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Academic work

A tale of essential tension between research and teaching

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DURING THE LAST fifteen years, European reforms in higher education have introduced differentiation into the fabric of academia, and triggered transformations in academic careers even if the various scientific disciplines and generations of academic researchers have been unequally exposed to the main impact of these reforms, that of a pervasive growth of individual and institutional competition on a national and international scale. Competition alters the architecture of organizations, the principles underpinning the evaluation of academic work and workers, the coupling of teaching and research (Locke 2012), the incentive tools for scientific production, and the correlation between working conditions and salary levels.

With increasing mobility of faculty and students, and with the whole industry of rankings, performance auditing and implementation of excellence frameworks, a growing value has been given to research activities, which are the most openly competitive. As a result, the reputation of a university's research has a far greater signalling value than the quality of its teaching mission. And research enjoys productivity gains that appear to be inaccessible to teaching, which, like other kinds of services undergoing rising costs and constant productivity, is subject to the ”Baumol disease” (Baumol 1967).

How is the functional link between teaching and research to be understood in a context of heightened competition between and within universities? We know that teaching in contact with advanced research has greater value than teaching which is distant from it, and which only passes on knowledge produced elsewhere (Price 1970; Cole 1983). We also know that the quality of academic research varies according to the quality of the PhD students involved. But are teaching and research tasks intrinsically complementary, to the extent that we could consider them as generating mutual gains? Or are they, on the contrary, sufficiently distinct to separate , which would imply that, were they not, academics would perform essentially conflicting roles within the same job? Or should they be separated endogenously, and not *a priori*, according to the various abilities people display, once they have been put to the test of academic professionalization and classified on the basis of the preferences, resources, and constraints determining each one's work and performance?

Three options surface: complementarity; substitution; sheer dissimilarity and nil correlation between quality of teaching and research.

Analysing the asymmetrical relationship between the two tasks seems to provide a fruitful agenda of investigation. There are striking dissimilarities between them: the production function of teaching is additive, while that of research is multiplicative. This is why management of research activities has granted increasing importance to the concentration of critical masses of talent to leverage the faculty's research potential. Meanwhile, teaching staff becomes more substitutable once they move (or are moved) away from the frontiers of advanced research. Unsurprisingly, given the crucial importance of reputational capital to higher education institutions, tension between research and teaching missions is mounting.

My main argument is as follows. In research, the distribution of individual productivity and professional visibility has a highly skewed, Pareto-like profile, whereas individual performance in teaching has a normal, Gaussian, distribution. Since the chances of success in each activity are distributed very differently, their conjunction functions like a risk- management mechanism, both individually and collectively. Yet given the differential return on effort and ability in the two tasks, complementarity is best understood when redefined as complementarity under asymmetry.

Teaching and research: the antinomy of complementarity and substitution effects

A considerable number of studies and a large set of meta-analyses[1] have been devoted to the correlation between the quality of teaching and that of research.

Complementarity

Arguments supporting complementarity are easy to find. Let me aim the question in a first direction: research contributes to the quality and effectiveness of teaching. This is an argument of conditional necessity: without research, no teaching would be possible. One provides the content of the other, for knowledge evolves constantly, and it would be unthinkable to teach students obsolete, routine knowledge that is too distant from the cutting edge of research. By investing in research, a teacher knows how to update and improve the content being taught, and to include the newest subjects and the most recent and original methods.

Symmetrically, how can teaching contribute to research? At least in two ways. First, teaching requires one to contextualize and thus to move away from the straightforward road of specialization which, in research, implies the exploration of narrowly defined questions.

1 In this section, I draw primarily on Hattie & Marsh (1996) and Marsh & Hattie (2002).

Secondly, teaching demands that the teacher have sound knowledge of the subjects taught, to be able to communicate effectively, to facilitate understanding, and to support the students' motivation. Teaching is something of a dramatic art that involves a stock of knowledge and an ability to clarify matters, based on the ability to put oneself in others' shoes.

Even though this is clearly a relationship of complementarity, the very conception of knowledge underpinning it has to be adjusted. This was what Boyer did, for example, in *Scholarship reconsidered* (1990), as he distinguished four types of scholarship: discovery, integration, application, and transmission. If these four types of scholarship are inseparable, the partitioning, specialization and ranking of academic tasks distort the conception of both teaching and research.

