To assess whether such a trend is also present for French economics departments, and because our panel spans a fairly long period of time, we repeat all our analyses for two sub-periods separately, 1990–1997 and 1998-2005. These periods are interesting because it was only at the end of the nineties that, first, the internet started to be systematically used to search for literature and circulate papers and second, that publications in peer-reviewed non-French journals became the norm when evaluating academics. Both may have contributed to a change in the effect of departments on publications. However, as the results reported in Appendix F show, all the conclusions we draw in this paper are broadly stable between the two periods and correspond to what is found over the period 1990-2005.[21] In particular, we do not observe any decline in the strength of department externalities over time.

[21]The minor observed changes relate to the lower productivity of women and older academics, which is less pronounced, and to the sorting on individual observed characteristics, which is larger over the 1998-2005 period.

6. The channels of department externalities

The last step in our analysis is to identify the channels through which department externalities operate. This consists in studying both the impact of the specialisation variable in the first step of the estimation and the determinants of the department fixed effect in the second step estimation.

Specialisation is the only variable that is both department- and JEL code-specific. It assesses whether having a large share of department publications in a given field helps academics to publish in that field. This is called a localisation effect in economic geography,[22] and it can reflect external (to the firm or individual) but local economies of scale taking place within industries, or in this case fields. Table 4 shows that department specialisation does indeed have a positive effect on the quantity published in the field by an academic. The effect, at 0.368, is pretty large, since the specialisation elasticity is usually found in the range 0.010-0.050 for productivity in market activities. This is somewhat offset here because specialisation variability is lower across departments than across cities. Still, when one increases the share of publications in a field in the department by 50% (corresponding to half a standard error at the median), the number of papers published in that field increases by 16.1%.[23]

By contrast, there is no direct significant impact of specialisation on the quality of publications, whether measured with the medium or the top journal quality index. But specialisation does have an indirect positive impact on quality, due to the positive impact of quantity on quality. The indirect impact of specialisation is 0.027 for quality and 0.163 for top quality.[24] Last, and contrary to some other determinants of department fixed effects, the impact of specialisation is almost not affected when individual fixed effects are introduced into the specification (Table 14 in Appendix B).

Table 7 reports the impact of department variables on the estimated department fixed effect for each publication variable. Table 35 in Appendix G does the same when individual fixed effects are controlled for in the first step estimation. Since the dependent variable is estimated in a first step, we must correct for measurement errors on it. We do so using Feasible Generalised Least Square ('FGLS' columns) and we systematically compare the estimates with Ordinary Least Squares ('OLS' columns). Table 7 shows that results are almost not sensitive to the use of OLS or FGLS. This confirms that department fixed effects are pretty precisely estimated in the first step, or at least that no large bias could result from measurement error on them. When individual fixed effects are considered, as presented in Table 35, the same conclusion is reached.

The impact of the size of the local economy on local productivity is one of the most studied questions in economic geography. We could have controlled for such a variable here, such as the total size of the city where the university is located, for example. However, we believe that local externalities can be even more localised as regards academic activities that need face-to-face contact. Therefore, we use the size of the department defined as its number of academics, which is in itself an interesting variable, since it is at least partly in the hands of the department head, the university or the central government (in many European countries, for instance). We then test the relevance of our choice of spatial scale in two ways. First, we also include a research access variable that corresponds to the proximity to other

[22]For all references to empirical economic geography in this section, please refer to Combes, Mayer, and Thisse (2008*c*).

[23]$1.5^{0.368} - 1$.

[24]0.368×0.075 and 0.368×0.442 respectively.

Table 7: determinants of department fixed effects

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	0.100[a]	0.101[a]	0.198[a]	0.174[a]	0.067[a]	0.078[a]	0.172[a]	0.192[a]
	(0.014)	(0.014)	(0.012)	(0.012)	(0.013)	(0.013)	(0.033)	(0.034)
Women	0.230[b]	0.229[b]	0.490[a]	0.355[a]	0.334[a]	0.448[a]	1.173[a]	1.558[a]
	(0.102)	(0.104)	(0.090)	(0.109)	(0.095)	(0.114)	(0.247)	(0.297)
Age	0.034[a]	0.033[a]	0.029[a]	0.021[a]	0.025[a]	0.022[a]	0.081[a]	0.072[a]
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.010)	(0.013)
Diversity	0.662[a]	0.662[a]	0.448[a]	0.367[a]	0.323[a]	0.329[a]	1.037[a]	1.019[a]
	(0.026)	(0.026)	(0.023)	(0.046)	(0.024)	(0.047)	(0.063)	(0.123)
Research Access	−0.017[b]	−0.017[b]	−0.011	−0.005	0.015[b]	0.013[c]	0.042[b]	0.031
	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.020)	(0.020)
Non-USA Openness	1.287[a]	1.290[a]	1.451[a]	1.262[a]	1.435[a]	1.347[a]	4.941[a]	4.680[a]
	(0.202)	(0.202)	(0.179)	(0.220)	(0.188)	(0.229)	(0.491)	(0.597)
USA Openness	0.858[a]	0.853[a]	0.210	0.088	1.023[a]	1.084[a]	3.522[a]	3.563[a]
	(0.276)	(0.276)	(0.245)	(0.228)	(0.257)	(0.241)	(0.669)	(0.628)
Heterogeneity	−1.147[a]	−1.145[a]	−1.082[a]	−0.900[a]	−0.752[a]	−0.757[a]	−2.539[a]	−2.493[a]
	(0.039)	(0.039)	(0.035)	(0.105)	(0.037)	(0.107)	(0.095)	(0.280)
Stars	0.828[b]	0.832[b]	1.549[a]	1.387[a]	2.527[a]	2.538[a]	7.691[a]	7.759[a]
	(0.375)	(0.375)	(0.332)	(0.328)	(0.349)	(0.345)	(0.909)	(0.899)
Positions	yes	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.82	0.82	0.86	0.93	0.75	0.85	0.82	0.90
Observations	1209	1209	1209	1209	1209	1209	1209	1209

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively.

departments, which allows us to separate very local externalities from more extended ones. Second, we provide estimates in Section 7 at the city level.

Department size has a positive and significant impact on all measures of individual productivity when individual fixed effect are not controlled for: the probability to publish, the number of publications and their average quality. The largest effect is obtained for the average quantity of publications, at 0.198.[25] It is much larger than standard estimates in economic geography for city size, which are at most at 0.090. As in the economic geography literature, we obtain that the impact is much lower when individual fixed effects are controlled for in the first step estimation, although, as we saw above, spatial sorting is less marked for academics than for market activities. Still, the effect is now 0.161 for quantity (OLS estimate in Table 35), still much larger than the standard 0.020 found for market activities when individual fixed effects are controlled for, even if the effect is positive but no longer significant for the other dimensions of publication.[26] When individual fixed effects are not controlled for, doubling the size of a department (corresponding to about half a standard error at the median) increases the average

[25]Here we use the OLS estimates, which are more directly comparable with the literature, but as we have already remarked, differences with FGLS are generally small, at least when individual fixed effects are not controlled for.

[26]Department size is one of the variables for which the difference between OLS and FGLS is rather large and which experiences more generally a pretty large increase in standard error when individual fixed effects are controlled for. This may reflect the issue mentioned in Section 2 about the difficulty of estimating individual and department fixed effects separately when mobility is not large enough.

quantity of articles by 14.7%,[27] which in turn has an additional indirect positive effect on quality and top quality. The direct effect of department size on quality and top quality increases them by 4.8% and 12.7% respectively.[28] From the variance analysis reported in Table 8 for quality and in Tables 36, 37 and 38 in Appendix G for publishing, quantity and top quality respectively, we observe that department size has some explanatory power of the department fixed effect, especially for quantity. However, many other variables, commented below, have a larger explanatory power. This contrasts with the usual findings of the economic geography literature, where size is found to be the main explanation of productivity differences across locations. Therefore, larger departments do make academics more productive but other factors can play an even larger role.

Research access has little significant impact on department externalities. This contrasts with the economic geography findings where market access variables almost always have large and positively significant effects on productivity. In Table 7, the market potential effect is around ten times smaller than what is usually found and the elasticity is not always significantly different from zero, and it is never significant when individual fixed effects are considered in the first step (see Table 35). Therefore, agglomeration effects appear to be very localised for academic activities, more than for market activities in general. This finding is consistent with the importance of face-to-face contact for certain activities, as argued by Gaspar and Glaeser (1998). For instance, Arzaghi and Henderson (2008) find for the advertising agency industry that agglomeration effects take place at the block level in Manhattan. The very localised nature of interactions in science is also consistent with Agrawal and Goldfarb (2008), who find that bitnet (an early version of internet) did not impact academic collaborations between very distant institutions more than between close ones. Once outside the department, the impact of other academics does not depend on where they are located.[29]

It is important to note that we control, at least partly, for the role of co-authors through the openness variables. The literature on academic networks (see for instance Laband and Tollison (2000), Rosenblat and Mobius (2004) or Goyal, van der Leij, and Moraga-González (2006)) shows that distance to co-authors has significantly increased over time. If the links to co-authors were not controlled for, research access could have had a stronger effect, at least for the first years in our sample when internet use was less widespread. Not only does having co-authors abroad and in the USA increase both the individual quantity and quality of publications for an academic, as we show in Section 4, but we also find that a larger proportion of academics in the department with co-authors abroad creates a positive publication externality for all academics, as shown by the lines 'Non-USA openness' and 'USA openness' in Table 7. We probably capture the fact that in a world where distance does not matter once outside the department, being connected with other academics elsewhere, and in particular in the USA where a large share of academic activity takes place, is important. This is fully consistent with the large role of networks in academia underlined by the literature we have just quoted. We find that all dimensions of the publication activity (probability to publish, number of publications and their quality) are affected but that the effect is larger and larger as we move across these dimensions. However, these two variables do not have a very large explanatory power, since the variance of their effect is lower than that of department size

Table 8: variance analysis of the department fixed effects for the average publication quality

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.525	1.000	0.381	1.000
Composition effects	0.207	-0.129	0.144	-0.084
Size	0.058	0.055	0.017	-0.022
Gender	0.036	-0.088	0.040	-0.023
Age	0.086	-0.016	0.068	-0.068
Positions	0.153	-0.164	0.120	-0.051
Research strategy effects	0.510	0.760	0.313	0.608
Diversity	0.139	0.537	0.105	0.465
Research Access	0.023	0.303	0.024	-0.135
Non-USA Openness	0.093	0.473	0.033	0.292
USA Openness	0.059	0.453	0.055	0.318
Heterogeneity	0.273	0.678	0.183	0.563
Stars	0.122	0.409	0.057	0.255
Residuals	0.293	0.558	0.278	0.729

The table presents the variance analysis of the estimation reported in Table 7 column (5) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 35 column (5) in Appendix G. For the meaning of the figures reported, see the note to Table 5.

while the correlation with the department fixed effect is similar, as reported in Table 37.

Similarly, both women and older academics exert positive externalities on other academics' publications, again whatever the publication dimension, but these variables have an even lower explanatory power of the department fixed effect than department size and openness. Therefore, these are not the effects that drive externality disparities between departments. Still, it is interesting to notice that two categories of academics who publish less individually, as we show in Section 4, exert a positive externality on the publications of their colleagues. Also interesting is the fact that the reverse is observed for some positions who publish more individually but exert a negative externality on other department academics. In general, we observe that less productive positions exert larger externalities (see the details of position externalities in Table 34 in Appendix G).

The variables that really drive the differences in department externalities belong to the group we label as department 'research strategy', although, like size, their effect decreases somewhat when individual fixed effects are controlled for in the first step. The first variable relates to the heterogeneity of academics in terms of publication records. The larger it is, the lower the department effects. Local externalities are strongest in the most homogeneous departments, those where people have similar publication records. Moreover, heterogeneity has the largest explanatory power of the department fixed effect, since its effect presents both the largest standard error and the largest correlation with the dependent variable (See Table 8 for the average publication quality and Tables 36, 37 and 38 in Appendix G for the probability to publish, the publication quantity and the publication top quality respectively). When individual fixed effects are controlled for, increasing heterogeneity (that is decreasing homogeneity) by 25% (corresponding to around half a standard error at the median) induces a decrease of 28% in the

[27] $2^{0.198} - 1$.

[28] $2^{0.067} - 1$ and $2^{0.172} - 1$.

[29] Alternative specifications of the research access variable, with squared distance or square root of distance as denominator, lead to similar results.

average publication top quality, of 11% in the publication quality, of 19% in the number of publications and of 16% in the probability to publish.[30] We are not aware of any similar finding in the literature.

Importantly, this positive effect of homogeneity within the department does not prevent star academics, who are in general an important source of heterogeneity, from exerting a positive externality. Having academics within the top 1% of academics in France is positive for all other academics in the department. The effect is largest for publication top quality, then around three times smaller for publication quality, and then even smaller for quantity and the probability to publish. The explanatory power of this variable is also pretty high, much larger than for the department composition variables (size, age, women, position), although it is only about half that of heterogeneity. Attracting a star to a department is difficult, since stars represent only 1% of the sample, by definition. However, the return, on top of the individual effect captured in the first step, would be large according to our estimations. For a department of average size (around 30 academics), having one more star increases the share of stars by around 0.03, which, when individual fixed effects are controlled for, increases the average publication top quality by 9.2%, the quality by 3.6% and the quantity by 7.2%.[31] These figures are of the same magnitude as the impact of dead stars on the publication record of their co-authors estimated by Azoulay *et al.* (2010), which is between 5 and 16%. An important difference here is that the effect concerns the whole department and not only the star's co-authors.

The last department characteristic we study relates to its diversity in terms of research fields. This is the characteristic with the second highest explanatory power, after heterogeneity. It has a significant positive effect on all the publication dimensions, with the largest impact on the average publication top quality. Increasing diversity by 50% (again corresponding to about half a standard error from the median) increases the average publication top quality by 36.3%, the quality by 10.4%, the quantity by 24.0% and the probability to publish by 17.3%.[32] Academics in departments with a share of publications similar in all fields do benefit from a positive externality from this variety in research fields.

Finally, when we divide our sample into two periods, 1990–1997 and 1998–2005, almost all these conclusions appear to hold for both sub-periods, as the tables in Appendix H show. This underlines the stability of agglomeration and peer effects over time, despite the dramatic changes in research technology (internet, computers, internationalisation, etc.) that occurred over that period. Two of the observed changes are a small positive impact of department size on publication quality and a non-significant impact of the share of stars on all publication dimensions over the 1990–1997 period, when individual fixed effects are controlled for.

7. Robustness checks: teaching, spatial scale, and reverse causality

Although we have already mentioned some robustness of our results, we now investigate further possible estimation issues.

[30] $1.25^{-1.485} - 1$, $1.25^{-0.504} - 1$, $1.25^{-0.930} - 1$, and $1.25^{-0.779} - 1$ respectively, from the OLS estimates in Table 35 in Appendix G.

[31] $e^{2.925\times0.03} - 1$, $e^{1.177\times0.03} - 1$, and $e^{2.313\times0.03} - 1$ respectively, from the OLS estimate in Table 35 in Appendix G.

[32] $1.50^{0.763} - 1$, $1.50^{0.244} - 1$, $1.50^{0.530} - 1$, and $1.50^{0.393} - 1$ respectively, from the OLS estimates in Table 35 in Appendix G.

Role of the teaching load

Research and teaching are often argued to be substitute activities for academics. Controlling for position fixed effects and position externalities is a first way to control for the differences in compulsory teaching hours between different academics in France. Now, within positions and even controlling for department size, departments possibly differ in terms of the number of students enrolled in their programmes. This can put more or less pressure on department academics and research time. Alternatively, a larger share of graduate students for instance may exert a positive externality on the academics' publication activity. Therefore, testing which of the two effects dominates is interesting *per se*, in addition to checking whether teaching is a possible missing variable that could bias some of our results.

