How Ambitious Should You Be?
Researchers' Project Choices with Signalling Concerns

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Abstract

Researchers can signal their ability to the academic community through publications. When choosing a research project, they face a fundamental trade-off: more ambitious projects entail higher risk of failing, but their successful completion provides a stronger signal of ability. I show that researchers' signalling game admits a (stable) *publish-or-perish equilibrium*, in which having no publications is interpreted by the market as a signal of very low ability, and many talented researchers optimally choose incremental research projects. Extending this model allows to assess how several current trends in the academic research market affect researchers' incentives to carry out extensive research.

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1 Introduction

Successful publishing in academia plays a crucial role in determining the fate of ideas, while at the same time influencing the career advancement of individual scholars. Hiring, promotion and tenure decisions are increasingly based on publication records, and so are grants and other subsidies. In many countries, the reliance on publications as indicators of scientific ability replaced the tacit reward system of the past, in which educational and research qualities were assessed in an informal manner, and researchers were mostly motivated by non-market incentives (e.g., priority in discovery). It is therefore hardly surprising that survey evidence reveals that the wide majority of researchers, across different fields, experience pressure to publish in peer-reviewed journals, and that tenure-track faculty are more motivated to publish to increase their professional reputation than tenured faculty (see, e.g., Miller et al., 2011; Van Dalen and Henkens, 2012).

While a *publish-or-perish* environment may stimulate individual and aggregate productivity, the mentioned survey evidence also shows that perceived pressure to publish is likely to deter researchers, especially those who are seeking tenure, from doing non-traditional research. Indeed, starting with Wood (1990), many scholars across different fields have expressed concerns that the pressure to publish may *lower standards*, deterring academics from conducting creative research. For instance, De Rond and Miller (2005) argue that, since junior faculty often have to play a *numbers game* to earn tenure, where the relevant criteria highly rely on the number of articles published and the relative prestige of their outlets, there may be too much emphasis on productivity at the expense of innovation. This generates output that may be seen as relatively incremental, lacking in significance and substance. An over-competitive environment may thus ultimately hinder scientific progress. Yet, no formal analysis of researchers' incentives in the current academic environment, which could shed light on these concerns, has been proposed so far, to the best of my knowledge.

The aim of this paper is precisely to provide and analyse a model linking researchers' incentives, which shape their individual research agenda, to aggregate outcomes in the academic research market, such as the amount of *extensive* vs *incremental* research output, and the allocation of researchers to universities. The starting point of the analysis is that, as already argued by Stephan (1996), researchers, and young scholars in particular, have to choose their research projects with care to signal their ability to the reference scientific community. In other words, they must select, besides a line of research, a *research strategy*: in particular, "the use of a novel method can prove rewarding, but the risk of coming up empty-handed can be quite large when an unorthodox approach is employed". Thus, when choosing a research project to undertake, a researcher faces the following trade-off. On the one hand, undertaking a more ambitious project comes at a larger risk of failing. Intuitively, tackling a long-standing problem in the field — attempting at proving the Riemann hypothesis is a compelling, though perhaps too extreme, example — or adopting a novel, maybe interdisciplinary, approach to address an important question is likely to lead to no publishable results. This is because the researcher will often be unable to prove a 'hard' theorem (nor that its statement is false), and a novel approach may well prove unfruitful to shed light on the investigated phenomena. On the other hand, successful completion of an ambitious project provides a stronger signal of the researcher's ability, compared to completion of incremental research projects. In an environment where her reputation, hence career prospects, crucially depend on her research output, this acts as a powerful career-booster (e.g., can secure her a tenured position in a highly prestigious university).

How do researchers' career concerns shape their individual project choice decisions? Can their career concerns discourage extensive research, as argued by many scholars, despite ambitious projects' completion signalling high ability? On aggregate, is there excessive or too little extensive research in equilibrium compared to the social optimum?

To address these questions, I build a simple researchers' career-concerns model in a (stochastic) signalling game setting. Researchers are privately informed about their own ability type, which determines the probability of successfully completing research projects. Each has to choose whether to undertake an *incremental research* project, which is more likely to succeed, or instead a more ambitious *extensive research* project, which is more risky (i.e., fails with larger probability), but whose completion is more valuable to the research community or, more broadly, to society. High-ability types have a comparative advantage over low-ability types in completing any project, but their advantage is most significant when it comes to extensive research projects: successful completion of such projects thus provides a stronger signal of high ability. Importantly, the academic community can only observe completed projects: the idea is that each researcher publishes her findings, if any, but cannot convey hard information about her project choice if she failed. Thus, consistently with the motivating evidence, the academic community evaluates researchers only based on their *publication record*.