The logical deduction of this plural conception of knowledge is that the academic profession is a ”mosaic of talents”. The multidimensional characterization of knowledge lends itself to a horizontal differentiation of academic profiles and of their qualities, rather than a hierarchization according to only one dominant dimension, research.

To the majority of professors, these functional arguments for the ”unity of teaching and research” are cogent (Schuster & Finkelstein 2006). And actually, who, when embarking on an academic career, would *a priori* refute the ideal of a complementarity of functions, since entry into that career is precisely the product of a transmission of experiences in teaching and research?

The functional link of teaching and research is the pillar of the Humboldtian pattern of higher education institutions (Schimank & Winnes 2000; Gingras 2003), which amounts to:

1. a model of statutory non-differentiation between teaching and research;
2. a model in which most resources made available to academics are not specifically assigned to one of the two functions;
3. a model that, unlike in the US, is not grounded in an all-encompassing stratification of higher education institutions according to their research potential.

This conception of intrinsic complementarity is egalitarian in essence. It is embraced by those who denounce the shortcomings of individualizing performance evaluation, and who wish to emphasize the normative strength of status to overcome the puzzling issue of multi-tasking.

Note what the model postulates: that it is primarily in the presence of good conditions of work organization that quality teaching can be combined correctly and even optimally with quality research. There is no radically asymmetrical distribution of the ability to carry out one or the other type of work. There are only more or less favourable conditions, from both an organizational, individual and systemic point of view. And complementarity is undermined whenever the system of scientific competition seeks to obtain greater productivity from unbundling than from coupling the functions.

Substitution

Now we also know that there are negative complementarity or substitution effects (trade-offs). Teaching and research may be positive complements up to a certain point, but beyond a given level of teaching load, the time left for research diminishes dramatically.

This amounts to the ”scarcity of resources” model (Hattie & Marsh 1996). Both teaching and research are labour intensive. Since time, energy and commitment to each are limited, there is conflict between the different roles, and thus personal and organizational trade-offs.

This is why the massification of higher education has put the Humboldtian model under growing pressure:

> Whenever a huge increase in student numbers occurs at the same time that government is unwilling or unable to increase resources accordingly, university research in countries following the Humboldtian pattern is threatened by marginalisation, because no formal regulations or organisational mechanisms exist to prevent a shift of working time and resources from research to teaching […]. This ”crowding out” of research by teaching is accompanied by a ”driving out” into extra-university research institutes. If research conditions at universities are worsening because they are overloaded with teaching, it becomes attractive for research policy to establish research institutes outside universities (Schimank & Winnes 2000:399).

Another argument emphasizing negative complementarity points to the strategic behavior that the faculty may adopt when facing an asymmetrical valuation of performances in teaching and research. According to the ”divergent reward system” model (Marsh 1987; Hattie & Marsh 1996), research obtains an increasing, and (so says the model) a disproportionate advantage in the progression and management of professional careers, and may grant access to highly-paid jobs with the best working conditions in top universities.

In an agency perspective, this refers to the issue of multi-tasking. If an activity combines two jobs of unequal value, the individual who benefits from sufficient leeway will invest more in the one that is valued the most and that provides the highest gratification, both immediately and in the long term, from a career perspective, owing to greater visibility within and beyond his/her organization. As stated by Gautier and Wauthy (2007:275–276):

> the emergence of a market for academics induces more severe career concerns. As a matter of fact, while the quality of individual research output is reasonably easily assessed, teaching quality is mainly or only evaluated at the level of a whole program, rather than at an individual level. Therefore, an academic is likely to put more effort on research than teaching because research outputs are more easily appropriable than teaching efforts.

A key point surfacing from the negative complementarity view is that research performance has a higher value than teaching quality, and increasingly so. In order to understand why, it is worth emphasizing two major dissimilarities between research and teaching.