Unfortunately, the number of students is only reported in our data set since 1999 and is not available for all universities, which largely reduces the number of observations. That is why we do not include such effects in our main set of estimations. Still, since 1999 and for a majority of universities, we know not only the total number of students studying economics (which we measure per academic present in the department, since the role of department size is assessed separately), but also the share of students at the undergraduate level (which in France corresponds to the first two years after high school), graduate level (third and fourth years) and postgraduate level (fifth year and PhD).

Columns (1), (3), (5) and (7) in Table 9 replicate the corresponding columns in Table 7, but on the sub-sample of observations for which data on students is available. All results are fully consistent with those described in Section 6 and none of the effects changes sign or significance, although a little precision is sometimes lost. The main conclusion is reached when the overall teaching load and the distribution of students between levels are controlled for, in columns (2), (4), (6) and (8). Our results on the determinants of the academic publication activity are therefore robust to the consideration of their second main task: teaching. Moreover, students do not seem to exert any positive or negative role on publication activity. The only significant effect concerns the fact that a larger share of students at undergraduate level increases the probability to publish. The number and quality of publications are not affected by the number and composition of students.

Spatial scale

Above, we argued that it is interesting to determine whether externalities spill over the department's boundaries, and we commented the role of the research assess variable in this perspective. Now, in many empirical economic geography studies, the spatial scale at which estimations are performed is mainly guided by data availability. It can correspond equally well to rather small units like cities as to larger ones like regions or states. We believe that for the publication activity, the department is the most relevant scale at which scientific interactions take place, which is why we chose it for our main set of estimations. Now, and closer to what is usually done in economic geography, we can consider something larger that corresponds to the city. We use employment areas, which are 341 spatial units that fully cover France and were specifically built by INSEE, the French National Institute of Statistics, to study the role of local labour markets. For many employment areas, there are either no universities or only one (for 38 universities): considering department or employment area is therefore the same. Six employment areas host two departments, four employment areas host three departments, and three employment areas host four or more departments. Tables 10 and 11, which replicate Tables 4 and 7 at the employment

Table 9: role of teaching

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Size	0.117[a]	0.115[a]	0.170[a]	0.132[a]	0.056[b]	0.056[c]	0.212[a]	0.154[c]
	(0.028)	(0.032)	(0.029)	(0.030)	(0.027)	(0.032)	(0.073)	(0.087)
Women	-0.101	-0.105	0.054	0.135	0.452[a]	0.461[a]	1.086[b]	1.002[b]
	(0.214)	(0.207)	(0.194)	(0.184)	(0.166)	(0.168)	(0.478)	(0.480)
Age	0.026[a]	0.028[a]	0.017[b]	0.019[b]	0.033[a]	0.033[a]	0.076[a]	0.084[a]
	(0.008)	(0.008)	(0.007)	(0.008)	(0.005)	(0.005)	(0.014)	(0.015)
Diversity	0.520[a]	0.463[a]	0.432[a]	0.412[a]	0.336[a]	0.327[a]	1.055[a]	1.035[a]
	(0.071)	(0.064)	(0.057)	(0.058)	(0.040)	(0.039)	(0.110)	(0.111)
Research Access	-0.017	0.007	-0.008	0.004	-0.008	-0.004	0.006	0.023
	(0.015)	(0.017)	(0.014)	(0.014)	(0.010)	(0.011)	(0.027)	(0.030)
Non-USA Openness	1.131[b]	1.088[b]	0.431	0.477	1.593[a]	1.579[a]	4.752[a]	4.939[a]
	(0.446)	(0.456)	(0.404)	(0.396)	(0.327)	(0.327)	(0.980)	(0.990)
USA Openness	1.977[b]	2.627[a]	2.099[a]	2.222[a]	0.761	0.845	4.002[b]	4.494[a]
	(0.806)	(0.881)	(0.685)	(0.715)	(0.538)	(0.558)	(1.613)	(1.629)
Heterogeneity	-1.043[a]	-1.009[a]	-1.044[a]	-1.039[a]	-0.853[a]	-0.849[a]	-2.806[a]	-2.785[a]
	(0.085)	(0.080)	(0.073)	(0.071)	(0.055)	(0.055)	(0.162)	(0.162)
Stars	2.801[b]	2.682[b]	1.642	1.427	3.493[a]	3.502[a]	13.508[a]	12.731[a]
	(1.309)	(1.236)	(1.395)	(1.359)	(1.001)	(1.019)	(2.917)	(2.913)
Teaching-load		-0.020		0.047		0.005		-0.094
		(0.045)		(0.041)		(0.032)		(0.085)
% Undergraduate		0.766[a]		0.162		0.129		0.060
		(0.160)		(0.163)		(0.126)		(0.371)
% Postgraduate		0.335		-0.057		0.076		-0.487
		(0.217)		(0.203)		(0.157)		(0.456)
Positions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.71	0.73	0.78	0.79	0.76	0.76	0.81	0.81
Observations	349	349	349	349	349	349	349	349

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively.

area level, show that once again, none of the effects changes sign or significance by comparison with the department level. Therefore, it is possible that agglomeration and peer effects in economics operate at a geographical level slightly larger than the department. Importantly, this robustness of our conclusions to the level of spatial aggregation allows us to propose an instrumentation strategy to assess the possible role of reverse causality, the issue to which we now turn.

Reverse causality

It is possible that when academics choose where to locate, they take into consideration some of the variables we explain, typically the number or the quality of publications by members of the department. As argued in Section 2, this would create a reverse causality issue in the second step estimation for almost all the variables we introduce. For instance, Combes *et al.* (2008*a*) show, for productivity in market activities, that the impact of city size would be overestimated for that reason by around 20% when using OLS. Unfortunately, gathering instruments at the department level for variables as diverse as those we consider seems an impossible task. Our instrumentation strategy is therefore based on two tricks.

Table 10: determinants of individual publications at the employment area level

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Women	-0.375^a	-0.400^a	-0.090^a	-0.421^a	0.042^a	-0.323^a	0.109^b	-1.043^a
	(0.022)	(0.015)	(0.014)	(0.039)	(0.015)	(0.039)	(0.042)	(0.101)
Age	-0.105^a	-0.097^a	-0.031^a	-0.116^a	-0.000	-0.092^a	-0.014	-0.299^a
	(0.010)	(0.006)	(0.005)	(0.010)	(0.006)	(0.010)	(0.015)	(0.027)
Age square	0.000^a	0.000^a	0.000^a	0.001^a	-0.000	0.000^a	0.000	0.001^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Authors number			-0.920^a	-0.889^a	0.295^a	0.293^a	1.061^a	1.037^a
			(0.013)	(0.010)	(0.020)	(0.011)	(0.053)	(0.029)
Non-USA Openness			0.363^a	0.336^a	0.256^a	0.247^a	0.895^a	0.861^a
			(0.014)	(0.011)	(0.020)	(0.011)	(0.058)	(0.028)
USA Openness			0.339^a	0.315^a	0.417^a	0.392^a	1.266^a	1.180^a
			(0.021)	(0.014)	(0.025)	(0.014)	(0.068)	(0.038)
Star			0.505^a	0.441^a	0.895^a	0.828^a	2.567^a	2.342^a
			(0.034)	(0.023)	(0.045)	(0.023)	(0.125)	(0.061)
Diversity			-0.131^a	-0.084^a	0.002	-0.003	0.103^a	0.088^a
			(0.010)	(0.007)	(0.010)	(0.007)	(0.027)	(0.017)
Specialisation				0.344^a		0.001		-0.001
				(0.005)		(0.006)		(0.015)
Quantity					0.088^a	0.079^a	0.495^a	0.463^a
					(0.008)	(0.005)	(0.022)	(0.013)
Selection			-0.164^a	1.928^a	-0.509^a	1.732^a	-1.631^a	5.399^a
			(0.038)	(0.237)	(0.056)	(0.237)	(0.170)	(0.624)
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jel Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Emp. Area Time FE	No	Yes	No	Yes	No	Yes	No	Yes
R^2			0.28	0.38	0.33	0.37	0.43	0.47
Observations	782730	778104	39330	39330	39330	39330	39330	39330

Standard error between brackets. ^{a}, ^{b}, ^{c}: significant at the 1%, 5% and 10% levels respectively. 'Publishing': Logit model for the probability to have at least one publication. 'Quantity', 'Quality', and 'Top quality': Heckman two-step Generalized Tobit models. The first step consists in a Probit model for the probability to publish. The variable 'Selection' in the second step is the inverse of Mills' ratio from the Probit equation. Variables are defined in Section 2.

First, we propose to evaluate the presence of reverse causality at the employment area level, for which more data is available, while OLS results are very close to those at the department level, as we have just shown. For instance, it is pretty clear that the number of academics in economics is positively correlated with the overall population of the employment area, as large cities generally host large universities. Now, the correlation between these two variables is far from perfect: - an interesting property that should make it easier to satisfy the exogeneity condition of the instruments. Not all cities have the same tradition as regards the presence of universities and some smaller cities may have larger universities. Moreover, history has led some universities to specialise in different fields and what we instrument is the size of the economics department, not the size of the whole university.

The second trick consists in instrumenting variables one by one without any further control variable. Instrumenting all variables simultaneously would require a large number of instruments and, most importantly, over-identification tests become doubtful when there are too many instrumented variables and instruments. Moreover, if instruments are shown to be valid, instrumentation solves problems of both reverse causality and missing variables, and therefore instrumental variable techniques should provide a consistent estimate for the effect of each variable even when introduced alone. Lastly, note

Table 11: determinants of employment area fixed effects

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	0.051[a]	0.051[a]	0.137[a]	0.129[a]	0.033[b]	0.040[a]	0.050	0.083[b]
	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)	(0.015)	(0.040)	(0.039)
Women	0.606[a]	0.601[a]	0.834[a]	0.755[a]	0.645[a]	0.842[a]	2.066[a]	2.723[a]
	(0.146)	(0.147)	(0.126)	(0.147)	(0.123)	(0.144)	(0.325)	(0.380)
Age	0.045[a]	0.045[a]	0.041[a]	0.031[a]	0.043[a]	0.039[a]	0.123[a]	0.106[a]
	(0.005)	(0.006)	(0.005)	(0.007)	(0.005)	(0.007)	(0.012)	(0.017)
Diversity	0.631[a]	0.631[a]	0.473[a]	0.404[a]	0.312[a]	0.347[a]	0.942[a]	0.999[a]
	(0.036)	(0.036)	(0.031)	(0.051)	(0.030)	(0.050)	(0.079)	(0.132)
Research Access	−0.008	−0.008	0.024[a]	0.031[a]	0.011	0.017[b]	0.046[b]	0.055[b]
	(0.010)	(0.010)	(0.008)	(0.009)	(0.008)	(0.008)	(0.022)	(0.022)
Non-USA Openness	1.796[a]	1.797[a]	2.040[a]	1.949[a]	2.148[a]	1.966[a]	6.954[a]	6.502[a]
	(0.333)	(0.333)	(0.288)	(0.333)	(0.280)	(0.326)	(0.741)	(0.861)
USA Openness	1.802[a]	1.800[a]	0.367	0.163	0.479	0.991[b]	2.535[b]	3.554[a]
	(0.528)	(0.528)	(0.457)	(0.442)	(0.444)	(0.428)	(1.176)	(1.135)
Heterogeneity	−1.146[a]	−1.145[a]	−1.012[a]	−0.915[a]	−0.809[a]	−0.850[a]	−2.506[a]	−2.567[a]
	(0.056)	(0.056)	(0.049)	(0.116)	(0.047)	(0.115)	(0.126)	(0.302)
Stars	3.152[b]	3.177[b]	5.683[a]	5.970[a]	5.735[a]	6.202[a]	19.793[a]	20.465[a]
	(1.232)	(1.232)	(1.065)	(1.017)	(1.036)	(0.985)	(2.743)	(2.610)
Positions	yes	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.80	0.80	0.87	0.93	0.75	0.86	0.80	0.89
Observations	767	767	767	767	767	767	767	767

Standard error between brackets. ^{a}, ^{b}, ^{c}: significant at the 1%, 5% and 10% levels respectively.

that our purpose here is not to obtain definite values for each of the effects we estimate, but only to confirm that no major endogeneity issue largely biases the conclusions drawn in the previous sections, by changing the sign or significance of some variables, for instance.

In order to perform meaningful over-identification tests, we need many instruments, possibly different in their nature. Therefore, in addition to the employment area population in 1999, which is pretty obviously a determinant of many of the explanatory variables considered, as we have just argued in the case of department size, we also use the share of engineers in local employment (still in 1999). The intuition is that hard science universities or Grandes Ecoles are often located in areas where high-tech industries, and therefore engineering professions, are over-represented. Then, given the French tradition of centralisation and following other economic geography studies on French data, we use a physical geography variable in the form of a peripherality index. This is the average distance of the employment area to all other employment areas (without any weighting, by population or employment for instance, to reduce possible endogeneity).

Tables 12 present OLS and IV estimates for the impact of some of the most important variables of the second step: size, diversity, heterogeneity and stars. To assess the quality of the instrumentation, we report the Shea partial R^2, the p-value of the over-identification test and the Cragg-Donald statistics that check for the possible weakness of the instruments. Over-identification tests are passed, except for the impact of diversity on quantity, and the instruments are not weak, in the sense that the lowest Cragg-Donald value is 12. The conclusion is that the impact of size, diversity, heterogeneity and stars on any component of research productivity is robust to instrumentation. If anything, instrumental variable estimates are of larger magnitude than OLS ones. Clearly, better assessing the role of reverse causality, which is never done in the literature on peer effects in academia, unlike studies in other domains (see for instance Bramoullé, Djebbari, and Fortin (2009) for a recent contribution), remains high on the research agenda but at least the results obtained here make us confident that the OLS estimates we present do not largely over-estimate the true impact of the variables.

Table 12: instrumental variable estimates

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Panel (a): Size only								
Size	0.140[a]	0.152[a]	0.232[a]	0.294[a]	0.107[a]	0.189[a]	0.311[a]	0.550[a]
	(0.019)	(0.028)	(0.016)	(0.025)	(0.016)	(0.020)	(0.046)	(0.059)
Shea p. R^2		0.42		0.42		0.42		0.42
J-stat p-value		0.97		0.38		0.26		0.40
Cragg-Donald		255.2		255.2		255.2		255.2
R^2	0.59	-	0.48	-	0.50	-	0.49	-
Panel (b): Diversity only								
Diversity	0.906[a]	1.227[a]	0.876[a]	2.137[a]	0.540[a]	1.453[a]	1.635[a]	4.197[a]
	(0.050)	(0.140)	(0.046)	(0.286)	(0.043)	(0.203)	(0.123)	(0.566)
Shea p. R^2		0.08		0.04		0.04		0.04
J-stat p-value		0.25		0.01		0.12		0.08
Cragg-Donald		30.9		16.7		16.2		16.2
R^2	0.73	-	0.62	-	0.60	-	0.61	-
Panel (c): Heterogeneity only								
Heterogeneity	-1.209[a]	-2.021[a]	-1.043[a]	-2.903[a]	-0.788[a]	-2.325[a]	-2.515[a]	-6.573[a]
	(0.075)	(0.438)	(0.073)	(0.613)	(0.051)	(0.435)	(0.146)	(1.266)
Shea p. R^2		0.03		0.03		0.03		0.03
J-stat p-value		0.21		0.21		0.67		0.57
Cragg-Donald		11.8		11.8		11.8		11.8
R^2	0.70	-	0.53	-	0.60	-	0.62	-
Panel (d): Stars only								
Stars	8.511[a]	22.238[a]	11.151[a]	59.541[a]	9.618[a]	26.081[a]	31.554[a]	73.877[a]
	(1.330)	(4.348)	(1.756)	(11.134)	(1.217)	(3.441)	(3.483)	(9.805)
Shea p. R^2		0.13		0.08		0.13		0.13
J-stat p-value		0.09		0.13		0.46		0.27
Cragg-Donald		52.8		29.6		52.8		52.8
R^2	0.58	-	0.40	-	0.50	-	0.51	-
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	735	735	735	735	735	735	735	735

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively. Each panel corresponds to a different estimation where a single explanatory variable is considered. Instruments for size are the logarithm of the employment area population and the share of engineers in employment in 1990. Instruments for diversity are the logarithm of population in 1990 and peripherality for publishing, the logarithm of population in 1999 and the share of engineers in employment for quantity and the logarithm of population and the share of engineers in 1990 for quality and top quality. Instruments for heterogeneity are peripherality and the share of engineers. Instruments for the share of stars are the logarithms of population in 1990 and 1999 for quantity and peripherality and the share of engineers for publishing, quality and top quality. The first steps of the IV two-stage least squares are reported in Table 53 in Appendix J.