In a standard reduced-form model, where a researcher's payoff coincides with her average type inferred by the market contingent on such information, I show that the outlined game admits two (interior) equilibria. While both equilibria exhibit a cutoff structure, whereby researchers whose ability-type exceeds (is below) a threshold choose extensive (incremental) research projects, an equilibrium in which this threshold is relatively low, which exhibits a fairly large amount of extensive research, coexists with an equilibrium characterized by a large cutoff type, in which even many talented researchers undertake incremental research projects. The intuition behind this multiplicity result lies in the strategic complementarity forces at play in this game. If most researchers are expected to choose ambitious projects in equilibrium, then publishing incremental research confers little *honour* (since only very low-ability types self-select into such projects), whereas having no publication conveys little *stigma* (since many failures come from relatively good types failing high-profile projects). Hence, for given ability, any researcher has relatively strong incentives to undertake ambitious projects. On the contrary, any researcher has (all else equal) weaker incentives to be ambitious if most of her fellows are expected to choose low-profile projects. This is because, in this case, self-selecting into incremental research projects does not provide a bad signal, whereas researchers with no publications are likely to be very low types who were not able to successfully pursue low-profile projects. Importantly, only this latter equilibrium is stable (in a standard, *tâtonnement* sense). Thus, a *publish-or-perish equilibrium*, in which, because of the very low 'reputation' associated with having no publications, even some of the highest-ability scholars work on incremental research projects, arises as a consequence of strategic complementarities among researchers' project choices.

Notably, these results hold under the assumption that the market is perfectly able to assess the published projects' quality. If, because of specialization, the market only infers papers' quality based on the prestige of the publication outlet, as it seems increasingly to be the case in economics (Heckman and Moktan, 2020), then the baseline analysis presupposes that scientific journals are *perfect quality certifiers* — i.e., successful high-profile and low-profile projects are always published by top-journals and second-tier journals, respectively. Assuming instead, realistically, some imperfections in their certification technology leads to even less extensive research being carried out in equilibrium. The same result obtains if top journals exhibit a space constraint (as hinted, in economics, by the empirical evidence in Card and DellaVigna, 2013), or are unwilling to publish *negative*, or non-significant, results (as it seems happening in many fields: see Fanelli (2012) and references therein).

Other factors that hinder extensive research are: *(i)* large effort and/or opportunity costs associated with research activities, because the stigma from having no publication is worsened when such outcome is mostly attributed to very bad types who, having low chances to succeed, are not willing to sink such costs; *(ii)* the possibility of undertaking a larger number of low-profile projects, given that extensive research projects require comparatively more time: in this case, relatively high-ability researchers can separate themselves from lower ability ones by having more incremental publications — i.e., through their *productivity* rather than through their *creativity*; and *(iii)* explicit monetary incentives, in the form of cash bonuses contingent on publications (Franzoni et al., 2011), if these cannot be tailored to the research quality, because choosing incremental research projects increases the chances of cashing these bonuses. These results allow to identify several policies which can promote high-quality research: e.g., reduce the burden of teaching and/or administrative duties, evaluate candidates only based on their best pieces of research (e.g., by capping the number of publications they can submit when applying for a position), or granting monetary bonuses only for top-publications.

Also the availability of further sources of information on researchers' ability (e.g., reference letters, Alma mater's prestige) is likely to foster extensive research. This is because, thanks to such information, high-ability types are less worried to be pooled with low types in case of failure, and so tend to be more ambitious. Yet, the reverse result emerges if good (extra-)information can only be revealed for very high-ability types, who would anyway choose extensive research projects: in this case, as slightly lower types cannot aspire to be pooled with these top-scholars, they will be mostly concerned about separating themselves from the bad types by succeeding in incremental research projects.

Finally, the model is enriched by modelling the demand-side of the academic job market, so that researchers' equilibrium payoffs explicitly depend on features of the labour market. The analysis is cast in a matching-tournament setting (Cole et al., 1992, 1998; Hopkins, 2012) with heterogeneous employers (i.e., universities that differ in prestige), under the assumption that the value from a researcher-university match exhibits complementarity among their vertical types. In both Transferable Utility and Non-Transferable Utility environments (corresponding to cases with full wage flexibility and constrained wages, respectively), I find that, in all interior equilibria, the stable matching is such that applicants with low-profile publications are hired by better universities compared to applicants with no publications. This shows that a *publish-or-perish* system is likely to emerge as a stable equilibrium of the academic labour market.