Dissimilarities between research and teaching

Uncertainty

The final value of a research project is indeterminate at the beginning, and is in general uncertain and delayed. No deterministic representation of such an uncertain undertaking is appropriate (Bonaccorsi 2009), even if the level and nature of uncertainty vary across fields and problems (Whitley 1984). Various arrangements help minimize the risk associated with the uncertain course of a project or provide some insurance against risk, e.g. the adoption of research portfolios that contain projects with varying degrees of uncertainty (Stephan 1996) or the organization of a ”network of enterprise” (Gruber 1989) or the most efficient team assembly mechanisms in collaboration networks (Guimera et al. 2005).

By contrast, the process and outcome of teaching is more certain, for the teacher as well as for the students. Knowledge exploitation and transmission (as opposed to knowledge exploration) is a safer process. Textbooks and training programmes have thus a functional level of standardization, at the undergraduate level.

Yet teaching quality is also more difficult to assess. Conventional wisdom holds that ”higher-quality” teachers promote better educational outcomes. Yet,

> since teacher quality cannot be directly observed, measures have largely been driven by data availability […]. At the postsecondary level, student evaluations of professors are widely used in faculty promotion and tenure decisions. However, teachers can influence these measures in ways that may reduce actual student learning. Teachers can ”teach to the test.” Professors can inflate grades or reduce academic content to elevate student evaluations (Carrell & West 2010:409).

There is thus no agreed way of assessing teaching quality and what students really learn.

As a result, research and teaching differ as to the contractual problems of observability of effort and enforceability of obligations. Teaching is ”regulated by a contract defined on inputs (e.g. a given number of hours of courses per year), while research is regulated by contracts on outputs (e.g. the academic promotion is assigned only if a certain number of articles have been published in certain journals, irrespective of the effort actually put in place)” (Bonaccorsi 2009:93).

Inequality in teaching and research performance

Individual performance in research shows extreme inequality with regard to scientific productivity. The highly skewed distribution of publications was first observed by Alfred Lotka (1926) and ”Lotka's law” was confirmed by countless scientometric studies (de Solla & Price 1986; Seglen 1992). As shown by Larivière, Archambault, Macaluso and Gingras (2010) in a Canadian study, the skewed distribution also concerns the funding of research. The analysis of distributions reveals a Pareto concentration of productivity, visibility, and the competitive allocation of resources obtained through the funding of projects. About one fifth of academics produce four fifths of all publications. One fifth of academics account for over four fifths of all citations. And research funding for projects is similarly skewed. A more precise analysis reveals variations between disciplines, but they only marginally nuance the Pareto law of wide inequality between academics in research.

Scientific productivity is not only characterized by extreme inequality at a point in time; it is also characterized by increasing inequality over the careers of a cohort of scientists, suggesting that at least some of the processes at work are state dependent, as demonstrated by Merton (1968) in his model of cumulative advantage (the so-called Matthew effect).

It is also worth pointing out that inequality in productivity does not translate to proportional inequality in academic salary gaps. This is where the uncertainty principle may dampen the impact of the extreme inequality levels observed in research outcomes.

By contrast, the distribution of individual teaching performance has a Gaussian profile. Admittedly, there are measurement issues, as I mentioned. Yet, as repeatedly shown in countless surveys, the teaching skills and effectiveness of teachers assessed by their students are normally distributed, even if the distribution is right-skewed (see for example Hoffman & Oreopoulos 2009).

Tractability

Both sides of the argument may be correct, and positive and negative complementarities tend to cancel one another out, in which case we would observe a zero relationship between teaching and research. More specifically, the conclusion of Hattie and Marsh in their influential meta-analysis is the following:

> the expected relationship between research productivity and teaching evaluations can be predicted by principles of partial correlation. If time on research and time on teaching are negatively correlated, time on research is correlated positively with research output measures, and the correlation between time on teaching and teaching evaluations is zero, then it is most likely that the correlation between teaching and research is zero-and not negative (Hattie & Marsh 1996:509; see also Marsh 1987:300).

Since the nil correlation between teaching and research quality seems to be the only sound conclusion to draw, there are two ways of going about this. The first way is to have a closer look at the interaction of ability and effort in teaching and research. The second way is to identify a set of contextualization variables such as disciplines, type and level of research practised, and level of teaching dispensed, as well as organizational variables, including the nature of the academic institution, the general organizational framework of higher education, and the specific properties of each national model. Here I will focus only on the level of teaching.