8. Conclusion

Location matters for the publication performance of academics. A careful variance analysis of individual publication determinants shows that the explanatory power of department effects represents at least half the explanatory power of individual effects. When explaining department performance, selection and local effects have similar explanatory power. As argued by Waldinger (2012), this corresponds better to what many academics have in mind, given the time they spend assessing the relative qualities of departments. This is in sharp contrast with previous findings from the literature, which conclude to the presence of small, if not totally absent local effects. We attribute this difference in conclusions to the fact that we have access to an exhaustive data set of all academic economists in France, whom we can follow over time and across locations even when they do not publish, which presents the further advantage of not biasing the computation of department characteristics. Moreover, we also have access to more individual variables, some of which vary over time, which are usually unavailable. We also separately study the determinants of the probability to publish, the number of publications and their average quality, whereas only a quality-adjusted number of publications is generally considered in the literature.

Due to numerous possible sources of missing variable and reverse causality issues involved when estimating agglomeration and peer effects, we do not claim to present a conclusive assessment of the role of department characteristics on individual performance. The possibility of combining bibliometric and administrative sources as we do here will certainly be extended in the future (to longer periods, other fields and countries) and this should allow researchers to find even more sources of exogenous variations to properly assess the role of endogenous and exogenous individual and department characteristics. Putting more structure to the underlying models of network formation and agglomeration and peer effects, which are only implicit here and therefore treated as a black box, should also certainly help to improve the estimated specifications. Ultimately, important results should be obtained for the better design of higher education and research policies.

References

Abowd, John M., Francis Kramarz, and David N. Margolis. 1999. High wage workers and high wage firms. *Econometrica* 67(2):251–333.

Agrawal, Ajay and Avi Goldfarb. 2008. Restructuring research: Communication costs and the democratization of university innovation. *American Economic Review* 98(4):1578–1590.

Arzaghi, Mohammad and J. Vernon Henderson. 2008. Networking off madison avenue. *Review of Economic Studies* 75(4):1011–1038.

Auriol, Emmanuel, Guido Friebel, and Frauke Lammers. 2012. The firm as the locus of social comparisons: Internal labor markets versus up-or-out. Discussion Paper 8831, Centre for Economic Policy Research.

Azoulay, Pierre, Joshua S. Graff Zivin, and Jialan Wang. 2010. Superstar extinction. *Quarterly Journal of Economics* 125(2):549–589.

Besley, Tim and Maitreesh Ghatak. 2008. Social incentives. *American Economic Review* 98(2):206–211.

Borjas, George J. and Kirk B. Doran. 2012. The Collapse of the Soviet Union and the Productivity of American Mathematicians. *Quarterly Journal of Economics* 127(3):1143–1203.

Bramoullé, Yann, Habiba Djebbari, and Bernard Fortin. 2009. Identification of peer effects through social networks. *Journal of Econometrics* 150:41–55.

Combes, Pierre-Philippe, Gilles Duranton, and Laurent Gobillon. 2008*a*. Spatial wage disparities: Sorting matters! *Journal of Urban Economics* 63:723–742.

Combes, Pierre-Philippe and Laurent Linnemer. 2003. Where are the economists who publish? publication concentration and stock rankings in europe. *Journal of the European Economic Association,* 1:1250–1308.

Combes, Pierre-Philippe and Laurent Linnemer. 2010. Inferring missing citations. a quantitative multi-criteria ranking of all journals in economics. *GREQAM Working Paper* (2010-25).

Combes, Pierre-Philippe, Laurent Linnemer, and Michael Visser. 2008*b*. Publish or peer-rich (skills and networks in hiring economics professors). *Labour Economics* 15(3):456–474.

Combes, Pierre-Philippe, Thierry Mayer, and Jacques-François Thisse. 2008*c*. *Economic Geography: The integration of Regions and Nations*. New Jersey: Princeton University Press.

Dubois, Pierre, Jean-Charles Rochet, and Jean-Marc Schlenker. 2011. Productivity and mobility in academic research: Evidence from mathematicians. Processed, Toulouse School of Economics.

Ductor, Lorenzo. 2011. Does co-authorship lead to higher academic productivity? Processed, Universidad de Alicante.

Ductor, Lorenzo, Marcel Fafchamps, Sanjeev Goyal, and Marco J. van der Leij. 2011. Social networks and research output. Processed, Oxford University.

Gaspar, Jess and Edward L. Glaeser. 1998. Information technology and the future of cities. *Journal of Urban Economics* 43(1):136 – 156.

Gobillon, Laurent. 2004. The estimation of cluster effects in linear panel models. Processed, INED.

Goyal, Sanjeev, Marco J. van der Leij, and José Luis Moraga-González. 2006. Economics: An emerging small world. *Journal of Political Economy* 114:403–412.

Hellerstein, Judith K., David Neumark, and Kenneth R. Troske. 1999. Wages, productivity, and worker characteristics: Evidence from plant-level production functions and wage equations. *Journal of Labour Economics* 17(3):409–446.

Hollis, Aidan. 2001. Co-authorship and the output of academic economists. *Labour Economics* 8(4):503 – 530.

Jackson, Matthew O. 2011. An overview of social networks and economic applications. In Alberto Bisin Jess Benhabib and Matthew O. Jackson (eds.) *Handbook of Social Economics*, volume 1. Amsterdam: North-Holland, 511–585.

Jacobs, Jane. 1968. *The Economy of Cities*. New-York: Vintage.

Kim, Han E., Adair Morse, and Luigi Zingales. 2009. Are elite universities losing their competitive edge? *Journal of Financial Economics* 93:353–381.

Laband, David N. and Robert D. Tollison. 2000. Intellectual collaboration. *Journal of Political Economy* 108(3):632–662.

Lotka, Alfred James. 1926. The frequency distribution of scientific productivity. *Journal of the Whashington Academy of Sciences* 16(12):317–23.

Marshall, Alfred. 1890. *Principles of Economics*. London: Macmillan.

Medoff, Marshall H. 2003. Collaboration and the quality of economics research. *Labour Economics* 10(5):597 – 608.

Melo, Patricia C., Daniel J. Graham, and Robert B. Noland. 2009. A meta-analysis of estimates of urban agglomeration economies. *Regional Science and Urban Economics* 39(3):332–342.

Moretti, Enrico. 2011. Local labor markets. In Orley Ashenfelter and David Card (eds.) *Handbook of Labor Economics*, volume 4B. Amsterdam: North-Holland, 1237–1313.

Moulton, Brent R. 1990. An illustration of a pitfall in estimating the effects of aggregate variables on micro units. *Review of Economics and Statistics* 72(2):334–338.

Oyer, Paul. 2006. Initial labor market conditions and long-term outcomes for economists. *Journal of Economic Perspectives* 20(3):143–160.

Rosenblat, Tanya S. and Markus M. Mobius. 2004. Getting closer or drifting apart? *Quarterly Journal of Economics* 119(3):971–1009.

Rosenthal, Stuart S. and William C. Strange. 2004. Evidence on the nature and sources of agglomeration economies. In Vernon Henderson and Jacques-François Thisse (eds.) *Handbook of Regional and Urban Economics*, volume 4. Amsterdam: North-Holland, 2119–2171.

Sacerdote, Bruce. 2011. Peer effects in education: How might they work, how big are they and how much do we know thus far? In Stephen Machin Eric A. Hanushek and Ludger Woessmann (eds.) *Handbook of the Economics of Education*, volume 3. Amsterdam: Elsevier, 249 – 277.

Sauer, Raymond D. 1988. Estimates of the returns to quality and coauthorship in economic academia. *Journal of Political Economy* 96(4):855–866.

Waldinger, Fabian. 2012. Peer effects in science - Evidence from the dismissal of scientists in Nazi Germany. *Review of Economic Studies* 79(2):838–861.

Appendix A. Top 50 journals

Table 13: top 50 journals

Journal	Rank	Quality	Top quality
quarterly journal of economics	1	100.0	100.0
american economic review	2	98.1	94.4
journal of political economy	3	96.2	89.1
econometrica	4	95.7	87.7
review of economic studies	5	81.0	53.1
journal of financial economics	6	80.6	52.4
journal of monetary economics	7	75.8	43.6
review of economics and statistics	8	74.1	40.7
journal of economic theory	9	72.8	38.5
journal of finance	10	72.2	37.6
journal of econometrics	11	68.6	32.3
economic journal	12	64.5	26.8
rand journal of economics	13	63.7	25.8
journal of public economics	14	62.0	23.9
journal of international economics	15	61.5	23.3
journal of the european economic association	16	57.0	18.5
european economic review	17	55.2	16.8
journal of labor economics	18	55.1	16.7
international economic review	19	54.7	16.4
games and economic behavior	20	54.1	15.8
review of financial studies	21	49.1	11.8
journal of business and economic statistics	22	48.1	11.1
journal of health economics	23	43.9	8.5
journal of development economics	24	42.7	7.8
journal of human resources	25	42.2	7.5
journal of money, credit, and banking	26	41.9	7.3
journal of law and economics	27	40.7	6.8
journal of accounting and economics	28	40.5	6.6
journal of urban economics	29	40.0	6.4
journal of environmental economics and management	30	37.6	5.3
journal of economic growth	31	37.4	5.2
journal of economic dynamics and control	32	36.1	4.7
journal of economic behavior and organization	33	35.8	4.6
world development	34	35.8	4.6
review of economic dynamics	35	35.3	4.4
journal of applied econometrics	36	35.0	4.3
economic theory	37	34.0	3.9
econometric theory	38	33.7	3.8
journal of law, economics, and organization	39	32.1	3.3
health economics	40	31.5	3.1
american journal of agricultural economics	41	31.4	3.1
journal of industrial economics	42	31.1	3.0
international journal of industrial organization	43	31.0	3.0
journal of economic history	44	31.0	3.0
journal of economic perspectives	45	30.5	2.8
economics letters	46	30.4	2.8
journal of risk and uncertainty	47	30.0	2.7
scandinavian journal of economics	48	30.0	2.7
journal of financial and quantitative analysis	49	29.7	2.6
ecological economics	50	29.5	2.6

Appendix B. Determinants of individual publications with individual fixed effects

Table 14: determinants of individual publications with individual fixed effects

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Age square	-0.001[a]	-0.001[a]	-0.000[b]	0.000[a]	-0.000[a]	0.000	-0.001[a]	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Authors number			-0.901[a]	-0.856[a]	0.253[a]	0.252[a]	0.877[a]	0.882[a]
			(0.019)	(0.014)	(0.022)	(0.013)	(0.055)	(0.034)
Non-USA Openness			0.190[a]	0.174[a]	0.056[a]	0.063[a]	0.241[a]	0.246[a]
			(0.018)	(0.013)	(0.019)	(0.012)	(0.051)	(0.031)
USA Openness			0.215[a]	0.196[a]	0.195[a]	0.181[a]	0.522[a]	0.488[a]
			(0.026)	(0.018)	(0.023)	(0.016)	(0.065)	(0.041)
Star			0.310[a]	0.287[a]	0.587[a]	0.583[a]	1.574[a]	1.563[a]
			(0.034)	(0.027)	(0.052)	(0.025)	(0.123)	(0.063)
Diversity			-0.146[a]	-0.092[a]	0.004	0.004	0.047	0.052[a]
			(0.011)	(0.008)	(0.012)	(0.008)	(0.031)	(0.019)
Specialisation				0.346[a]		0.008[c]		0.035[a]
				(0.005)		(0.005)		(0.012)
Quantity					0.059[a]	0.056[a]	0.356[a]	0.346[a]
					(0.006)	(0.005)	(0.016)	(0.012)
Selection			-0.085[c]	2.310[a]	0.043	1.552[a]	0.083	4.550[a]
			(0.046)	(0.384)	(0.050)	(0.349)	(0.126)	(0.894)
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jel Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department Time FE	No	Yes	No	Yes	No	Yes	No	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2			0.51	0.60	0.63	0.66	0.71	0.73
Observations	427662	425178	38984	38984	38984	38984	38984	38984

Standard error between brackets. [a], [b], [c] Significant at the 1%, 5% and 10% levels respectively.

Appendix C. Variance analysis of individual publication quality

Table 15: variance analysis of average individual publication quality

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quality	0.452	1.000		0.452	1.000	
Individual effects	0.482	0.424	0.188	0.503	0.673	0.089
Individual fixed effect	-	-	-	0.358	0.683	0.061
Gender	0.068	0.050	0.006	-	-	-
Age	0.285	0.132	-0.052	0.015	-0.134	0.031
Position fixed effect	0.273	0.157	0.199	0.141	0.081	0.007
Authors number	0.060	0.215	0.059	0.054	0.215	0.045
Non-USA openness	0.048	0.277	0.133	0.012	0.277	0.070
USA openness	0.055	0.317	0.173	0.027	0.317	0.106
Star	0.072	0.338	0.205	0.054	0.338	0.124
Individual diversity	0.002	-0.141	-0.187	0.001	0.141	0.156
Jel fixed effect	0.260	0.204	0.066	0.247	0.174	0.034
Department effects	0.237	0.367	1.000	0.156	0.242	1.000
Department fixed effect	0.238	0.366	1.000	0.157	0.240	1.000
Specialisation	0.003	0.039	-0.145	0.004	0.039	-0.100
Quantity	0.034	0.134	0.088	0.025	0.134	0.034
Selection	0.390	-0.305	-0.425	0.297	-0.280	-0.316
Residuals	0.352	0.779	0	0.265	0.586	0

The table presents the variance analysis of the estimation reported in Table 4 column (6) and of the same regression also including individual fixed effects that is reported in Table 14 column (6) in Appendix B.

Table 16: variance analysis of individual publication top quality

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: top quality	1.303	1.000		1.303	1.000	
Individual effects	1.610	0.484	0.202	1.517	0.724	0.139
Individual fixed effect	-	-	-	0.998	0.739	0.133
Gender	0.235	0.070	0.005	-	-	-
Age	0.943	0.142	-0.047	0.087	0.144	-0.033
Position fixed effect	0.926	0.198	0.205	0.435	0.134	0.036
Authors number	0.213	0.236	0.062	0.190	0.236	0.032
Non-USA openness	0.169	0.335	0.140	0.048	0.335	0.082
USA openness	0.166	0.360	0.182	0.072	0.360	0.115
Star	0.200	0.375	0.218	0.145	0.375	0.131
Individual diversity	0.024	0.179	0.192	0.017	0.179	0.161
Jel fixed effect	0.874	0.228	0.073	0.724	0.201	0.036
Department effects	0.758	0.400	1.000	0.416	0.267	0.999
Department fixed effect	0.760	0.398	1.000	0.417	0.263	1.000
Specialisation	0.012	0.071	-0.144	0.017	0.071	-0.117
Quantity	0.202	0.214	0.096	0.158	0.214	0.041
Selection	1.313	-0.364	-0.445	0.869	-0.337	-0.335
Residuals	0.924	0.709	0	0.678	0.520	0

The table presents the variance analysis of the estimation reported in Table 4 column (8) and of the same regression also including individual fixed effects that is reported in Table 14 column (8) in Appendix B.