While throughout the paper I focus on the academic research market, it is worth remarking that the model insights apply more broadly to R&D markets where innovators have signalling concerns. Indeed, there is a well-established evidence that start-ups use patents as signals of high innovative ability to secure financing by venture capitalists (Conti et al., 2013a,b). More generally, as firms' innovative ability is often associated with higher stock returns (see, e.g., Hirshleifer et al., 2013), they have strong incentives to build a reputation for being highly innovative. These signalling incentives may significantly impact their R&D strategies. The present model examines how they affect the way firms deal with a fundamental trade-off between low-risk/low-value and high-risk/high-value R&D projects. Thus, while, since the pioneering works of Schumpeter and Arrow, distortions in the level and the direction of innovation in R&D markets are typically attributed to appropriability problems, this paper sheds some light on distortions arising from innovators' image/career concerns. It is shown that, even if innovators can fully appropriate the social value of their R&D output, and high-value projects' completion signals high innovation ability, there may be an inefficiently low amount of disruptive research projects carried out in equilibrium.

The article is organized as follows. After reviewing the related literature, in Section 2 I set-up and develop the analysis of the baseline career-concerns model. Several extensions and implications of the model are discussed in Section 3. Section 4 proposes a matching-tournament model of the academic job market. Section 5 concludes, highlighting a few alleys for future research. All proofs are in Appendix.

Related literature. Stemming from Becker (1975, 1979), a few theoretic models have studied how academics' incentives affect the quality of teaching and research in equilibrium — see De Philippis (2021) for a more recent contribution in a multi-task agency setting, and related empirical evidence. These models focus on the trade-off between allocating time and effort in teaching and research activities, whereas my paper is centred on the trade-off between intensive and extensive research.[1]

More closely related to my work are thus papers focusing on research effort and output. Ellison (2002) considers two dimensions of research quality, one being the importance of the main ideas and the other measuring further aspects of quality that journals' referees take into account in their recommendations. He examines how the research community *social norms* affect the publishing process, hence researchers' quality choices along these two dimensions. More recently, Checchi et al. (2021) develop a researchers' contest model in a all-pay auction setting. They consider a number of academics who work in the same area and compete for a promotion by exerting costly effort to produce research output. The model predicts that more capable researchers respond to increases in the importance of publications for promotion by exerting more effort, whereas less able researchers are discouraged by competition and do the opposite. Their empirical findings align with these predictions. In Farhi et al. (2013), researchers' payoff depend on the 'market' assessment of their (exogenous) papers' quality based on the publication outlet, whereas in the present paper the quality of their research output is instrumental to signal their own ability. Moreover, unlike in my model, researchers choose a submission strategy (i.e., whether to first target a top-journal, incurring the risk of being rejected, or to directly submit to a second-tier journal so to obtain a quick publication) rather than a research project and, more importantly, they have no private information. Thus, these works do not explicitly deal with

[1] A similar trade-off has been recently examined by Carnehl and Schneider (2022), though in a very different setting, with a single decision maker. A related strand of the literature has examined how R&D policies affect the direction of innovation — see, e.g., Bryan and Lemus (2017), Akcigit et al. (2021). Their focus is however on appropriability problems and preemption mechanisms, rather than on signalling concerns.

researchers' project choices and signalling concerns.

My modelling approach is closer to social signalling models where agents have image concerns. Influential works by Bénabou and Tirole (2006, 2011) study individuals' incentives to engage in prosocial behaviour when they value (besides, to different extents, the private costs/benefits and the positive externalities associated to such conduct) their *social image*. Similar to my model, each agent's choices are driven by a honour-stigma trade-off, whose terms are shaped by all agents' actions. Yet, while they study deterministic models where the action taken by agents is perfectly observable, research project outcomes are stochastic in the present environment, with the chosen project being observable only in case of success,[2] and agents differ in productivity rather than in preferences.