It is worth noting that what the two opposite models of positive or negative correlation have in common is that there is a normal, Gaussian, distribution of the ability to do a good job in teaching or to perform well in research. Any mechanism that incentivizes the distinct performance in one or the other task will lead to role strain. In other words, the first two views postulate that complementarity is the default option, and that role strain is generated by an imbalance of incentives and gratifications: the default option is an egalitarian one.

Now what if we take into account the considerable level of inequality in research productivity and reputation? Inequality could be explained by differences among scientists in their ability and motivation to do creative research. Put in a simple model, as in the paper by Mas-Colell (2003) I now discuss, this means that the individual production function involves five independent variables: human capital (essentially, accumulated training), talent for teaching, talent for research, effort in teaching and effort in research. The two talent variables are givens. The production of teaching services depends positively on human capital, the talent for teaching and the effort on teaching. Likewise, the production of research depends positively on human capital, the effort on research and the talent for research. If the two kinds of talent are of equal value, and equally distributed, the egalitarian view of the academic work is saved. The issue is only one of observability and assessment.

Now here is the point where the model quoted from Mas-Colell's paper departs from the egalitarian perspective:

> There is a key difference between teaching and research that concerns the role of talent and effort: the marginal rate of transformation along the talent-effort isoquant makes effort comparatively more valuable in teaching, and talent comparatively more valuable in research. Oversimplifying, we could say that quality of teaching is fundamentally a matter of effort, and thus it is open to any individual no matter what his, or her, natural teaching talent, while quality of research requires, beyond effort, an essential component of talent (Mas-Colell 2003:21).

Why does talent have more value for increasing research productivity than for teaching productivity? They are two possible causes: 1) talent is more valuable in research since using it has a multiplicative effect only in research; 2) time spent on graduate teaching is positively correlated with research productivity, whereas time spent on undergraduate teaching is negatively correlated.

Talent for research: the power of an interaction of normally distributed factors
How do we explain inequalities in research productivity (Menger 2014)? A first approach transforms scientific activity into a normal activity in which the gaps in success levels are explained by a combination of factors that are usually responsible for differences and variations of performance in high-skilled jobs: social background, age, gender, quality of education, working conditions, and the organizational environment. As differences of success are unusually high, another factor is often put forward, particularly in view of the enigmatic factorial explanation of exceptional success: the fact of having particular abilities or the ”sacred spark”, to quote Allison and Stewart (1974).

Attempts to measure one by one the correlations between various dimensions of ability or the various personality traits, on the one hand, and scientific productivity, on the other hand, always produce disappointing results since the correlations observed are weak or inconclusive.

What alternative should we explore? In the spirit of Shockley (1957), research productivity can be modelled as the outcome of a number of features that interact multiplicatively rather than additively. For example, the model may include the personality traits that are usually mentioned to emphasize wherein researchers' and teachers' profiles differ. Much research seeks to characterize the qualities of the inventive and creative researcher. The predominant features that emerge from studies in social and cognitive psychology[2] are: ambition, perseverance, resilience, aversion to vague situations and to fuzzy compromises, a high coefficient of strong independence, the fact of being demanding of others, intrinsic motivation for obsession-driven work, and a taste for constant experimentation.

Teachers' characteristics are different: they tend to be sociable and empathetic, open to interaction, available, encouraging, liberal and not authoritarian. They prefer communication to mulling over ideas, and are readily able to put themselves in the other person's shoes rather than refusing to be influenced or pressurized by him/her. This contrasts with researchers who have to be obsessive, before coming to terms with critical arguments and integrating them.

Transposed into epistemological terms, the argument means the following: research maximizes rationality, critical thinking, the desire to transcend established truths and the given state of knowledge, and openness to the discontinuity of ruptures and emergent ideas. Teaching, on the other hand, requires less abstraction, but a taste for illustration and maieutics, the ability to alternate criticism of and confidence in established truths, and the capacity to compromise and adjust to various audiences and variable educational situations. This implies tolerance with regard to the effect produced, when the content of scientific knowledge is twisted so that the teacher can offer it in a stimulating and appropriable form.