Appendix D. Determinants of individual publications with the details of position effects

Table 17: determinants of individual publication with detailed position effects

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Women	-0.368^a	-0.373^a	-0.090^a	-0.376^a	0.043^a	-0.297^a	0.102^b	-1.024^a
	(0.022)	(0.015)	(0.013)	(0.035)	(0.014)	(0.036)	(0.041)	(0.093)
Age	-0.104^a	-0.090^a	-0.030^a	-0.107^a	0.002	-0.084^a	-0.010	-0.292^a
	(0.010)	(0.006)	(0.005)	(0.010)	(0.005)	(0.010)	(0.015)	(0.026)
Age square	0.000^a	0.000^a	0.000^a	0.001^a	-0.000	0.000^a	0.000	0.001^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
A-CR	-0.530^a	-0.432^a	0.036	-0.275^a	0.189^a	-0.191^a	0.644^a	-0.626^a
	(0.100)	(0.065)	(0.041)	(0.053)	(0.061)	(0.053)	(0.167)	(0.139)
A-MCF	-2.147^a	-2.232^a	0.205^a	-1.227^a	0.458^a	-1.187^a	1.351^a	-4.018^a
	(0.165)	(0.099)	(0.067)	(0.180)	(0.061)	(0.181)	(0.173)	(0.476)
A-PR	0.727^a	1.079^a	0.232^b	1.318^a	0.359^a	1.076^a	1.220^a	3.709^a
	(0.260)	(0.061)	(0.117)	(0.119)	(0.073)	(0.120)	(0.203)	(0.315)
Other	-0.987^a	-0.971^a	0.328^a	-0.514^a	0.412^b	-0.463^a	1.062^c	-1.866^a
	(0.284)	(0.158)	(0.100)	(0.147)	(0.197)	(0.149)	(0.620)	(0.390)
CR cnrs	0.737^a	0.556^a	0.121^a	0.560^a	0.078^a	0.564^a	0.210^a	1.815^a
	(0.037)	(0.026)	(0.023)	(0.056)	(0.028)	(0.057)	(0.078)	(0.149)
CR inra	0.763^a	0.683^a	0.060^b	0.561^a	0.060^c	0.492^a	0.241^b	1.774^a
	(0.060)	(0.044)	(0.028)	(0.073)	(0.036)	(0.073)	(0.104)	(0.193)
DE ehess	2.625^a	2.002^a	0.155^b	1.724^a	-0.068	1.640^a	0.334	5.864^a
	(0.086)	(0.071)	(0.075)	(0.196)	(0.094)	(0.198)	(0.247)	(0.519)
DR cnrs	1.623^a	1.384^a	0.230^a	1.288^a	0.006	1.175^a	-0.022	3.777^a
	(0.051)	(0.031)	(0.030)	(0.131)	(0.039)	(0.133)	(0.109)	(0.348)
DR inra	1.314^a	1.175^a	0.140^a	1.014^a	-0.114^a	0.787^a	-0.357^a	2.735^a
	(0.049)	(0.042)	(0.031)	(0.117)	(0.039)	(0.118)	(0.113)	(0.310)
PR	1.143^a	1.062^a	0.176^a	1.019^a	-0.094^a	0.845^a	-0.152^b	2.933^a
	(0.027)	(0.014)	(0.020)	(0.101)	(0.025)	(0.102)	(0.073)	(0.267)
Insee	1.744^a	1.287^a	0.209^a	1.102^a	0.218^b	1.150^a	0.779^a	3.844^a
	(0.138)	(0.066)	(0.053)	(0.134)	(0.085)	(0.136)	(0.203)	(0.356)
IPC	1.998^a	1.464^a	0.342^a	1.358^a	0.124^b	1.232^a	0.577^a	4.131^a
	(0.114)	(0.079)	(0.062)	(0.144)	(0.058)	(0.145)	(0.179)	(0.381)
No-05	-0.974^a	-0.933^a	0.104^a	-0.671^a	0.221^a	-0.597^a	0.742^a	-1.958^a
	(0.045)	(0.023)	(0.024)	(0.085)	(0.029)	(0.086)	(0.086)	(0.225)
No-37	-1.534^a	-1.411^a	-0.190^a	-1.247^a	0.110	-1.168^a	0.422^c	-3.684^a
	(0.144)	(0.094)	(0.066)	(0.132)	(0.095)	(0.133)	(0.236)	(0.350)
Authors number			-0.917^a	-0.868^a	0.292^a	0.279^a	1.050^a	0.989^a
			(0.014)	(0.010)	(0.018)	(0.011)	(0.047)	(0.029)
Non-USA Openness			0.362^a	0.319^a	0.253^a	0.242^a	0.889^a	0.854^a
			(0.014)	(0.010)	(0.018)	(0.011)	(0.052)	(0.028)
USA Openness			0.338^a	0.322^a	0.408^a	0.377^a	1.243^a	1.129^a
			(0.021)	(0.014)	(0.025)	(0.014)	(0.073)	(0.038)
Star			0.492^a	0.413^a	0.877^a	0.772^a	2.504^a	2.156^a
			(0.032)	(0.023)	(0.045)	(0.023)	(0.123)	(0.061)
Diversity			-0.131^a	-0.060^a	-0.002	-0.007	0.087^a	0.074^a
			(0.011)	(0.007)	(0.010)	(0.007)	(0.027)	(0.017)
Specialisation				0.368^a		0.007		0.024^c
				(0.005)		(0.005)		(0.013)
Quantity					0.087^a	0.075^a	0.491^a	0.442^a
					(0.007)	(0.005)	(0.019)	(0.014)
Selection			-0.180^a	1.861^a	-0.565^a	1.662^a	-1.743^a	5.600^a
			(0.036)	(0.232)	(0.047)	(0.234)	(0.142)	(0.614)
Jel Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department Time FE	No	Yes	No	Yes	No	Yes	No	Yes
R^2			0.28	0.43	0.33	0.40	0.43	0.50
Observations	771426	760122	38984	38984	38984	38984	38984	38984

Standard error between brackets. ^{a}, ^{b}, ^{c}: significant at the 1%, 5% and 10% levels respectively. A-CR: other research fellow; A-MCF: non-university assistant professor; A-PR: non-university professor; CR cnrs: CNRS research fellow; CR inra: INRA research fellow; DE ehess: EHESS research professor; DR cnrs: CNRS research professor; DR inra: INRA research professor; PR: university professor; Insee: national statistical institute engineers; IPC: Ponts-et-Chaussées engineers. Reference: assistant professor. No-05: Pure economist professor position ('section 5'); No-37: Pure economist research position ('section 37').

Appendix E. Variance analysis at the department level

Table 18: variance analysis of the quantity published at the department level

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quantity	0.373	1.000		0.373	1.000	
Individual effects	0.432	0.413	0.242	0.527	0.496	0.047
Individual fixed effect	-	-	-	0.435	0.213	-0.115
Gender	0.075	0.112	0.059	-	-	-
Age	0.278	-0.065	-0.074	0.177	0.087	0.031
Position fixed effect	0.347	0.194	0.222	0.239	0.158	0.109
Authors number	0.211	0.486	0.018	0.208	0.486	0.037
Non-USA openness	0.052	0.074	0.096	0.028	0.074	0.081
USA openness	0.033	0.109	0.252	0.020	0.109	0.204
Star	0.031	0.242	0.296	0.022	0.242	0.253
Individual diversity	0.018	0.118	-0.353	0.027	0.118	-0.347
Jel fixed effect	0.174	0.007	0.135	0.236	0.004	0.142
Department effects	0.500	0.555	0.946	0.482	0.364	0.948
Department fixed effect	0.617	0.446	1.000	0.591	0.293	1.000
Specialisation	0.217	0.011	-0.666	0.204	0.011	-0.656
Selection	0.591	-0.140	-0.696	0.575	-0.111	-0.649
Residuals	0.001	-0.022	0	0.001	-0.011	0

The table presents the variance analysis of the estimation reported in Table 4 column (4) and of the same regression also including individual fixed effects that is reported in Table 14 column (4) in Appendix B, once they are averaged by department.

Table 19: variance analysis of the publication top quality at the department level

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: top quality	1.282	1.000		1.282	1.000	
Individual effects	1.652	0.583	0.250	1.619	0.784	0.115
Individual fixed effect	-	-	-	1.102	0.778	0.087
Gender	0.204	0.070	0.006	-	-	-
Age	0.883	0.090	-0.113	0.078	0.070	-0.046
Position fixed effect	1.020	0.369	0.274	0.373	0.223	-0.005
Authors number	0.241	0.348	0.074	0.215	0.348	0.073
Non-USA openness	0.139	0.453	0.193	0.040	0.453	0.129
USA openness	0.115	0.525	0.343	0.050	0.525	0.256
Star	0.162	0.567	0.384	0.117	0.567	0.230
Individual diversity	0.022	0.247	0.390	0.015	0.247	0.347
Jel fixed effect	0.721	0.263	0.108	0.604	0.222	0.048
Department effects	1.615	0.661	1.000	1.033	0.449	1.000
Department fixed effect	1.622	0.660	1.000	1.041	0.448	1.000
Specialisation	0.014	-0.124	-0.461	0.020	-0.124	-0.409
Quantity	0.165	0.215	0.140	0.129	0.215	-0.003
Selection	1.778	-0.442	-0.678	1.132	-0.423	-0.568
Residuals	0.001	-0.032	0	0.001	0.031	0

The table presents the variance analysis of the estimation reported in Table 4 column (8) and of the same regression also including individual fixed effects that is reported in Table 14 column (8) in Appendix B, once they are averaged by department.

Appendix F. First step estimation analysis for the two subperiods, 1990–1997 and 1998–2005

A. Determinants of individual publications

Table 20: determinants of individual publications without individual fixed effects

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Women	-0.588[a]	-0.650[a]	-0.013	-0.739[a]	0.067[b]	-0.587[a]	0.159[b]	-1.836[a]
	(0.045)	(0.032)	(0.022)	(0.110)	(0.027)	(0.111)	(0.075)	(0.291)
Women$\times\mathbb{1}(t \geq 1998)$	0.285[a]	0.362[a]	-0.109[a]	0.428[a]	-0.035	0.396[a]	-0.092	1.088[a]
	(0.051)	(0.036)	(0.028)	(0.115)	(0.031)	(0.116)	(0.088)	(0.304)
Age	-0.145[a]	-0.114[a]	-0.024[a]	-0.160[a]	-0.003	-0.131[a]	-0.025	-0.410[a]
	(0.019)	(0.011)	(0.008)	(0.022)	(0.008)	(0.022)	(0.022)	(0.059)
Age$\times\mathbb{1}(t \geq 1998)$	0.051[b]	0.028[b]	-0.008	0.061[b]	0.008	0.071[a]	0.019	0.167[b]
	(0.023)	(0.013)	(0.010)	(0.025)	(0.011)	(0.025)	(0.028)	(0.066)
Age square	0.001[a]	0.001[a]	0.000[c]	0.001[a]	0.000	0.001[a]	0.000	0.002[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age square$\times\mathbb{1}(t \geq 1998)$	-0.001[b]	-0.000[c]	0.000	-0.000[b]	-0.000	-0.001[a]	-0.000	-0.001[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Authors number			-0.924[a]	-0.859[a]	0.326[a]	0.296[a]	1.180[a]	1.082[a]
			(0.020)	(0.017)	(0.033)	(0.019)	(0.089)	(0.051)
Authors number$\times\mathbb{1}(t \geq 1998)$			0.006	-0.017	-0.045	-0.018	-0.175[c]	-0.120[c]
			(0.027)	(0.021)	(0.039)	(0.024)	(0.105)	(0.062)
Non-USA Openness			0.397[a]	0.335[a]	0.183[a]	0.189[a]	0.740[a]	0.740[a]
			(0.029)	(0.021)	(0.034)	(0.022)	(0.091)	(0.057)
Non-USA Openness$\times\mathbb{1}(t \geq 1998)$			-0.052	-0.024	0.090[b]	0.068[a]	0.179	0.140[b]
			(0.033)	(0.025)	(0.039)	(0.025)	(0.110)	(0.066)
USA Openness			0.359[a]	0.342[a]	0.382[a]	0.363[a]	1.092[a]	1.030[a]
			(0.037)	(0.027)	(0.054)	(0.027)	(0.150)	(0.071)
USA Openness$\times\mathbb{1}(t \geq 1998)$			-0.031	-0.034	0.022	0.011	0.178	0.120
			(0.045)	(0.031)	(0.061)	(0.032)	(0.171)	(0.084)
Star			0.603[a]	0.496[a]	0.950[a]	0.827[a]	2.746[a]	2.348[a]
			(0.048)	(0.036)	(0.069)	(0.037)	(0.191)	(0.096)
Star$\times\mathbb{1}(t \geq 1998)$			-0.172[a]	-0.122[a]	-0.111	-0.095[b]	-0.335	-0.302[b]
			(0.064)	(0.047)	(0.094)	(0.048)	(0.258)	(0.126)
Diversity			-0.197[a]	-0.123[a]	0.030[c]	0.026[b]	0.125[a]	0.114[a]
			(0.016)	(0.012)	(0.018)	(0.012)	(0.045)	(0.032)
Diversity$\times\mathbb{1}(t \geq 1998)$			0.095[a]	0.091[a]	-0.050[b]	-0.048[a]	-0.064	-0.059
			(0.021)	(0.014)	(0.022)	(0.014)	(0.056)	(0.038)
Specialisation				0.352[a]		-0.006		0.011
				(0.008)		(0.009)		(0.024)
Specialisation$\times\mathbb{1}(t \geq 1998)$				0.023[b]		0.016		0.013
				(0.010)		(0.011)		(0.029)
Quantity					0.123[a]	0.113[a]	0.619[a]	0.555[a]
					(0.013)	(0.010)	(0.038)	(0.027)
Quantity$\times\mathbb{1}(t \geq 1998)$					-0.049[a]	-0.050[a]	-0.177[a]	-0.151[a]
					(0.015)	(0.012)	(0.044)	(0.031)
Selection			-0.152[a]	2.828[a]	-0.318[a]	2.331[a]	-0.956[a]	7.013[a]
			(0.041)	(0.452)	(0.060)	(0.457)	(0.176)	(1.200)
Selection$\times\mathbb{1}(t \geq 1998)$			-0.022	-1.117[b]	-0.410[a]	-1.206[b]	-1.314[a]	-2.468[c]
			(0.064)	(0.531)	(0.085)	(0.537)	(0.258)	(1.409)
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jel Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department Time FE	No	Yes	No	Yes	No	Yes	No	Yes
R^2			0.29	0.43	0.34	0.40	0.44	0.50
Observations	771426	760122	38984	38984	38984	38984	38984	38984

Standard error between brackets. [a], [b], [c] Significant at the 1%, 5% and 10% level, respectively. Crossed terms (with $\mathbb{1}(t \geq 1998)$) indicate the additional effect for the 1998-2005 period.