A project choice model where innovators aim to signal their ability to the market has been proposed by Chen (2015). She analyses CEOs choices of a safe vs a risky investment, whose probability of success depends on the CEOs (binary) ability type.[3] Yet, in her model project choice is always observable and, as a consequence, signalling concerns unambiguously yield over-investment in the risky project in equilibrium compared to the social optimum.[4]

2 Baseline model

2.1 Set-up and assumptions

Environment. There is a continuum of mass one of researchers. Each of them has to choose a research project to undertake. Research projects are risky: they either succeed ($s = 1$) or fail ($s = 0$). The probability of successful project completion depends: *(i)* on project characteristics, and *(ii)* on the researcher's talent/ability. As for *(i)*, I consider two project categories $P \in \{L, H\}$: holding the researcher's ability fixed, *incremental research* projects L succeed with larger probability compared to *extensive research* projects H. As for *(ii)*, each researcher has an *ability type* $\theta \in [\underline{\theta}, \overline{\theta}]$, distributed according to a cumulative distribution function $F(\cdot)$ with positive and differentiable density $f(\cdot)$. Higher types — i.e., more talented researchers — are more likely to complete any project, and their comparative advantage over lower types is more relevant when it comes to high-quality (i.e., extensive research) projects.

Formally, denoting by $p_P(\theta) \triangleq \Pr[s = 1|P, \theta]$ the probability that a researcher of ability θ successfully completes any project $P \in \{L, H\}$, the following assumptions are imposed:

A1. $p'_L(\theta) > 0$ for all $\theta \in [\underline{\theta}, \overline{\theta}]$, and $p_L(\overline{\theta}) = 1$;

A2. $\dfrac{\mathrm{d}}{\mathrm{d}\theta}\left(\dfrac{p_H(\theta)}{p_L(\theta)}\right) > 0$ for all $\theta \in [\underline{\theta}, \overline{\theta}]$, with $\lim\limits_{\theta \to \underline{\theta}} \dfrac{p_H(\theta)}{p_L(\theta)} = 0$ and $\dfrac{p_H(\overline{\theta})}{p_L(\overline{\theta})} = 1$.

[2] Hence, on the technical side, my work relates to stochastic signalling models (see, e.g., Matthews and Mirman, 1983; Hertzendorf, 1993; Jeitschko and Normann, 2012) in which the signal observed by the market is a *noisy version* of the action chosen by the agent.

[3] In allowing researchers to choose instead between two different risky projects, my work is somehow related to the literature on signalling with multiple signals: see, e.g., Quinzii and Rochet (1985) and Engers (1987), who however resort to deterministic models.

[4] For related CEOs project choice models, see Aghion et al. (2013) and Galasso and Simcoe (2011), whose analysis is cast in a career concern setting *à la* Holmström (1999), so that agents have no private information to start with.

Information and payoffs. Project completion is hard information and the 'market' is perfectly able to observe the characteristics of a successfully completed project (i.e., whether it is a L- or a H-project). By contrast, project choice is soft information. Hence, conditional on failure, a researcher cannot produce verifiable evidence on the characteristics of the project she undertook. Each researcher is privately informed about her ability type θ, and her payoff is $\mathbb{E}[\tilde{\theta}|\mathcal{I}]$ — i.e., her expected ability as inferred by the market based on the publicly observed information $\mathcal{I}$. Formally, let $\mathcal{M}_P^1$ and $\mathcal{M}^0$ denote the researcher's *reputations* when the market observes successful completion of the chosen project — i.e., $\mathcal{M}_P^1 \triangleq \mathbb{E}[\tilde{\theta}|s=1,P]$ — and that the researcher failed her project — i.e., $\mathcal{M}^0 \triangleq \mathbb{E}[\tilde{\theta}|s=0]$ — respectively. Then, each researcher's project choice problem is formalized as follows:

$$P^*(\theta) \in \underset{P\in\{L,H\}}{\arg\max}\, u_P(\theta) \triangleq p_P(\theta)\mathcal{M}_P^1 + (1-p_P(\theta))\mathcal{M}^0. \tag{1}$$

In equilibrium, reputations are computed using Bayes rule (whenever possible) given researchers' equilibrium strategy $P^*(\theta)$.

Discussion. The baseline model outlined so far aims to capture a basic trade-off faced by researchers in many fields at early stages of their career.[5] For example, PhD students in economics are required to produce a Job Market Paper (JMP), whose quality is undoubtedly the most important signal to their prospective employees in the academic job market. Universities' hiring committees screen applicants' potential to do high-quality research mostly based on their JMPs: hiring decisions in the best universities are taken after candidates present their JMPs in dedicated seminars (*job market talks*).