2 See, for example, Hennessey & Amabile (2010).

Take the propensity to publish papers, as discussed in Shockley's paper. What factors may be responsible for the unequal production of articles? Shockley proposes a list, to characterize the process leading to the publication of an article, a process that amounts to a series of tests:

1. the ability to find a good problem to explore,
2. the ability to explore it,
3. the ability to recognize a fertile result when it appears,
4. the ability to know when to stop and to write up results,
5. the ability to write one's article well,
6. the ability to learn from criticism (to be constructive rather than defensive),
7. the determination to submit one's article to a scientific journal,
8. perseverance to make changes and to react to the observations of the journal's referees.

The propensity to publish is then the result of a log-normal distribution, due to the interaction between numerous independent factors, each of which is distributed normally. Because they must be combined, they determine productivity in a multiplicative rather than an additive way. In other words, a set of normal causes, by composition, produces unusual results. The resulting distribution tends towards a log-normal distribution profile as the number of factors involved increases.

Building on Shockley's model, Allison and Stewart (1974) have noted that the less routine the tasks required are, the greater the number of factors involved in their execution will be. The distribution of performance in the accomplishment of these tasks therefore becomes increasingly asymmetrical with less routine activities, and increasingly sensitive to a greater number of factors. It therefore comes as no surprise that there is no significant correlation between scientific productivity and each of its determinants taken separately.

What can we conclude from this reasoning? On the basis of abilities and skills that, individually, may be very normally distributed, significant differences of professional success can emerge. The essential point is that these qualities work together, and that their combination (the multiplier effect of their association) has effects out of proportion with the respective distribution of each of them. But the list of these qualities is not a simple standard nomenclature of abilities that must necessarily be possessed in normal or more-than-normal quantities.

In fact some of these qualities are revealed or formed only gradually, through accumulation of experience and through on-the-job learning. It is therefore absurd, if we wish to explain the inventiveness of some scientists, to start with the assumption of differences between individuals that are considerable *a priori*, as in the naïve argument of the genius offered by Dame Nature to the world. But it is also impossible to invoke only omnipotent social forces, chance, or external constraints to propose an alternative explanation by assuming that individuals have exactly the same abilities, and that their performance is highly unequal only because of a set of circumstances out of their control.

Thus without the introduction of a dose of inter-individual heterogeneity, we are unable to explain the differences in performance at each stage, in a career model consisting of sequences of competing tests. But once again, this coefficient of individual heterogeneity stems from a combination of factors which, taken one by one, may very well be fairly normally distributed. The multiplicative nature of the production of research is precisely what makes its process uncertain (non-routine, subject to failures and discontinuities) and what makes the early detection of ”talented” researchers uncertain (Menger, 2014).

Now this is also what makes teaching and research functionally complementary in quite another perspective than that reviewed earlier. Stinchcombe (1963), building on the Davis-Moore theory of stratification, has proposed distinguishing between two categories of industries. The first category includes activities in which a talented professional's contribution to the success of a given project or enterprise is more than proportional to that which distinguishes him/her from his/her colleagues; that is, his/her unique personal qualities contribute greatly to the success of the team or organization. These are the professions in which there is the fiercest competition to attract and remunerate individuals deemed exceptionally talented, and it is here that the concentration of earnings creates situations of winner-take-all or winner-take-the-most. In this category, Stinchcombe mentions scientific research, the arts and the entertainment industry, and sports. Talent in these sectors or professions is a ”multiplicative” factor of production. For example, the exceptional value attributed to a researcher will help his/her team or university obtain significant research resources and new, promising opportunities for collaboration. In the second category, individual contributions – even spectacularly successful ones – cannot considerably increase the organization's or team's reputation or profit. In these activities, the required skills come down to an ”additive” factor of production, and they are more homogeneously distributed. In teaching in undergraduate colleges, or in artisanal production, the presence of professionals who display exceptional (or deplorable) performance does not add considerable prestige to (or discredit) the profession in question. The hiring process for these jobs involves a careful screening of applicants as well as long periods of apprenticeship.