Table 21: Determinants of individual publications with individual fixed effects

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Age square	-0.001^a	-0.001^a	-0.000	0.000^c	-0.001^a	-0.000^a	-0.002^a	-0.001^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age square$\times\mathbb{1}(t \geq 1998)$	0.000	0.000	0.000	-0.000	0.000^a	-0.000	0.000^a	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Authors number			-0.947^a	-0.888^a	0.209^a	0.229^a	0.787^a	0.862^a
			(0.025)	(0.021)	(0.036)	(0.020)	(0.089)	(0.052)
Authors number$\times\mathbb{1}(t \geq 1998)$			0.070^a	0.048^b	0.070^c	0.040^c	0.147	0.046
			(0.026)	(0.023)	(0.038)	(0.023)	(0.096)	(0.059)
Non-USA Openness			0.244^a	0.225^a	-0.035	-0.017	0.089	0.123^b
			(0.031)	(0.023)	(0.038)	(0.021)	(0.097)	(0.054)
Non-USA Openness$\times\mathbb{1}(t \geq 1998)$			-0.077^b	-0.069^a	0.119^a	0.106^a	0.194^b	0.164^a
			(0.033)	(0.025)	(0.038)	(0.023)	(0.099)	(0.059)
USA Openness			0.286^a	0.260^a	0.139^a	0.128^a	0.377^a	0.370^a
			(0.042)	(0.030)	(0.049)	(0.028)	(0.135)	(0.071)
USA Openness$\times\mathbb{1}(t \geq 1998)$			-0.097^b	-0.081^b	0.061	0.059^c	0.166	0.131^c
			(0.043)	(0.033)	(0.055)	(0.030)	(0.145)	(0.078)
Star			0.327^a	0.331^a	0.688^a	0.685^a	1.824^a	1.849^a
			(0.048)	(0.038)	(0.063)	(0.034)	(0.150)	(0.088)
Star$\times\mathbb{1}(t \geq 1998)$			-0.019	-0.063	-0.159^b	-0.174^a	-0.384^b	-0.471^a
			(0.052)	(0.046)	(0.070)	(0.042)	(0.181)	(0.109)
Diversity			-0.201^a	-0.149^a	0.021	0.015	0.003	-0.017
			(0.015)	(0.013)	(0.020)	(0.012)	(0.049)	(0.030)
Diversity$\times\mathbb{1}(t \geq 1998)$			0.085^a	0.087^a	-0.027	-0.018	0.066	0.102^a
			(0.018)	(0.015)	(0.022)	(0.014)	(0.053)	(0.035)
Specialisation				0.319^a		-0.004		0.019
				(0.008)		(0.008)		(0.020)
Specialisation$\times\mathbb{1}(t \geq 1998)$				0.042^a		0.017^c		0.022
				(0.010)		(0.009)		(0.024)
Quantity					0.065^a	0.069^a	0.408^a	0.407^a
					(0.012)	(0.009)	(0.033)	(0.023)
Quantity$\times\mathbb{1}(t \geq 1998)$					-0.010	-0.017^c	-0.075^b	-0.083^a
					(0.013)	(0.010)	(0.036)	(0.026)
Selection			0.013	0.926^a	0.145^b	0.746^a	0.330^b	1.472^a
			(0.055)	(0.193)	(0.062)	(0.175)	(0.156)	(0.448)
Selection$\times\mathbb{1}(t \geq 1998)$			-0.108	-0.081	-0.171^b	0.326^c	-0.420^b	0.922^b
			(0.073)	(0.192)	(0.078)	(0.175)	(0.202)	(0.447)
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jel Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department Time FE	No	Yes	No	Yes	No	Yes	No	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2			0.51	0.60	0.63	0.66	0.71	0.73
Observations	427662	425178	38984	38984	38984	38984	38984	38984

Standard error between brackets. ^{a}, ^{b}, ^{c} Significant at the 1%, 5% and 10% level, respectively. Crossed terms (with $\mathbb{1}(t \geq 1998)$) indicate the additional effect for the 1998-2005 period.

B. Variance analysis of individual publications

Table 22: Variance analysis of the individual publication quantity, 1990-1997

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quantity	0.464	1.000		0.464	1.000	
Individual effects	0.710	0.309	0.112	0.373	0.635	-0.050
Individual fixed effect	-	-	-	0.314	0.378	-0.080
Gender	0.165	0.055	-0.038	-	-	-
Age	0.454	0.029	-0.050	0.108	-0.019	0.017
Position fixed effect	0.511	0.112	0.168	0.114	0.072	0.027
Authors number	0.206	0.380	-0.061	0.213	0.380	-0.011
Non-USA openness	0.063	0.112	0.089	0.043	0.112	0.060
USA openness	0.052	0.116	0.142	0.039	0.116	0.081
Star	0.057	0.208	0.211	0.038	0.208	0.130
Individual diversity	0.042	0.067	-0.198	0.051	0.067	-0.132
Jel fixed effect	0.362	0.093	0.050	0.105	0.098	0.001
Department effects	0.396	0.307	0.883	0.223	0.380	0.659
Department fixed effect	0.405	0.146	1.000	0.200	0.142	1.000
Specialisation	0.194	0.320	-0.286	0.176	0.320	-0.302
Selection	0.764	-0.155	-0.473	0.202	-0.143	-0.308
Residuals	0.334	0.721	0	0.287	0.596	0

The table presents the variance analysis of the estimation reported in Table 20 column (4) and of the same regression also including individual fixed effects that is reported in Table 21 column (4) for the 1990-1997 period.

Table 23: Variance analysis of the individual publication quantity, 1998-2005

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quantity	0.452	1.000		0.452	1.000	
Individual effects	0.392	0.335	0.092	0.324	0.628	-0.071
Individual fixed effect	-	-	-	0.290	0.413	-0.055
Gender	0.072	0.109	0.041	-	-	-
Age	0.267	0.021	-0.043	0.090	-0.010	0.002
Position fixed effect	0.282	0.088	0.098	0.106	0.077	-0.071
Authors number	0.179	0.341	-0.016	0.171	0.341	-0.016
Non-USA openness	0.062	0.109	0.109	0.031	0.109	0.063
USA openness	0.045	0.118	0.110	0.026	0.118	0.059
Star	0.031	0.149	0.117	0.022	0.149	0.080
Individual diversity	0.010	0.037	-0.154	0.020	0.037	-0.098
Jel fixed effect	0.172	0.086	0.036	0.068	0.107	-0.006
Department effects	0.243	0.376	0.685	0.200	0.373	0.515
Department fixed effect	0.205	0.146	1.000	0.136	0.111	1.000
Specialisation	0.181	0.339	-0.212	0.174	0.339	-0.192
Selection	0.378	-0.124	-0.361	0.153	-0.113	-0.193
Residuals	0.354	0.782	0	0.293	0.656	0

The table presents the variance analysis of the estimation reported in Table 20 column (4) and of the same regression also including individual fixed effects that is reported in Table 21 column (4) for the 1998-2005 period.

Table 24: Variance analysis of the individual average publication quality, 1990-1997

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quality	0.501	1.000		0.501	1.000	
Individual effects	0.682	0.383	0.181	0.450	0.719	-0.029
Individual fixed effect	-	-	-	0.354	0.612	-0.039
Gender	0.131	0.032	-0.044	-	-	-
Age	0.374	0.113	-0.036	0.167	0.116	0.003
Position fixed effect	0.397	0.153	0.196	0.105	-0.018	-0.108
Authors number	0.071	0.225	0.095	0.055	0.225	0.058
Non-USA openness	0.036	0.244	0.087	0.003	-0.244	0.022
USA openness	0.055	0.327	0.164	0.019	0.327	0.059
Star	0.096	0.391	0.225	0.079	0.391	0.073
Individual diversity	0.009	0.161	0.208	0.005	0.161	0.106
Jel fixed effect	0.380	0.191	0.060	0.163	0.244	0.006
Department effects	0.341	0.355	1.000	0.163	0.235	1.000
Department fixed effect	0.341	0.355	1.000	0.163	0.236	1.000
Specialisation	0.003	-0.015	0.180	0.002	-0.015	0.040
Quantity	0.052	0.142	0.069	0.032	0.142	-0.011
Selection	0.630	-0.277	-0.461	0.163	-0.248	-0.192
Residuals	0.379	0.756	0	0.295	0.594	0

The table presents the variance analysis of the estimation reported in Table 20 column (6) and of the same regression also including individual fixed effects that is reported in Table 21 column (6) for the 1990-1997 period.

Table 25: Variance analysis of the individual average publication quality, 1998-2005

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quality	0.430	1.000		0.430	1.000	
Individual effects	0.365	0.463	0.210	0.429	0.729	0.087
Individual fixed effect	-	-	-	0.325	0.654	0.075
Gender	0.044	0.058	0.031	-	-	-
Age	0.220	0.141	-0.051	0.171	0.143	-0.031
Position fixed effect	0.197	0.167	0.204	0.112	0.069	-0.010
Authors number	0.057	0.209	0.050	0.055	0.209	0.042
Non-USA openness	0.052	0.293	0.156	0.018	0.293	0.095
USA openness	0.054	0.313	0.186	0.027	0.313	0.113
Star	0.060	0.306	0.197	0.042	0.306	0.111
Individual diversity	0.007	-0.131	-0.181	0.001	-0.131	-0.151
Jel fixed effect	0.184	0.222	0.080	0.169	0.178	0.047
Department effects	0.185	0.380	1.000	0.116	0.232	0.999
Department fixed effect	0.185	0.378	1.000	0.117	0.229	1.000
Specialisation	0.005	0.051	-0.120	0.006	0.051	-0.073
Quantity	0.028	0.130	0.093	0.023	0.130	0.036
Selection	0.249	-0.321	-0.407	0.194	-0.297	-0.289
Residuals	0.339	0.788	0	0.250	0.579	0

The table presents the variance analysis of the estimation reported in Table 20 column (6) and of the same regression also including individual fixed effects that is reported in Table 21 column (6) for the 1998-2005 period.

Table 26: Variance analysis of the individual average publication top quality, 1990-1997

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: top quality	1.401	1.000		1.401	1.000	
Individual effects	2.088	0.461	0.203	1.276	0.792	-0.044
Individual fixed effect	-	-	-	1.043	0.627	-0.054
Gender	0.409	0.051	-0.047	-	-	-
Age	1.130	0.115	-0.036	0.561	0.118	-0.004
Position fixed effect	1.235	0.218	0.211	0.280	0.038	-0.020
Authors number	0.259	0.257	0.092	0.207	0.257	0.001
Non-USA openness	0.140	0.315	0.099	0.023	0.315	-0.023
USA openness	0.156	0.373	0.175	0.056	0.373	0.032
Star	0.271	0.444	0.243	0.214	0.444	0.049
Individual diversity	0.039	0.192	0.214	0.006	-0.192	-0.091
Jel fixed effect	1.138	0.215	0.073	0.363	0.291	-0.009
Department effects	1.015	0.392	1.000	0.383	0.199	1.000
Department fixed effect	1.017	0.392	1.000	0.383	0.198	1.000
Specialisation	0.006	0.047	-0.182	0.010	0.047	-0.040
Quantity	0.257	0.230	0.088	0.189	0.230	0.002
Selection	1.894	-0.349	-0.482	0.322	-0.315	-0.156
Residuals	0.948	0.677	0	0.726	0.512	0

The table presents the variance analysis of the estimation reported in Table 20 column (8) and of the same regression also including individual fixed effects that is reported in Table 21 column (8) for the 1990-1997 period.

Table 27: Variance analysis of the individual average publication top quality, 1998-2005

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: top quality	1.261	1.000		1.261	1.000	
Individual effects	1.352	0.504	0.214	1.215	0.793	0.143
Individual fixed effect	-	-	-	0.968	0.650	0.135
Gender	0.173	0.077	0.031	-	-	-
Age	0.817	0.155	-0.042	0.590	0.156	-0.024
Position fixed effect	0.756	0.192	0.204	0.310	0.075	-0.002
Authors number	0.197	0.225	0.056	0.186	0.225	0.042
Non-USA openness	0.177	0.344	0.159	0.058	0.344	0.101
USA openness	0.167	0.355	0.194	0.073	0.355	0.123
Star	0.168	0.336	0.202	0.113	0.336	0.113
Individual diversity	0.017	0.172	0.188	0.027	0.172	0.133
Jel fixed effect	0.719	0.240	0.078	0.405	0.221	0.048
Department effects	0.636	0.409	1.000	0.276	0.274	0.997
Department fixed effect	0.637	0.406	1.000	0.277	0.267	1.000
Specialisation	0.012	0.082	-0.119	0.020	0.082	-0.075
Quantity	0.183	0.207	0.094	0.147	0.207	0.033
Selection	1.004	-0.374	-0.428	0.434	-0.349	-0.272
Residuals	0.911	0.722	0	0.655	0.523	0

The table presents the variance analysis of the estimation reported in Table 20 column (8) and of the same regression also including individual fixed effects that is reported in Table 21 column (8) for the 1998-2005 period.

C. Variance analysis at the department level

Table 28: Variance analysis of the quantity published at the department level, 1990-1997

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quantity	0.415	1.000		0.415	1.000	
Individual effects	0.740	0.364	0.173	0.433	0.620	-0.143
Individual fixed effect	-	-	-	0.365	0.301	-0.254
Gender	0.151	0.047	-0.042	-	-	-
Age	0.446	-0.041	-0.015	0.101	0.061	-0.059
Position fixed effect	0.566	0.233	0.152	0.131	0.095	0.023
Authors number	0.231	0.506	-0.006	0.238	0.506	0.098
Non-USA openness	0.059	0.087	0.039	0.040	0.087	0.041
USA openness	0.034	0.104	0.331	0.026	0.104	0.190
Star	0.041	0.256	0.417	0.027	0.256	0.260
Individual diversity	0.037	0.148	-0.429	0.045	0.148	-0.284
Jel fixed effect	0.324	0.022	0.128	0.100	-0.007	0.096
Department effects	0.785	0.357	0.975	0.397	0.433	0.906
Department fixed effect	0.917	0.308	1.000	0.482	0.361	1.000
Specialisation	0.230	-0.012	-0.659	0.208	-0.012	-0.591
Selection	1.038	-0.129	-0.737	0.268	-0.092	-0.550
Residuals	0.001	0.041	0	0.001	0.056	0

The table presents the variance analysis of the estimation reported in Table 20 column (4) and of the same regression also including individual fixed effects that is reported in Table 21 column (4) for the 1990-1997 period, once they are averaged by department.

Table 29: Variance analysis of the quantity published at the department level, 1998-2005

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quantity	0.333	1.000		0.333	1.000	
Individual effects	0.347	0.421	0.236	0.356	0.600	-0.188
Individual fixed effect	-	-	-	0.306	0.335	-0.207
Gender	0.061	0.189	0.193	-	-	-
Age	0.238	-0.094	-0.122	0.079	0.117	0.035
Position fixed effect	0.295	0.191	0.233	0.123	0.082	-0.051
Authors number	0.192	0.459	-0.017	0.185	0.459	-0.024
Non-USA openness	0.047	0.062	0.149	0.023	0.062	0.054
USA openness	0.032	0.117	0.207	0.019	0.117	0.084
Star	0.026	0.221	0.155	0.018	0.221	0.131
Individual diversity	0.009	0.085	-0.342	0.018	0.085	-0.246
Jel fixed effect	0.129	-0.004	0.149	0.052	-0.037	0.072
Department effects	0.427	0.601	0.939	0.303	0.464	0.866
Department fixed effect	0.526	0.468	1.000	0.371	0.353	1.000
Specialisation	0.193	0.053	-0.650	0.186	0.053	-0.580
Selection	0.477	-0.147	-0.686	0.184	-0.119	-0.428
Residuals	0.001	-0.029	0	0.001	-0.062	0

The table presents the variance analysis of the estimation reported in Table 20 column (4) and of the same regression also including individual fixed effects that is reported in Table 21 column (4) for the 1998-2005 period, once they are averaged by department.