When a graduate student must choose the topic and the methodology for her JMP, she is of course more informed than the market about her ability in doing research. At this stage, she knows that successfully pursuing an ambitious project (H-project in this model) will allow her to be hired by a prestigious international university, because completing an ambitious project is a stronger signal of ability compared to completion of an incremental research project (L-project). Yet, undertaking a more ambitious project also comes along with a larger risk of failing. For instance, adopting a novel approach to address an important question is more likely to lead to no presentable results, because that approach may well prove unfruitful, whereas (for given researcher's ability) employing a well-established approach is more likely to deliver some, though not path-breaking, results (Stephan, 1996).

Importantly, in the academic job market the relative prestige of successful high-quality vs low-quality projects, as well as the 'stigma' from failing the JMP project, depend on the equilibrium project choices (and outcomes) of all job market candidates, as these shape the competitive arena and the employees' expectations. By affecting researchers' career prospects, these in turn drive their individual project choices. To capture these features in the simplest possible way, in the baseline model, following the standard signalling (Spence, 1973) and career-concerns (Holmström, 1999) models, I take

[5]While throughout the paper I refer to the market of academic research, the same model also applies to other labour markets where (risky) projects' completion signals employers' ability to current or prospective employees, thereby affecting their career prospects (e.g., Aghion et al., 2013).

a reduced-form approach whereby each researcher's payoff equals her ability perceived by the market. This is also consistent with the evidence (e.g., Miller et al., 2011) that researchers highly value their professional recognition (i.e., their reputation in the scientific community) *per se*. Explicit incentives (on top of implicit, career-concerns driven, ones) are considered in Section 3.5, whereas the demand-side of the job market is endogenised in Section 4.

The assumptions of binary project choice (H vs L) and outcome (success vs failure) are quite standard in project choice models (e.g., Aghion et al., 2013; Chen, 2015) and maintained throughout merely for the sake of tractability. Binary actions are considered also in signalling models of prosocial behaviour *à la* Bénabou and Tirole (2006, 2011). For related discussions and slightly more general choices and outcomes, see Sections 3.3 and 3.4.

Also the informational assumptions are rather stark in some respects. First, no information about project choice is revealed conditional on failure.[6] Second, project quality is perfectly observable contingent on success, which requires consensus in the scientific community on the relevance of the contribution. Third, the market can condition its evaluation of researchers on the observable project outcome only. Yet, these assumptions seems rather natural in a world where hiring/promotion decisions are based on publications, so that the evaluation of research quality is *de facto* 'delegated' to academic journals. Under this interpretation of the model, successful H-projects are published in 'top-tier' journals, a successful L-project yields a paper which can be published in a 'second-tier' journal, whereas no publishable results are obtained if the project fails (any such submission is rejected by all journals). Note that the baseline model assumes that academic journals are *perfect quality certifiers* (as, e.g., in Farhi et al., 2013). Section 3.1 extends the model to allow for imperfect certification (or lack of consensus in the academic community), whereas Section 3.2 examines how the results change when further information about the researcher's type, besides her 'publication record', is available to the market.

2.2 Equilibrium analysis

2.2.1 Preliminaries

From the formulation of the project choice problem (1), it immediately follows that type θ chooses a H-project if and only if[7]

$$p_H(\theta)[\mathcal{M}_H^1 - \mathcal{M}^0] \geq p_L(\theta)[\mathcal{M}_L^1 - \mathcal{M}^0]. \tag{2}$$

In what follows, I restrict attention to *interior equilibria* — i.e., semi-separating equilibria in which a positive-measure set of types chooses both projects. In any such Perfect Bayesian Equilibrium (PBE), all reputations are obtained by Bayes rule — i.e., there are no off-path beliefs to specify (pooling equilibria are discussed at the end of this section).

Intuitively, for (interior) equilibria to arise: *(i)* all publications must have a value — i.e., $\mathcal{M}_P^1 > \mathcal{M}^0$

[6] Intuitively, in this model every researcher who fails would have incentive to claim to have tackled a H-project, which makes any such claim uninformative. If, by contrast, project choice was always observable, then clearly the baseline model would feature a unique equilibrium where all types choose H-projects, which would make the analysis uninteresting.

[7] As a tie-breaking condition, it is assumed throughout that researchers choose H-projects in case of indifference. As the set of indifferent types is a singleton — i.e., a zero-measure subset of $[\underline{\theta}, \overline{\theta}]$ — this assumption is immaterial to the results.

for $P \in \{L, H\}$; and *(ii)* high-profile publications must confer more prestige compared to low-profile ones — i.e., $\mathcal{M}_H^1 > \mathcal{M}_L^1$. As for *(i)*, if success were to improve reputation only for one kind of project, then all researchers would choose such projects; moreover, given that higher-ability types are more likely to succeed in any project, Bayes rule implies that the best reputation cannot be achieved by failing. As for *(ii)*, everyone would choose L-projects if these, besides being less risky (i.e., less likely to bring the lowest reputation $\mathcal{M}^0$), were also more (or equally) rewarding in case of success.