The key point from this is as follows: in the first category of activities, the probability of obtaining a very good result is low and most performances produce average results. To the organization, the costs of hiring someone who turns out to underperform in the riskiest part of his/her job are small in comparison to the benefits it stands to gain from hiring someone exceptional. This leads to a policy of employment or contractual relations that brings in a great number of different individuals – the aim being to find the ”real gem” (Baron & Kreps, 1999).

The academic profession combines the two types of activity. So the question follows, as raised by Mas-Colell (2003:22):

> to attain a given teaching/research combination, should the institution choose first a high teaching talent to, practically speaking, guarantee good teaching without much expense of effort, and then rely on incentives to reach the desired research level? Or should it focus first on research talent and rely on the incentive part to guarantee the teaching objective? The conjecture is that this second alternative is superior to the first.

As the likelihood of finding the real gem (the high-profile research type) is low, the combination of teaching and research may provide a rationale behind the oversupply or overstaffing[3] mechanism inherent in the unbalanced return on uncertain outcomes.

To phrase it otherwise, since the chances of success in each activity are distributed very differently, their conjunction functions like a risk-management mechanism, both individually and collectively. The uncertain and more variable part of academic work and performance benefits from the status granted the teaching mission: the more certain utility and the more normal performance in the latter profile act like a shelter and a mechanism for subsidizing the activity that has variable performance and uncertain outcomes.

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3 Here is the way Roger Geiger (2008:11) describes the rationale behind overstaffing:

”The job of a tenure-track university professor is unique in the amount of continual investment made by employers in the human capital, or intellectual growth, of the employee. These investments include a generous amount of time expected to be allocated for scholarship and research, about 40 percent of the year entirely free from assigned work, paid leaves for intellectual development, and the supporting infrastructure of libraries, laboratories, and information/communication technology. The quid pro quo, of course, is that these resources will be employed to develop a very high level of expertise in a specialized field, and to employ that expertise to advance the field through research and publications, and sometimes to share that knowledge through service - in addition to teaching. Individuals who meet these criteria are rewarded with tenure, and the university continues to invest in their knowledge growth until retirement.

As the faculty role becomes more research intensive, structural changes become increasingly evident. Two strategies are apparent: staffing redundancy and reliance on full-time, non-tenure track teachers.

Departments heavily engaged in sponsored research have long resorted to staffing redundancy by employing many more faculty members than are strictly needed to teach their courses. […] My own department of ten faculty, for example, has theoretical ”teaching power” of 37 courses per year. My colleagues and I actually teach about 15. And it is still often difficult to cover these offerings. Without this redundancy it would be impossible to accommodate buy-outs, leaves, and other reductions in teaching loads.

Departments in which sponsored research creates fewer buyouts – humanities, social sciences, and business – have developed other coping strategies. They face a critical problem in the considerable cognitive distance that exists between faculty scholarship and undergraduate learning needs. Mathematics has long recruited part-time teachers to staff multiple introductory sections, as have English and foreign language departments to handle first-year language/writing courses. Now the same kind of problem is faced by prestigious economics departments, for example, which prefer to have professors focus on economic theory; or business schools, where esoteric faculty research bears little relation to the basic courses needed by a multitude of undergraduate majors. In such situations, departments have increasingly resorted to full-time, fixed-term faculty to fill the gap. In this way, these departments are able to utilize tenure-track faculty to teach advanced seminars, conduct research, and publish in leading journals, while still meeting student demand for basic courses.”

Moreover, an academic career unfolds within the same profession over decades. It is simply the balance of the different tasks to fulfil, that varies over time. But research productivity tends to decline, while teaching productivity remains fairly constant. Therefore, the assurance mechanism described above explains that the asymmetrical association of research with teaching has inter-temporal flexibility. The set of tasks of an academic evolves throughout his/her career, according to the preferences, negotiations and obligations that the management of multitasking entails. In that respect, the dual loyalty of academics to their institution and to their professional community (Crane 1970) may act as a device to balance out the benefits of mobility in the academic market and the protection offered by the teaching-research nexus that helps manage the declining research productivity.