Table 30: Variance analysis of the publication quality at the department level, 1990-1997

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quality	0.469	1.000		0.469	1.000	
Individual effects	0.735	0.448	0.169	0.490	0.704	-0.094
Individual fixed effect	-	-	-	0.425	0.612	-0.087
Gender	0.120	0.040	-0.055	-	-	-
Age	0.367	0.045	-0.062	0.156	0.024	0.049
Position fixed effect	0.451	0.307	0.153	0.130	-0.100	-0.202
Authors number	0.079	0.361	0.121	0.061	0.361	0.175
Non-USA openness	0.033	0.308	0.077	0.003	-0.308	-0.025
USA openness	0.036	0.482	0.326	0.013	0.482	0.163
Star	0.068	0.501	0.395	0.056	0.501	0.130
Individual diversity	0.008	0.235	0.431	0.004	0.235	0.234
Jel fixed effect	0.338	0.228	0.090	0.143	0.262	-0.078
Department effects	0.730	0.644	1.000	0.362	0.555	1.000
Department fixed effect	0.729	0.645	1.000	0.361	0.555	1.000
Specialisation	0.004	0.114	0.462	0.003	0.114	0.157
Quantity	0.047	0.063	-0.009	0.029	0.063	-0.120
Selection	0.856	-0.389	-0.644	0.216	-0.360	-0.241
Residuals	0.001	0.025	0	0.001	0.014	0

The table presents the variance analysis of the estimation reported in Table 20 column (6) and of the same regression also including individual fixed effects that is reported in Table 21 column (6) for the 1990-1997 period, once they are averaged by department.

Table 31: Variance analysis of the publication quality at the department level, 1998-2005

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: quality	0.385	1.000		0.385	1.000	
Individual effects	0.331	0.665	0.343	0.443	0.806	0.002
Individual fixed effect	-	-	-	0.377	0.685	-0.055
Gender	0.037	0.067	0.079	-	-	-
Age	0.195	0.115	-0.126	0.149	0.101	-0.057
Position fixed effect	0.200	0.346	0.364	0.087	0.034	-0.020
Authors number	0.061	0.352	0.113	0.059	0.352	0.151
Non-USA openness	0.039	0.542	0.318	0.013	0.542	0.158
USA openness	0.039	0.493	0.340	0.019	0.493	0.223
Star	0.050	0.535	0.330	0.035	0.535	0.175
Individual diversity	0.006	-0.246	-0.382	0.001	-0.246	-0.285
Jel fixed effect	0.127	0.309	0.127	0.122	0.200	0.085
Department effects	0.389	0.772	1.000	0.287	0.440	1.000
Department fixed effect	0.391	0.770	1.000	0.288	0.441	1.000
Specialisation	0.005	-0.113	-0.395	0.007	-0.113	-0.237
Quantity	0.021	0.191	0.188	0.017	0.191	-0.038
Selection	0.313	-0.443	-0.668	0.233	-0.433	-0.502
Residuals	0.001	-0.012	0	0.001	-0.005	0

The table presents the variance analysis of the estimation reported in Table 20 column (6) and of the same regression also including individual fixed effects that is reported in Table 21 column (6) for the 1998-2005 period, once they are averaged by department.

Table 32: Variance analysis of the publication top quality at the department level, 1990-1997

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: top quality	1.371	1.000		1.371	1.000	
Individual effects	2.266	0.520	0.178	1.401	0.799	-0.109
Individual fixed effect	-	-	-	1.238	0.669	-0.101
Gender	0.374	0.069	-0.049	-	-	-
Age	1.110	0.036	-0.074	0.523	0.012	-0.001
Position fixed effect	1.399	0.384	0.159	0.297	-0.004	-0.066
Authors number	0.291	0.329	0.077	0.232	0.329	0.043
Non-USA openness	0.130	0.357	0.076	0.022	0.357	0.051
USA openness	0.102	0.523	0.345	0.037	0.523	0.106
Star	0.192	0.580	0.436	0.151	0.580	0.105
Individual diversity	0.034	0.250	0.447	0.005	-0.250	-0.251
Jel fixed effect	1.016	0.257	0.112	0.322	0.300	-0.112
Department effects	2.125	0.598	1.000	0.874	0.446	1.000
Department fixed effect	2.129	0.597	1.000	0.876	0.447	1.000
Specialisation	0.007	-0.144	-0.499	0.012	-0.144	-0.211
Quantity	0.230	0.198	0.051	0.169	0.198	-0.064
Selection	2.575	-0.436	-0.668	0.427	-0.401	-0.231
Residuals	0.001	0.087	0	0.001	-0.020	0

The table presents the variance analysis of the estimation reported in Table 20 column (8) and of the same regression also including individual fixed effects that is reported in Table 21 column (8) for the 1990-1997 period, once they are averaged by department.

Table 33: Variance analysis of the publication top quality at the department level, 1998-2005

	Without individual fixed effects			With individual fixed effects		
	Stand. error	Correlation	Sorting	Stand. error	Correlation	Sorting
Explained: top quality	1.202	1.000		1.202	1.000	
Individual effects	1.226	0.683	0.375	1.271	0.858	0.065
Individual fixed effect	-	-	-	1.097	0.700	0.017
Gender	0.145	0.068	0.071	-	-	-
Age	0.725	0.153	-0.098	0.514	0.131	-0.032
Position fixed effect	0.775	0.351	0.365	0.246	0.008	-0.040
Authors number	0.212	0.370	0.123	0.200	0.370	0.141
Non-USA openness	0.133	0.561	0.327	0.043	0.561	0.194
USA openness	0.120	0.531	0.377	0.052	0.531	0.266
Star	0.141	0.558	0.341	0.095	0.558	0.162
Individual diversity	0.015	0.244	0.380	0.024	0.244	0.211
Jel fixed effect	0.503	0.291	0.136	0.291	0.236	0.065
Department effects	1.289	0.714	1.000	0.699	0.455	1.000
Department fixed effect	1.295	0.712	1.000	0.704	0.455	1.000
Specialisation	0.013	-0.109	-0.431	0.021	-0.109	-0.246
Quantity	0.134	0.239	0.199	0.108	0.239	-0.029
Selection	1.266	-0.465	-0.726	0.521	-0.447	-0.443
Residuals	0.001	-0.084	0	0.001	0.063	0

The table presents the variance analysis of the estimation reported in Table 20 column (8) and of the same regression also including individual fixed effects that is reported in Table 21 column (8) for the 1998-2005 period, once they are averaged by department.

Appendix G. Second step analysis

Table 34: Determinants of department fixed effects with detailed position effects

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	0.100^{a}	0.101^{a}	0.198^{a}	0.174^{a}	0.067^{a}	0.078^{a}	0.172^{a}	0.192^{a}
	(0.014)	(0.014)	(0.012)	(0.012)	(0.013)	(0.013)	(0.033)	(0.034)
Women	0.230^{b}	0.229^{b}	0.490^{a}	0.355^{a}	0.334^{a}	0.448^{a}	1.173^{a}	1.558^{a}
	(0.102)	(0.104)	(0.090)	(0.109)	(0.095)	(0.114)	(0.247)	(0.297)
Age	0.034^{a}	0.033^{a}	0.029^{a}	0.021^{a}	0.025^{a}	0.022^{a}	0.081^{a}	0.072^{a}
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.010)	(0.013)
Diversity	0.662^{a}	0.662^{a}	0.448^{a}	0.367^{a}	0.323^{a}	0.329^{a}	1.037^{a}	1.019^{a}
	(0.026)	(0.026)	(0.023)	(0.046)	(0.024)	(0.047)	(0.063)	(0.123)
Research Access	−0.017^{b}	−0.017^{b}	−0.011	−0.005	0.015^{b}	0.013^{c}	0.042^{b}	0.031
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.020)	(0.020)
Non-USA Openness	1.287^{a}	1.290^{a}	1.451^{a}	1.262^{a}	1.435^{a}	1.347^{a}	4.941^{a}	4.680^{a}
	(0.202)	(0.202)	(0.179)	(0.220)	(0.188)	(0.228)	(0.491)	(0.597)
USA Openness	0.858^{a}	0.853^{a}	0.210	0.088	1.023^{a}	1.084^{a}	3.522^{a}	3.563^{a}
	(0.276)	(0.276)	(0.245)	(0.228)	(0.257)	(0.241)	(0.669)	(0.628)
Heterogeneity	−1.147^{a}	−1.145^{a}	−1.082^{a}	−0.900^{a}	−0.752^{a}	−0.757^{a}	−2.539^{a}	−2.493^{a}
	(0.039)	(0.039)	(0.035)	(0.105)	(0.036)	(0.107)	(0.095)	(0.280)
Stars	0.828^{b}	0.832^{b}	1.549^{a}	1.387^{a}	2.527^{a}	2.538^{a}	7.691^{a}	7.759^{a}
	(0.375)	(0.375)	(0.332)	(0.328)	(0.349)	(0.345)	(0.909)	(0.899)
A-CR	0.268^{c}	0.241	0.346^{a}	0.212^{c}	0.045	0.098	0.147	0.304
	(0.145)	(0.171)	(0.129)	(0.120)	(0.135)	(0.127)	(0.352)	(0.330)
A-MCF	1.259^{a}	1.261^{a}	0.912^{a}	0.809^{a}	1.090^{a}	1.230^{a}	3.607^{a}	3.977^{a}
	(0.142)	(0.143)	(0.126)	(0.178)	(0.132)	(0.184)	(0.345)	(0.480)
A-PR	−1.105^{a}	−1.112^{a}	−1.400^{a}	−1.330^{a}	−0.487^{b}	−0.506^{b}	−1.926^{a}	−1.922^{a}
	(0.238)	(0.278)	(0.211)	(0.204)	(0.222)	(0.215)	(0.578)	(0.561)
Other	3.769^{a}	3.754^{a}	4.229^{a}	3.184^{a}	1.790	1.569	4.993	4.520
	(1.317)	(1.329)	(1.168)	(1.018)	(1.225)	(1.083)	(3.193)	(2.816)
CR cnrs	0.105	0.099	0.010	0.024	0.147	0.100	0.235	0.311
	(0.157)	(0.162)	(0.139)	(0.140)	(0.146)	(0.147)	(0.380)	(0.383)
CR inra	−0.415^{a}	−0.440^{a}	−0.192^{c}	−0.163	−0.175	−0.155	−0.564^{c}	−0.534^{c}
	(0.126)	(0.141)	(0.111)	(0.115)	(0.117)	(0.121)	(0.305)	(0.315)
DE ehess	−0.103	−0.185	−0.051	−0.044	−1.341^{a}	−1.355^{a}	−3.599^{a}	−3.663^{a}
	(0.426)	(0.447)	(0.378)	(0.333)	(0.397)	(0.353)	(1.034)	(0.919)
DR cnrs	−0.562^{a}	−0.537^{a}	0.027	0.068	−0.165	−0.046	−0.124	0.178
	(0.134)	(0.142)	(0.119)	(0.117)	(0.125)	(0.123)	(0.326)	(0.320)
DR inra	−0.251^{b}	−0.263^{c}	−0.162	−0.088	0.188^{c}	0.214^{c}	0.197	0.346
	(0.117)	(0.135)	(0.104)	(0.108)	(0.109)	(0.113)	(0.283)	(0.294)
PR	−0.458^{a}	−0.443^{a}	0.258^{a}	0.281^{a}	0.061	0.106	0.428^{c}	0.578^{b}
	(0.102)	(0.106)	(0.090)	(0.093)	(0.095)	(0.098)	(0.247)	(0.255)
Insee	−0.561^{c}	−0.522	−0.081	0.003	0.260	0.307	0.926	1.135^{c}
	(0.289)	(0.321)	(0.257)	(0.210)	(0.269)	(0.224)	(0.701)	(0.583)
IPC	−0.913^{a}	−0.945^{a}	−0.395^{b}	−0.317	−1.286^{a}	−1.183^{a}	−3.847^{a}	−3.515^{a}
	(0.222)	(0.324)	(0.197)	(0.222)	(0.207)	(0.231)	(0.539)	(0.604)
No-05	0.343^{a}	0.326^{a}	0.176^{b}	0.173^{b}	−0.171^{b}	−0.184^{b}	−0.004	−0.181
	(0.091)	(0.096)	(0.081)	(0.077)	(0.085)	(0.082)	(0.221)	(0.212)
No-37	−0.487	−0.494	−0.081	−0.018	−0.394	−0.243	−1.762	−1.358
	(0.529)	(0.531)	(0.469)	(0.432)	(0.492)	(0.458)	(1.283)	(1.192)
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.82	0.82	0.86	0.93	0.75	0.85	0.82	0.90
Observations	1209	1209	1209	1209	1209	1209	1209	1209

Standard error between brackets. ^{a}, ^{b}, ^{c} Significant at the 1%, 5% and 10% level, respectively. A-CR: other research fellow; A-MCF: non-university assistant professor; A-PR: non-university professor; CR cnrs: CNRS research fellow; CR inra: INRA research fellow; DE ehess: EHESS research professor; DR cnrs: CNRS research professor; DR inra: INRA research professor; PR: university professor; Insee: national statistical institute engineers; IPC: Ponts-et-Chaussées engineers. Reference: assistant professor. No-05: Pure economist professor position ('section 5'); No-37: Pure economist research position ('section 37').

Table 35: Determinants of department fixed effects with individual fixed effects and detailed position effects