Thus, suppose $\mathcal{M}_H^1 > \mathcal{M}_L^1 > \mathcal{M}^0$. A type $\tilde{\theta}$ weakly favours a H-project if

$$\frac{p_H(\tilde{\theta})}{p_L(\tilde{\theta})} \geq \frac{\mathcal{M}_L^1 - \mathcal{M}^0}{\mathcal{M}_H^1 - \mathcal{M}^0},$$

where the RHS belongs to $(0, 1)$ and the LHS is increasing in the researcher's type (by A2). It then follows that any higher type $\theta > \tilde{\theta}$ strictly favours H-projects. By the same argument, if a type favours L-projects, then *a fortiori* any lower type optimally chooses a L-project. These observations yield the following result.

Lemma 1. *In any interior equilibrium, there exists a threshold (cutoff)* $\widehat{\theta} \in (\underline{\theta}, \overline{\theta})$ *such that* $P^*(\theta) = L$ *for all* $\theta < \widehat{\theta}$ *and* $P^*(\theta) = H$ *for all* $\theta \geq \widehat{\theta}$*.*

Given the cutoff $\widehat{\theta}$, Bayes rule yields

$$\mathcal{M}_L^1 = \mathcal{M}_L^1(\widehat{\theta}) \triangleq \mathbb{E}[\theta|\theta < \widehat{\theta}, s = 1] = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta) \mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta) \mathrm{d}F(\theta)},$$

$$\mathcal{M}_H^1 = \mathcal{M}_H^1(\widehat{\theta}) \triangleq \mathbb{E}[\theta|\theta \geq \widehat{\theta}, s = 1] = \frac{\int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta) \mathrm{d}F(\theta)}{\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta) \mathrm{d}F(\theta)},$$

and

$$\mathcal{M}^0 = \mathcal{M}^0(\widehat{\theta}) \triangleq \mathbb{E}[\theta|s = 0] = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta(1 - p_L(\theta)) \mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta(1 - p_H(\theta)) \mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} (1 - p_L(\theta)) \mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1 - p_H(\theta)) \mathrm{d}F(\theta)}.$$

Upon observing completion of a L-(H-)project, the market infers that the researcher's type is lower (higher) than the equilibrium cutoff type: $\mathcal{M}_L^1(\widehat{\theta}) < \widehat{\theta} < \mathcal{M}_H^1(\widehat{\theta})$. Moreover, $\mathcal{M}_L^1(\widehat{\theta}) > \mathcal{M}_L(\widehat{\theta}) \triangleq \mathbb{E}[\theta|\theta < \widehat{\theta}]$ and $\mathcal{M}_H^1(\widehat{\theta}) > \mathcal{M}_H(\widehat{\theta}) \triangleq \mathbb{E}[\theta|\theta \geq \widehat{\theta}]$: formally,

$$\mathcal{M}_L^1(\widehat{\theta}) = \mathcal{M}_L(\widehat{\theta}) + \frac{\mathrm{Cov}[\theta, p_L(\theta)|\theta < \widehat{\theta}]}{\mathbb{E}[p_L(\theta)|\theta < \widehat{\theta}]},$$

and

$$\mathcal{M}_H^1(\widehat{\theta}) = \mathcal{M}_H(\widehat{\theta}) + \frac{\mathrm{Cov}[\theta, p_H(\theta)|\theta \geq \widehat{\theta}]}{\mathbb{E}[p_H(\theta)|\theta \geq \widehat{\theta}]}.$$

This is because, higher types being more likely to succeed, success is positively correlated with a researcher's ability — i.e., the (conditional) covariances between θ and $p_P(\theta)$ (for $P = L, H$) are positive.