Research and graduate vs undergraduate teaching

A second factor that helps explain why the interaction between effort and ability has a greater impact on research productivity than on teaching productivity refers to the teaching level.

Numerous studies measuring student perception have shown a stronger positive association between research and teaching at the postgraduate level than at the undergraduate level. Similarly academics overwhelmingly support the position that the strength of the link is far greater at higher levels (Qamar uz Zaman 2004). The synergies between research and teaching increase with course level. At the advanced level, the research domain is closer to the teaching domain. Keeping up with the literature provides more direct benefits to teaching and research. Researchers can also identify talented, advanced students and involve them in research projects. The effectiveness of teaching and of research thus become mutually interdependent as students get closer to PhD studies and their work approaches that of an academic researcher (de Weert & van der Kaap 2014).

This is hardly new. What is really impressive now is to see how the share of PhD students over undergraduate students is a widely used indicator of research intensity and academic excellence (Bonaccorsi et al. 2007). For those universities that are becoming more international, the rules of the reputational competition (selectivity, internationalization, research intensity, country attractiveness) apply not only to hire or poach high-profile faculty, but also to match them with PhD students queueing to get admitted through highly selective admission processes. So it can be said that two different products are produced by the higher educational sector, research and graduate education, on the one hand, and undergraduate education, on the other hand (Nerlove 1972).

Note that the delivery of undergraduate education works the same way, when selectivity and hierarchy step in. This is so because of the customer input technology in education (Rothschild & White 1995). The main fact is that education can be better produced with good students who act not only as recipients of educational services, but as producers, too. Higher education is produced with a very strange technology in which the quality of the output depends on the quality of the customers who buy the service. Students, it appears, educate other students and some students do it better than others, so colleges care to whom they sell their product (Winston & Zimmermann 2004). Inputs of faculty and facilities matter, too, of course, but the quality of both individual students and the student body as a group counts for a great deal in the quality of educational services the institution delivers (Menger et al. 2015).

At the graduate level, this technology amounts to an assortative matching game, of which PhD students are a major component. In the assortative or selective matching game, academics benefit from associating with faculty of equal or superior ability and excellent PhD students. This is a component of the cumulative advantage mechanism that helps explain the magnification of inequality in research. The unique characteristic of assortative matching is that it provides ”matched” individuals with higher returns on their respective abilities than they would otherwise obtain in the case of random matching. This form of association, in other words, has a multiplicative effect. This is especially the case when work is organized on a project-by-project basis, as is common in research.

Other inputs that explain the magnification of inequality in research have to do with the fact research is open to the broadest environment possible (Waltman et al. 2011), whereas teaching is a service confined to an organization. Therefore, research may enjoy productivity gains that appear to be inaccessible to teaching. Some of the most significant productivity gains stem from the team organization of work in research (Wuchty et al. 2007) and from the networked architecture that follows the rules of assortative matching.

Conclusion

Starting from the antinomy of complementarity and substitution, I have suggested that the solution consist of recasting complementarity and of putting it under asymmetry. Asymmetry is fractal: it pervades the task design and the management of careers, but also plays a major role at the institutional level, where differentiation is a strategic concern.

Asymmetry may be endorsed in various ways. A first option is sheer stratification of higher education institutions, like in the US model of classification based on research intensity and the type and level of educational programs. This corresponds to a scheme of decentralized control, which, as stated by Clark (1987:101), has been ”virtually a necessary ingredient: No centralized public system can plan so much differentiation and make it work. Under these conditions, American academics have come to accept that a greatly muddled differentiation is a normal course of affairs”.

In the second place, a process of endogenous stratification may take place by means of competition, as in the German *Exzellenzinitiative* program or the French *Initiative d'excellence* or the British *Research Excellence Framework*. This endogenous stratification process looks like a mix of centralized control and decentralized differentiation. The French system deserves an additional comment. Universities in France, like most European universities, have been asked to perform well along all dimensions (teaching, research, extensive democratization of higher education) without considering possible trade-offs. The governance model is historically designed to balance all aspects of activity, from mass education to excellence in research to compliance with society's needs. Yet in reality, French universities are only one pillar of the post-secondary Teaching – Research nexus.