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	−0.010	0.003	0.161[a]	0.114[a]	0.020	0.014	0.057[c]	0.054
	(0.021)	(0.025)	(0.013)	(0.015)	(0.012)	(0.014)	(0.030)	(0.035)
Women	0.653[a]	0.283	0.867[a]	0.572[a]	0.367[a]	0.428[a]	0.412[c]	0.872[b]
	(0.154)	(0.195)	(0.099)	(0.151)	(0.090)	(0.137)	(0.224)	(0.346)
Age	0.054[a]	0.045[a]	0.036[a]	0.034[a]	0.020[a]	0.021[a]	0.058[a]	0.054[a]
	(0.006)	(0.007)	(0.004)	(0.008)	(0.004)	(0.007)	(0.009)	(0.018)
Diversity	0.393[a]	0.511[a]	0.530[a]	0.467[a]	0.244[a]	0.269[a]	0.763[a]	0.789[a]
	(0.039)	(0.041)	(0.025)	(0.073)	(0.023)	(0.066)	(0.057)	(0.169)
Research Access	−0.062[a]	−0.073[a]	−0.077[a]	−0.058[a]	−0.016[b]	−0.018[c]	0.007	−0.019
	(0.012)	(0.018)	(0.008)	(0.011)	(0.007)	(0.010)	(0.018)	(0.026)
Non-USA Openness	−0.025	−0.357	1.496[a]	1.160[a]	0.510[a]	0.718[a]	1.906[a]	2.238[a]
	(0.306)	(0.310)	(0.197)	(0.287)	(0.179)	(0.260)	(0.446)	(0.657)
USA Openness	1.457[a]	0.636	0.843[a]	0.617[b]	0.955[a]	0.802[a]	3.151[a]	2.285[a]
	(0.417)	(0.400)	(0.269)	(0.292)	(0.243)	(0.264)	(0.608)	(0.661)
Heterogeneity	−0.779[a]	−0.853[a]	−0.930[a]	−0.814[a]	−0.504[a]	−0.525[a]	−1.485[a]	−1.514[a]
	(0.059)	(0.060)	(0.038)	(0.127)	(0.035)	(0.115)	(0.086)	(0.294)
Stars	−1.978[a]	−0.881	2.313[a]	1.838[a]	1.177[a]	1.262[a]	2.925[a]	3.436[a]
	(0.567)	(0.555)	(0.365)	(0.395)	(0.331)	(0.358)	(0.826)	(0.895)
A-CR	−0.656[a]	−0.395	0.158	0.392[c]	0.150	0.140	0.089	0.155
	(0.219)	(0.386)	(0.141)	(0.220)	(0.128)	(0.199)	(0.320)	(0.503)
A-MCF	−0.172	0.377	0.339[b]	0.395[b]	0.444[a]	0.528[a]	1.230[a]	1.269[a]
	(0.215)	(0.269)	(0.139)	(0.201)	(0.125)	(0.182)	(0.313)	(0.459)
A-PR	0.323	0.556	−1.397[a]	−1.185[a]	−1.009[a]	−0.949[a]	−2.199[a]	−1.943[b]
	(0.360)	(0.382)	(0.232)	(0.341)	(0.210)	(0.310)	(0.525)	(0.782)
Other	1.878	2.238	2.465[c]	1.734	0.635	0.824	2.012	1.371
	(1.992)	(1.961)	(1.283)	(1.191)	(1.163)	(1.078)	(2.904)	(2.674)
CR cnrs	−0.362	−0.271	−0.235	−0.223	−0.015	0.136	−0.036	0.396
	(0.237)	(0.297)	(0.153)	(0.182)	(0.138)	(0.165)	(0.345)	(0.412)
CR inra	0.316[c]	0.111	−0.201	−0.065	−0.053	−0.330[b]	−0.192	−1.032[a]
	(0.190)	(0.242)	(0.122)	(0.151)	(0.111)	(0.137)	(0.277)	(0.342)
DE ehess	0.198	0.515	−0.477	0.145	−0.596	−0.826[b]	−2.066[b]	−2.588[a]
	(0.645)	(0.654)	(0.415)	(0.435)	(0.376)	(0.394)	(0.940)	(0.985)
DR cnrs	−1.074[a]	−0.997[a]	−0.448[a]	−0.511[a]	−0.395[a]	−0.329[b]	−1.395[a]	−1.287[a]
	(0.203)	(0.221)	(0.131)	(0.155)	(0.119)	(0.140)	(0.296)	(0.352)
DR inra	−0.969[a]	−0.798[a]	−0.730[a]	−0.650[a]	−0.138	0.134	−1.036[a]	−0.169
	(0.177)	(0.231)	(0.114)	(0.160)	(0.103)	(0.145)	(0.257)	(0.363)
PR	−1.022[a]	−0.916[a]	−0.319[a]	−0.132	−0.387[a]	−0.364[a]	−0.896[a]	−1.194[a]
	(0.154)	(0.197)	(0.099)	(0.140)	(0.090)	(0.127)	(0.225)	(0.320)
Insee	−0.924[b]	−1.031[b]	−0.985[a]	−0.839[a]	−0.817[a]	−0.837[a]	−2.434[a]	−2.462[a]
	(0.437)	(0.423)	(0.282)	(0.282)	(0.255)	(0.255)	(0.638)	(0.637)
IPC	0.127	0.070	−1.396[a]	−1.140[a]	−0.981[a]	−1.021[a]	−3.454[a]	−3.301[a]
	(0.336)	(0.343)	(0.217)	(0.323)	(0.196)	(0.293)	(0.490)	(0.739)
No-05	0.465[a]	0.423[b]	0.123	0.160	−0.218[a]	−0.014	−0.522[a]	−0.082
	(0.138)	(0.183)	(0.089)	(0.110)	(0.081)	(0.100)	(0.201)	(0.250)
No-37	0.261	1.520[c]	0.168	0.578	1.607[a]	0.879[c]	2.324[b]	1.806
	(0.800)	(0.844)	(0.516)	(0.510)	(0.467)	(0.462)	(1.166)	(1.149)
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.63	0.67	0.75	0.86	0.56	0.72	0.63	0.78
Observations	1209	1209	1209	1209	1209	1209	1209	1209

Standard error between brackets. [a], [b], [c] Significant at the 1%, 5% and 10% level, respectively. A-CR: other research fellow; A-MCF: non-university assistant professor; A-PR: non-university professor; CR cnrs: CNRS research fellow; CR inra: INRA research fellow; DE ehess: EHESS research professor; DR cnrs: CNRS research professor; DR inra: INRA research professor; PR: university professor; Insee: national statistical institute engineers; IPC: Ponts-et-Chaussées engineers. Reference: assistant professor. No-05: Pure economist professor position ('section 5'); No-37: Pure economist research position ('section 37').

Table 36: variance analysis of department fixed effects for the probability to publish

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.660	1.000	0.584	1.000
Composition effects	0.254	-0.131	0.216	0.057
Size	0.085	0.128	0.008	0.011
Gender	0.025	-0.119	0.071	0.028
Age	0.117	-0.066	0.187	0.002
Positions	0.190	-0.176	0.178	0.055
Research strategy effects	0.667	0.814	0.383	0.479
Diversity	0.285	0.695	0.169	0.393
Research Access	0.026	-0.162	0.095	0.016
Non-USA Openness	0.084	0.368	0.002	-0.072
USA Openness	0.050	0.337	0.084	0.109
Heterogeneity	0.417	0.694	0.283	0.391
Stars	0.040	0.291	0.096	-0.043
Residuals	0.315	0.477	0.476	0.815

The table presents the variance analysis of the estimation reported in Table 34 column (1) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 35 column (1) in Appendix G.

Table 37: variance analysis of the department fixed effects for publication quantity

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.614	1.000	0.585	1.000
Composition effects	0.290	0.115	0.305	0.010
Size	0.169	0.272	0.137	0.254
Gender	0.053	-0.098	0.094	-0.023
Age	0.100	-0.020	0.123	-0.087
Positions	0.146	-0.038	0.191	-0.100
Research strategy effects	0.585	0.776	0.581	0.725
Diversity	0.193	0.647	0.228	0.653
Research Access	0.017	-0.213	0.117	-0.025
Non-USA Openness	0.095	0.415	0.097	0.338
USA Openness	0.012	0.358	0.049	0.304
Heterogeneity	0.393	0.673	0.338	0.579
Stars	0.075	0.333	0.112	0.283
Residuals	0.279	0.454	0.307	0.525

The table presents the variance analysis of the estimation reported in Table 34 column (3) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 35 column (3) in Appendix G.

Table 38: variance analysis of department fixed effects for publication top quality

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	1.619	1.000	1.039	1.000
Composition effects	0.664	-0.166	0.445	-0.162
Size	0.147	0.056	0.049	0.002
Gender	0.127	-0.088	0.045	-0.063
Age	0.279	-0.026	0.198	-0.051
Positions	0.487	-0.205	0.389	-0.152
Research strategy effects	1.684	0.813	0.971	0.665
Diversity	0.445	0.572	0.328	0.540
Research Access	0.065	0.323	0.011	0.186
Non-USA Openness	0.322	0.508	0.124	0.332
USA Openness	0.204	0.490	0.182	0.347
Heterogeneity	0.923	0.721	0.540	0.600
Stars	0.372	0.445	0.141	0.276
Residuals	0.763	0.471	0.694	0.668

The table presents the variance analysis of the estimation reported in Table 34 column (7) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 35 column (7) in Appendix G.

Appendix H. Second step estimation analysis for the two subperiods, 1990–1997 and 1998–2005

A. Determinants of department fixed effects

Table 39: determinants of department fixed effects, 1990–1997

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	0.082[a]	0.082[a]	0.276[a]	0.244[a]	0.089[a]	0.102[a]	0.194[a]	0.217[a]
	(0.023)	(0.023)	(0.021)	(0.022)	(0.025)	(0.026)	(0.064)	(0.067)
Women	0.747[a]	0.739[a]	1.807[a]	1.516[a]	0.775[a]	0.859[a]	2.710[a]	3.162[a]
	(0.156)	(0.160)	(0.145)	(0.262)	(0.173)	(0.285)	(0.441)	(0.738)
Age	0.048[a]	0.047[a]	0.057[a]	0.045[a]	0.040[a]	0.034[a]	0.136[a]	0.120[a]
	(0.007)	(0.007)	(0.006)	(0.010)	(0.007)	(0.011)	(0.019)	(0.029)
Diversity	0.738[a]	0.737[a]	0.742[a]	0.606[a]	0.505[a]	0.497[a]	1.581[a]	1.531[a]
	(0.039)	(0.039)	(0.036)	(0.104)	(0.043)	(0.110)	(0.111)	(0.286)
Research Access	−0.014	−0.015	−0.034[a]	−0.023[c]	0.017	0.018	0.038	0.030
	(0.012)	(0.012)	(0.011)	(0.013)	(0.014)	(0.015)	(0.035)	(0.038)
Non-USA Openness	0.958[a]	0.959[a]	2.214[a]	1.866[a]	1.233[a]	1.001[b]	4.515[a]	3.874[a]
	(0.365)	(0.365)	(0.339)	(0.375)	(0.405)	(0.442)	(1.033)	(1.132)
USA Openness	2.214[a]	2.196[a]	1.597[a]	1.370[b]	2.611[a]	2.630[a]	7.807[a]	7.838[a]
	(0.532)	(0.533)	(0.495)	(0.555)	(0.590)	(0.648)	(1.506)	(1.660)
Heterogeneity	−1.203[a]	−1.202[a]	−1.544[a]	−1.300[a]	−1.054[a]	−1.027[a]	−3.150[a]	−3.065[a]
	(0.061)	(0.061)	(0.056)	(0.199)	(0.067)	(0.207)	(0.172)	(0.541)
Stars	−0.111	−0.106	1.670[a]	1.446[a]	1.667[b]	1.599[b]	5.100[a]	5.129[a]
	(0.610)	(0.610)	(0.567)	(0.504)	(0.677)	(0.629)	(1.726)	(1.596)
Positions	yes	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.84	0.84	0.91	0.96	0.79	0.87	0.84	0.91
Observations	558	558	558	558	558	558	558	558

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively.

Table 40: determinants of department fixed effects, 1998–2005

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	0.100[a]	0.101[a]	0.172[a]	0.150[a]	0.049[a]	0.059[a]	0.156[a]	0.176[a]
	(0.018)	(0.018)	(0.015)	(0.015)	(0.013)	(0.014)	(0.035)	(0.037)
Women	−0.195	−0.191	−0.229[b]	−0.223[c]	0.215[b]	0.302[a]	0.541[b]	0.812[a]
	(0.137)	(0.139)	(0.115)	(0.120)	(0.101)	(0.105)	(0.273)	(0.284)
Age	0.027[a]	0.026[a]	0.017[a]	0.012[b]	0.021[a]	0.019[a]	0.067[a]	0.059[a]
	(0.005)	(0.005)	(0.004)	(0.006)	(0.004)	(0.005)	(0.010)	(0.015)
Diversity	0.556[a]	0.556[a]	0.332[a]	0.278[a]	0.214[a]	0.202[a]	0.706[a]	0.655[a]
	(0.036)	(0.036)	(0.030)	(0.047)	(0.027)	(0.044)	(0.072)	(0.118)
Research Access	−0.029[a]	−0.029[a]	−0.003	−0.001	−0.001	−0.001	0.007	0.000
	(0.011)	(0.011)	(0.009)	(0.009)	(0.008)	(0.008)	(0.022)	(0.021)
Non-USA Openness	1.500[a]	1.501[a]	0.997[a]	0.940[a]	1.372[a]	1.267[a]	4.775[a]	4.523[a]
	(0.254)	(0.254)	(0.212)	(0.276)	(0.187)	(0.255)	(0.504)	(0.683)
USA Openness	0.621[c]	0.621[c]	0.279	0.234	0.632[b]	0.722[a]	2.658[a]	2.789[a]
	(0.341)	(0.341)	(0.286)	(0.275)	(0.251)	(0.236)	(0.679)	(0.643)
Heterogeneity	−1.049[a]	−1.047[a]	−0.956[a]	−0.830[a]	−0.521[a]	−0.516[a]	−2.116[a]	−2.071[a]
	(0.054)	(0.054)	(0.045)	(0.127)	(0.040)	(0.125)	(0.108)	(0.329)
Stars	0.996[c]	1.008[c]	0.751	0.569	2.979[a]	2.835[a]	8.711[a]	8.362[a]
	(0.557)	(0.557)	(0.466)	(0.455)	(0.410)	(0.393)	(1.108)	(1.067)
Positions	yes	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.76	0.76	0.79	0.88	0.74	0.88	0.81	0.91
Observations	651	651	651	651	651	651	651	651

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively.

Table 41: determinants of department fixed effects with individual fixed effects, 1990–1997

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	−0.023	−0.013	0.192[a]	0.150[a]	0.052[b]	0.051[b]	0.063	0.079
	(0.037)	(0.041)	(0.023)	(0.023)	(0.023)	(0.024)	(0.057)	(0.061)
Women	0.793[a]	0.595[b]	1.119[a]	0.724[a]	0.034	0.222	−0.949[b]	−0.031
	(0.254)	(0.301)	(0.154)	(0.194)	(0.157)	(0.193)	(0.394)	(0.487)
Age	0.042[a]	0.035[a]	0.005	0.006	0.006	0.006	0.013	0.009
	(0.011)	(0.012)	(0.007)	(0.008)	(0.007)	(0.008)	(0.017)	(0.021)
Diversity	0.425[a]	0.524[a]	0.297[a]	0.307[a]	0.048	0.111[c]	0.224[b]	0.337[b]
	(0.064)	(0.066)	(0.039)	(0.059)	(0.040)	(0.057)	(0.099)	(0.144)
Research Access	−0.064[a]	−0.091[a]	−0.079[a]	−0.053[a]	0.018	0.003	0.103[a]	0.041
	(0.020)	(0.025)	(0.012)	(0.014)	(0.012)	(0.014)	(0.031)	(0.037)
Non-USA Openness	−0.997[c]	−0.506	1.042[a]	0.920[a]	−0.563	−0.661[c]	−0.340	−0.868
	(0.595)	(0.601)	(0.361)	(0.336)	(0.367)	(0.352)	(0.923)	(0.880)
USA Openness	2.555[a]	0.994	0.761	0.472	0.891[c]	1.187[b]	2.474[c]	2.712[b]
	(0.868)	(0.867)	(0.527)	(0.483)	(0.536)	(0.508)	(1.346)	(1.269)
Heterogeneity	−0.864[a]	−0.834[a]	−0.516[a]	−0.459[a]	−0.309[a]	−0.306[a]	−0.555[a]	−0.558[b]
	(0.099)	(0.102)	(0.060)	(0.088)	(0.061)	(0.086)	(0.154)	(0.217)
Stars	−1.865[c]	−0.809	0.364	0.568	0.351	0.260	−0.102	0.430
	(0.995)	(0.953)	(0.604)	(0.517)	(0.614)	(0.550)	(1.542)	(1.372)
Positions	yes	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.54	0.58	0.60	0.78	0.37	0.51	0.36	0.51
Observations	558	558	558	558	558	558	558	558

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively.