Finally, the reputation contingent on failure can be rewritten as

$$\mathcal{M}^0(\widehat{\theta}) = \gamma(\widehat{\theta})\mathcal{M}^0_L(\widehat{\theta}) + (1-\gamma(\widehat{\theta}))\mathcal{M}^0_H(\widehat{\theta}), \tag{3}$$

with $\gamma(\widehat{\theta}) \triangleq \Pr[\theta < \widehat{\theta} | s = 0] \in (0,1)$,

$$\mathcal{M}^0_L(\widehat{\theta}) \triangleq \mathbb{E}[\theta|\theta < \widehat{\theta}, s = 0] = \mathcal{M}_L(\widehat{\theta}) - \frac{\mathrm{Cov}[\theta, p_L(\theta)|\theta < \widehat{\theta}]}{\mathbb{E}[1 - p_L(\theta)|\theta < \widehat{\theta}]} < \mathcal{M}_L(\widehat{\theta}),$$
$$\mathcal{M}^0_H(\widehat{\theta}) \triangleq \mathbb{E}[\theta|\theta \geq \widehat{\theta}, s = 0] = \mathcal{M}_H(\widehat{\theta}) - \frac{\mathrm{Cov}[\theta, p_H(\theta)|\theta \geq \widehat{\theta}]}{\mathbb{E}[1 - p_H(\theta)|\theta \geq \widehat{\theta}]} \in (\widehat{\theta}, \mathcal{M}_H(\widehat{\theta})).$$

In words, a researcher with no publication is with probability $\gamma(\cdot)$ a type $\theta < \widehat{\theta}$ who has failed a L-project — i.e., on average, $\mathcal{M}^0_L(\cdot) < \mathcal{M}_L(\cdot)$ — and with complementary probability a type $\theta \geq \widehat{\theta}$ who did not manage to complete a H-project — i.e., on average, $\mathcal{M}^0_H(\cdot) \in (\widehat{\theta}, \mathcal{M}_H(\cdot))$.

Note that, as $\widehat{\theta}$ grows larger, the probability $\gamma(\cdot)$ with which failures are attributed to an average type $\mathcal{M}^0_L(\cdot)$ increases (hence, the complementary probability with which they are attributed to an average type $\mathcal{M}^0_H(\cdot)$ decreases). As $\mathcal{M}^0_L(\cdot) < \mathcal{M}^1_L(\cdot) < \mathcal{M}^0_H(\cdot)$, it follows that the comparison between $\mathcal{M}^1_L(\cdot)$ and $\mathcal{M}^0(\cdot)$ depends on the equilibrium cutoff.

By contrast, $\mathcal{M}^1_H(\cdot)$ is the best reputation for every possible equilibrium cutoff. Indeed, from the above results it follows $\mathcal{M}^1_H(\cdot) > \mathcal{M}_H(\cdot)$, where $\mathcal{M}_H(\cdot) > \mathcal{M}^0_H(\cdot) > \mathcal{M}^0(\cdot)$ and $\mathcal{M}_H(\cdot) > \widehat{\theta} > \mathcal{M}^1_L(\cdot)$. The following lemma summarizes these results.

Lemma 2. *The reputations compare as follows:*

- $\mathcal{M}^1_H(\widehat{\theta}) > \max\{\mathcal{M}^0(\widehat{\theta}), \mathcal{M}^1_L(\widehat{\theta})\}$ *for all* $\widehat{\theta}$*;*
- *There is a threshold* $\underline{\widehat{\theta}} \in (\underline{\theta}, \overline{\theta})$ *such that* $\mathcal{M}^1_L(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$ *if and only if* $\widehat{\theta} > \underline{\widehat{\theta}}$.

Hence, any interior equilibrium must be such that $\widehat{\theta} > \underline{\widehat{\theta}}$.

High-profile publications always provide the best reputation, as only relatively high-types choose H-projects and, among them, the best ones are more likely to succeed. Whether having a low-profile publication yields a better reputation than having no publication instead depends on all researchers' equilibrium choices. Intuitively, given that the incentives to be ambitious are increasing with a researcher's ability, if most researchers choose H-projects, then self-selecting into L-projects is a bad signal, and many relatively low types undertaking H-projects implies that failures are mostly attributed to relatively good types who failed hard projects. Hence, $\mathcal{M}^0(\widehat{\theta}) > \mathcal{M}^1_L(\widehat{\theta})$ for $\widehat{\theta} < \underline{\widehat{\theta}}$. If, on the contrary, most researchers choose incremental research projects, then failures are mostly attributed to types failing L-projects that are on average worse than those who managed to complete such projects: hence, $\mathcal{M}^0(\widehat{\theta}) < \mathcal{M}^1_L(\widehat{\theta})$ for $\widehat{\theta} > \underline{\widehat{\theta}}$.

In equilibrium, the cutoff $\widehat{\theta} > \underline{\widehat{\theta}}$ is obtained from

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{\mathcal{M}^1_L(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}^1_H(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}. \tag{4}$$

In words, the type who is indifferent between undertaking a L- or a H-project is the one for whom the higher relative probability of success associated to low-profile projects equals the corresponding lower gain in reputation compared to having no publication, when the market correctly believes that any higher (lower) type chooses H-(L)-projects.