The French system of higher education and research is divided into three major components – universities, so-called Grandes Ecoles like Ecole Polytechnique and Ecole Normale Supérieure, and large research institutes such as CNRS (National Center for Scientific Research) or INSERM (National Institute for Medical Research) or INRIA (National Institute for Computer Science) as well as other, smaller, ones. Research institutes share resources and personnel with universities, in order to get access to doctoral programs and students, that provide them with an essential part of their human resources and creativity potential. So, researchers do teach, but only at the level where complementarity is necessary and productive. A significant number of the best doctoral students are trained in the Grandes Ecoles: although they belong to the French higher education system, those institutions have a privilege that is denied universities, that of selecting their students through a competitive admission scheme. The French Grandes Ecoles form indeed an oligopoly whose main competitive advantage is to secure access to ”preparatory classes”, a highly selective two-year educational program that allows students to compete to enter the Grandes Ecoles (business, engineering, humanities and science elite schools). Oligopoly is one distinctive feature. The other one is hierarchy, meaning that schools are ranked according to their status and reputation and performances (now measured more precisely than before) and that each school gets the student quality (measured after the test scores) that matches with its rank: a perfect creaming off process of admission and matching (Menger & Marchika 2014; Menger et al. 2015).

This is the way France, beyond its egalitarian doctrine, handles the controversial issue of stratification, selective admission and complementarity of teaching and research, though officially maintaining its doctrine of non-selectivity for accessing university. This threefold organization provides a striking illustration of how complementarity between teaching and research is not only easier to secure at the graduate level but functionally indispensable, and how French nonselective universities are left alone with the puzzling issue of complementarity between undergraduate and graduate education. Indeed, without sharing resources with university labs, large French research institutes could not work – nor could they legitimate the ”research only” unique privilege granted their personnel, with no risk for them to lose their position if underperforming.

Asymmetry between research and teaching increasingly impacts the design of academic jobs as competition takes place on a national and international scale. There is no way to escape that asymmetry. The coupling design helps explain how inequality may be tolerated even when reaching astonishingly high levels, as the Paretian profile of performance in research demonstrates. It also works as an insurance mechanism on a collective level (teaching provides outcomes of a more certain social value in the short term, whereas research appears both more uncertain and more valuable when we take the long-term perspective), and it provides self-insurance to the individual faculty against downswings, discontinuities and declining productivity in research over the course of a career.

This is why we may observe at the same time that the functional link is weakened wherever the substitution option leads to disconnect teaching from research through the use of contingent academic workforce (part-time and non tenure-track positions), mainly in ”teaching only” positions; and that aiming both at teaching and research excellence drives the competition and the stratification of higher education institutions. Actually the top-rank universities make use of more sophisticated academic employment and incentive designs than the ones adopted at lower ranks, where budgetary constraints as well as lower expected returns on investment in the reputational competition impose rougher trade-offs between research and teaching.

Martimort (2015) convincingly distinguishes between explicit and implicit productivity incentives in academia. The latter are associated with evaluations of faculty work that aggregate information on the multidimensional nature of the agents' activity and on convergences with the organization's different missions. By contrast, explicit incentives are associated with strictly measurable outputs and are designed to contractually remunerate productivity gains in the form of bonuses, piece-rate allowances rewarding each additional significant research publication, and teaching relief vs intensification (for a case study, see Menger et al. 2015).

Implicit incentives rely on an assortment of criteria with a subjective final weighting. They are informed by a more integrating organizational culture that loosely contractualizes the specific content of the activities to perform and the performances to achieve, so as to discourage opportunism and to foster trust. One could easily conclude that this kind of incentive is superior and should prevail across the board, were it not for competition and stratification. Indeed, in a framework of positional competition, top universities not only lead the field by attracting the best scholars and selecting the best undergraduate and graduate students on a global scale, but also impose their costly, research-based educational technology on the followers. The former rely primarily on implicit incentives to reach their dual objective: to act on academic productivity and maintain a culture of trust within the organization. As lower-ranking institutions manage a less homogenous body of scholars and students, they resort more often than not to explicit incentives that act as screening and sorting devices, in order to come up with the challenges posed by the shifting educational technology and the rat race of global academia.

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