Table 42: determinants of department fixed effects with individual fixed effects, 1998–2005

	Publishing		Quantity		Quality		Top quality	
	OLS (1)	FGLS (2)	OLS (3)	FGLS (4)	OLS (5)	FGLS (6)	OLS (7)	FGLS (8)
Size	−0.017	−0.018	0.122[a]	0.093[a]	0.000	−0.008	0.034	0.009
	(0.024)	(0.030)	(0.016)	(0.019)	(0.013)	(0.015)	(0.034)	(0.039)
Women	0.373[b]	0.243	0.009	−0.064	0.312[a]	0.271[b]	0.146	0.233
	(0.189)	(0.238)	(0.128)	(0.160)	(0.103)	(0.131)	(0.261)	(0.332)
Age	0.061[a]	0.056[a]	0.011[b]	0.010	0.017[a]	0.019[a]	0.033[a]	0.030[c]
	(0.007)	(0.009)	(0.005)	(0.008)	(0.004)	(0.007)	(0.010)	(0.017)
Diversity	0.400[a]	0.498[a]	0.235[a]	0.214[a]	0.148[a]	0.148[a]	0.298[a]	0.327[b]
	(0.050)	(0.055)	(0.034)	(0.060)	(0.027)	(0.052)	(0.069)	(0.132)
Research Access	−0.065[a]	−0.075[a]	−0.050[a]	−0.038[a]	−0.030[a]	−0.025[b]	−0.008	−0.014
	(0.015)	(0.021)	(0.010)	(0.013)	(0.008)	(0.010)	(0.021)	(0.026)
Non-USA Openness	0.705[b]	0.089	0.377	0.336	0.730[a]	0.868[a]	1.527[a]	1.765[a]
	(0.350)	(0.361)	(0.237)	(0.307)	(0.191)	(0.257)	(0.484)	(0.652)
USA Openness	1.030[b]	0.609	0.302	0.216	0.567[b]	0.460[c]	2.080[a]	1.230[c]
	(0.471)	(0.451)	(0.319)	(0.329)	(0.257)	(0.263)	(0.651)	(0.665)
Heterogeneity	−0.600[a]	−0.694[a]	−0.385[a]	−0.399[a]	−0.348[a]	−0.350[a]	−0.807[a]	−0.799[a]
	(0.075)	(0.075)	(0.051)	(0.112)	(0.041)	(0.099)	(0.103)	(0.252)
Stars	−2.192[a]	−0.797	2.007[a]	1.112[b]	1.074[b]	0.818[c]	2.285[b]	1.318
	(0.769)	(0.799)	(0.521)	(0.552)	(0.420)	(0.439)	(1.063)	(1.107)
Positions	yes	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.39	0.46	0.46	0.62	0.49	0.71	0.43	0.66
Observations	651	651	651	651	651	651	651	651

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively.

B. Variance analysis of the department fixed effects

Table 43: variance analysis of the department fixed effects for the probability to publish, 1990–1997

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.743	1.000	0.664	1.000
Composition effects	0.253	-0.120	0.189	0.071
Size	0.094	0.053	0.004	0.044
Gender	0.021	0.025	0.065	0.086
Age	0.093	-0.016	0.158	-0.033
Positions	0.194	-0.177	0.176	0.075
Research strategy effects	0.691	0.838	0.382	0.534
Diversity	0.317	0.726	0.187	0.403
Research Access	0.011	-0.279	0.091	-0.031
Non-USA Openness	0.060	0.324	0.007	-0.041
USA Openness	0.050	0.393	0.078	0.129
Heterogeneity	0.413	0.728	0.282	0.471
Stars	0.033	0.372	0.106	-0.100
Residuals	0.336	0.578	0.526	0.847

The table presents the variance analysis of the estimation reported in Table 39 column (1) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 41 column (1).

Table 44: variance analysis of the department fixed effects for the probability to publish, 1998–2005

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.594	1.000	0.508	1.000
Composition effects	0.224	-0.115	0.219	0.056
Size	0.094	0.192	0.004	-0.023
Gender	0.021	-0.286	0.066	-0.061
Age	0.113	-0.099	0.191	0.040
Positions	0.158	-0.168	0.164	0.053
Research strategy effects	0.626	0.787	0.372	0.438
Diversity	0.268	0.642	0.158	0.385
Research Access	0.011	-0.051	0.086	0.056
Non-USA Openness	0.081	0.415	0.010	-0.107
USA Openness	0.059	0.299	0.092	0.107
Heterogeneity	0.397	0.664	0.271	0.321
Stars	0.027	0.191	0.088	0.020
Residuals	0.321	0.399	0.430	0.773

The table presents the variance analysis of the estimation reported in Table 40 column (1) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 42 column (1).

Table 45: variance analysis of the department fixed effects for publication quantity, 1990–1997

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.914	1.000	0.479	1.000
Composition effects	0.318	0.038	0.198	0.263
Size	0.191	0.189	0.132	0.307
Gender	0.088	0.092	0.060	0.192
Age	0.109	0.003	0.036	-0.140
Positions	0.147	-0.219	0.096	0.051
Research strategy effects	0.745	0.854	0.302	0.574
Diversity	0.293	0.730	0.130	0.515
Research Access	0.001	-0.327	0.088	-0.017
Non-USA Openness	0.055	0.407	0.033	0.265
USA Openness	0.020	0.466	0.015	0.288
Heterogeneity	0.455	0.738	0.174	0.429
Stars	0.125	0.446	0.076	0.269
Residuals	0.363	0.732	0.329	0.770

The table presents the variance analysis of the estimation reported in Table 39 column (3) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 41 column (3).

Table 46: variance analysis of the department fixed effects for publication quantity, 1998–2005

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.529	1.000	0.371	1.000
Composition effects	0.303	0.078	0.184	0.163
Size	0.191	0.309	0.133	0.332
Gender	0.089	-0.304	0.061	-0.208
Age	0.131	-0.034	0.044	-0.090
Positions	0.138	-0.029	0.090	0.027
Research strategy effects	0.660	0.736	0.282	0.494
Diversity	0.248	0.576	0.110	0.456
Research Access	0.001	-0.115	0.083	0.141
Non-USA Openness	0.074	0.422	0.044	0.220
USA Openness	0.024	0.293	0.017	0.152
Heterogeneity	0.438	0.647	0.168	0.329
Stars	0.105	0.209	0.064	0.155
Residuals	0.324	0.060	0.293	0.688

The table presents the variance analysis of the estimation reported in Table 40 column (3) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 42 column (3).

Table 47: variance analysis of the department fixed effects for publication quality, 1990–1997

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.726	1.000	0.361	1.000
Composition effects	0.249	-0.070	0.103	0.121
Size	0.065	-0.001	0.019	-0.062
Gender	0.060	0.043	0.013	0.017
Age	0.082	-0.004	0.022	-0.070
Positions	0.196	-0.101	0.099	0.151
Research strategy effects	0.578	0.780	0.182	0.321
Diversity	0.194	0.618	0.052	0.211
Research Access	0.037	0.370	0.002	-0.147
Non-USA Openness	0.050	0.389	0.010	0.073
USA Openness	0.056	0.489	0.049	0.198
Heterogeneity	0.279	0.709	0.105	0.329
Stars	0.164	0.443	0.021	0.136
Residuals	0.386	0.760	0.323	0.896

The table presents the variance analysis of the estimation reported in Table 39 column (5) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 41 column (5).

Table 48: variance analysis of the department fixed effects for publication quality, 1998–2005

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	0.391	1.000	0.288	1.000
Composition effects	0.186	-0.176	0.090	0.001
Size	0.065	0.107	0.019	-0.022
Gender	0.061	-0.200	0.013	-0.074
Age	0.099	-0.022	0.027	-0.070
Positions	0.125	-0.202	0.088	0.038
Research strategy effects	0.503	0.749	0.170	0.528
Diversity	0.165	0.449	0.044	0.368
Research Access	0.035	0.254	0.002	-0.039
Non-USA Openness	0.067	0.559	0.014	0.323
USA Openness	0.066	0.451	0.058	0.294
Heterogeneity	0.268	0.644	0.101	0.482
Stars	0.137	0.394	0.018	0.211
Residuals	0.270	0.172	0.239	0.829

The table presents the variance analysis of the estimation reported in Table 40 column (5) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 42 column (5).

Table 49: variance analysis of the department fixed effects for publication top quality, 1990–1997

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	2.121	1.000	0.875	1.000
Composition effects	0.745	-0.131	0.266	0.033
Size	0.177	0.003	0.043	-0.046
Gender	0.179	0.051	0.048	0.046
Age	0.256	0.003	0.038	-0.017
Positions	0.567	-0.191	0.266	0.034
Research strategy effects	1.860	0.825	0.454	0.292
Diversity	0.599	0.652	0.118	0.251
Research Access	0.108	0.395	0.083	0.175
Non-USA Openness	0.197	0.422	0.034	0.083
USA Openness	0.201	0.523	0.136	0.160
Heterogeneity	0.942	0.734	0.232	0.267
Stars	0.458	0.484	0.018	0.117
Residuals	0.983	0.695	0.805	0.912

The table presents the variance analysis of the estimation reported in Table 39 column (7) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 41 column (7).

Table 50: variance analysis of the department fixed effects for publication top quality, 1998–2005

	Without individual fixed effects		With individual fixed effects	
	Stand. error	Correlation	Stand. error	Correlation
Explained: department fixed effect	1.298	1.000	0.703	1.000
Composition effects	0.584	-0.224	0.217	-0.055
Size	0.177	0.110	0.043	0.011
Gender	0.181	-0.223	0.049	0.110
Age	0.310	-0.053	0.046	-0.075
Positions	0.374	-0.250	0.215	-0.066
Research strategy effects	1.655	0.816	0.425	0.498
Diversity	0.507	0.490	0.100	0.337
Research Access	0.102	0.259	0.078	0.104
Non-USA Openness	0.266	0.590	0.045	0.321
USA Openness	0.237	0.490	0.160	0.319
Heterogeneity	0.906	0.713	0.223	0.453
Stars	0.384	0.407	0.015	0.217
Residuals	0.717	0.109	0.591	0.852

The table presents the variance analysis of the estimation reported in Table 40 column (7) and of the same regression when individual fixed effects are considered in the first step estimation, which is reported in Table 42 column (7).

Appendix I. Change of period, T=t+2

Table 51: determinants of individual publications, $\tau = t + 2$

	Publishing		Quantity		Quality		Top quality	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Women	-0.374^a	-0.375^a	-0.073^a	-0.195^a	-0.003	-0.220^a	-0.032	-0.953^a
	(0.032)	(0.021)	(0.013)	(0.060)	(0.020)	(0.080)	(0.052)	(0.206)
Age	-0.098^a	-0.085^a	-0.023^a	-0.059^a	-0.008	-0.058^a	-0.036^c	-0.244^a
	(0.013)	(0.008)	(0.005)	(0.015)	(0.008)	(0.020)	(0.020)	(0.052)
Age square	0.000^a	0.000^a	0.000^a	0.000^a	0.000	0.000^b	0.000	0.001^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Authors number			-0.944^a	-0.873^a	0.248^a	0.241^a	0.911^a	0.869^a
			(0.013)	(0.011)	(0.026)	(0.017)	(0.065)	(0.045)
Non-USA Openness			0.272^a	0.244^a	0.243^a	0.231^a	0.832^a	0.785^a
			(0.019)	(0.013)	(0.030)	(0.017)	(0.081)	(0.045)
USA Openness			0.267^a	0.258^a	0.364^a	0.310^a	1.097^a	0.939^a
			(0.030)	(0.017)	(0.035)	(0.023)	(0.098)	(0.060)
Star			0.397^a	0.334^a	1.274^a	1.196^a	3.641^a	3.374^a
			(0.029)	(0.020)	(0.037)	(0.026)	(0.101)	(0.068)
Diversity			-0.403^a	-0.297^a	-0.057^a	-0.063^a	-0.063	-0.078^a
			(0.012)	(0.009)	(0.015)	(0.012)	(0.041)	(0.030)
Specialisation				0.310^a		0.011		0.019
				(0.006)		(0.008)		(0.022)
Quantity					0.024^b	0.014	0.310^a	0.274^a
					(0.012)	(0.010)	(0.032)	(0.026)
Selection			-0.029	0.965^b	-0.319^a	1.243^b	-1.084^a	5.397^a
			(0.032)	(0.422)	(0.054)	(0.566)	(0.154)	(1.454)
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jel Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department Time FE	No	Yes	No	Yes	No	Yes	No	Yes
R^2			0.43	0.56	0.36	0.45	0.44	0.53
Observations	827221	783237	19022	19022	19022	19022	19022	19022

Standard error between brackets. ^{a}, ^{b}, ^{c}: significant at the 1%, 5% and 10% levels respectively.

Table 52: determinants of department fixed effects, $\tau = t + 2$

	Publishing		Quantity		Quality		Top quality	
	OLS	FGLS	OLS	FGLS	OLS	FGLS	OLS	FGLS
Size	-0.003	-0.002	0.139^{a}	0.122^{a}	0.033^{c}	0.031^{c}	0.015	0.035
	(0.014)	(0.014)	(0.012)	(0.012)	(0.018)	(0.018)	(0.043)	(0.043)
Women	0.293^{a}	0.286^{a}	0.043	-0.064	0.168	0.295^{c}	1.096^{a}	1.348^{a}
	(0.103)	(0.107)	(0.088)	(0.118)	(0.131)	(0.172)	(0.319)	(0.424)
Age	0.048^{a}	0.047^{a}	0.013^{a}	0.004	0.018^{a}	0.017	0.078^{a}	0.072^{a}
	(0.004)	(0.004)	(0.003)	(0.008)	(0.005)	(0.011)	(0.011)	(0.027)
Diversity	0.703^{a}	0.703^{a}	0.272^{a}	0.189^{b}	0.301^{a}	0.351^{a}	1.196^{a}	1.234^{a}
	(0.024)	(0.024)	(0.020)	(0.078)	(0.030)	(0.108)	(0.074)	(0.273)
Research Access	-0.016^{c}	-0.016^{b}	-0.006	0.000	0.011	0.003	0.018	-0.009
	(0.008)	(0.008)	(0.007)	(0.008)	(0.010)	(0.012)	(0.025)	(0.028)
Non-USA Openness	0.856^{a}	0.855^{a}	0.617^{a}	0.537^{b}	0.571^{c}	0.718^{c}	3.248^{a}	3.581^{a}
	(0.270)	(0.270)	(0.230)	(0.263)	(0.344)	(0.389)	(0.835)	(0.949)
USA Openness	0.789^{b}	0.784^{b}	-0.307	-0.391	1.759^{a}	1.743^{a}	4.710^{a}	4.877^{a}
	(0.369)	(0.369)	(0.316)	(0.314)	(0.472)	(0.475)	(1.143)	(1.145)
Heterogeneity	-1.318^{a}	-1.317^{a}	-0.704^{a}	-0.432^{b}	-0.569^{a}	-0.696^{b}	-2.543^{a}	-2.822^{a}
	(0.037)	(0.037)	(0.032)	(0.199)	(0.047)	(0.271)	(0.114)	(0.691)
Stars	1.043^{a}	1.043^{a}	0.914^{a}	0.666^{b}	1.198^{a}	1.441^{a}	5.832^{a}	5.762^{a}
	(0.333)	(0.333)	(0.284)	(0.334)	(0.425)	(0.493)	(1.030)	(1.205)
Positions	yes	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.86	0.86	0.76	0.91	0.62	0.79	0.77	0.90
Observations	1152	1152	1152	1152	1152	1152	1152	1152

Standard error between brackets. ^{a}, ^{b}, ^{c}: significant at the 1%, 5% and 10% levels respectively.

Appendix J. IV first steps regressions

Table 53: IV first step regressions

	Size (1)	Div. (2)	Div. (3)	Div. (4)	Het. (5)	Stars (6)	Stars (7)
Population 1990	0.677[a]	0.188[a]		0.037			-0.044[a]
	(0.065)	(0.023)		(0.032)			(0.016)
% Engineers	6.274[a]		1.511[a]	1.592[a]	-1.241[a]	0.111[a]	
	(0.868)		(0.394)	(0.399)	(0.214)	(0.013)	
Peripherality		0.382[a]			-0.063	0.005[a]	
		(0.055)			(0.043)	(0.001)	
Population 1999			0.045				0.049[a]
			(0.033)				(0.017)
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.42	0.08	0.05	0.04	0.03	0.13	0.08
Observations	735	735	735	735	735	735	735

Standard error between brackets. [a], [b], [c]: significant at the 1%, 5% and 10% levels respectively. Div. = diversity. Het. = heterogeneity.