The monotonicity assumption A2 implies that the LHS of (4) is increasing in $\widehat{\theta}$ for all $\widehat{\theta} \in (\underline{\theta}, \overline{\theta})$. To characterize equilibria, one must study the behaviour of the RHS as function of the equilibrium cutoff. To start with, I examine how $\widehat{\theta}$ affects reputations.

Lemma 3. *Reputations are such that:*

- $\mathcal{M}^1_P(\widehat{\theta}), P \in \{L, H\}$, *are increasing in* $\widehat{\theta}$*;*
- $\mathcal{M}^0(\widehat{\theta})$ *is inverted U-shaped in* $\widehat{\theta}$*, and decreasing in* $\widehat{\theta}$ *for all* $\widehat{\theta} > \widehat{\underline{\theta}}$*.*

If the cutoff type is a high-ability researcher, then self-selecting into a L-project conveys less stigma, and self-selecting into a H-project conveys more honour, so that both $\mathcal{M}^1_L(\widehat{\theta})$ and $\mathcal{M}^1_H(\widehat{\theta})$ are increasing in $\widehat{\theta}$.

By contrast, $\mathcal{M}^0(\cdot)$ is non-monotone in $\widehat{\theta}$. To understand the intuition behind this result, suppose that a positive mass of researchers above the cutoff type $\widehat{\theta}$, say $\theta \in [\widehat{\theta}, \widehat{\theta} + \Delta]$, with $\Delta > 0$ small enough, switch from choosing H-projects to L-projects. By choosing easier projects, these types will fail with lower probability. This implies that any observed failure will be attributed to them with lower probability — i.e., they will be given less weight when computing the average $\mathcal{M}^0(\cdot)$. If these *marginal types* are lower than the *average type* — i.e., for $\Delta \to 0$: $\widehat{\theta} < \mathcal{M}^0(\widehat{\theta})$, as it is true for $\widehat{\theta}$ small enough — then, following this switching, the average (which now accounts for these marginal types to a lesser extent) will increase. The opposite is true when the marginal types are larger than the average — i.e., for all $\widehat{\theta} > \mathcal{M}^0(\widehat{\theta})$. This is always the case in the relevant range of $\widehat{\theta}$ — i.e., for all $\widehat{\theta} > \widehat{\underline{\theta}}$: $\widehat{\theta} > \mathcal{M}^1_L(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$.

Building on these results, the next lemma characterizes the monotonicity of the RHS of (4).

Lemma 4. *A sufficient condition for the RHS of (4) to be increasing in* $\widehat{\theta}$ *for all* $\widehat{\theta} > \widehat{\underline{\theta}}$ *is* $[\mathcal{M}^1_L(\widehat{\theta})]' \geq [\mathcal{M}^1_H(\widehat{\theta})]'$*. This condition is always satisfied if the product* $p_L(\theta)f(\theta)$ *is an increasing function.*

To understand why $p_L(\theta)f(\theta)$ being increasing implies $[\mathcal{M}^1_L(\widehat{\theta})]' \geq [\mathcal{M}^1_H(\widehat{\theta})]'$, suppose for simplicity that all types are equally likely — i.e., θ is uniformly distributed — and consider, as before, researchers $\theta \in [\widehat{\theta}, \widehat{\theta} + \Delta]$ switching from H- to L-projects. These types were the less likely to complete a H-project. Hence, they were given a small weight in the computation of $\mathcal{M}^1_H(\cdot)$, which implies that this average does not increase much after their switching: both before and after the switching, completion of H-projects is mostly attributed to higher types. By contrast, being the highest ability researchers choosing L-projects following their switching (hence, the most likely to complete such projects), successful completion of a L-project is attributed to these researchers with relatively large probability, which implies that $\mathcal{M}^1_L(\cdot)$ significantly increases after their switching.

In order for this result to be reverted, it must be the case that the density $f(\theta)$ is steeply decreasing, so that, despite $p_L(\theta)$ being increasing, the product $p_L(\theta)f(\theta)$ is decreasing. To see this, note that, in this case, most researchers are low-ability types $\theta < \widehat{\theta}$. Then, even if types $\theta \in [\widehat{\theta}, \widehat{\theta} + \Delta]$ are, after their switching, the most likely to succeed in L-projects, they constitute a small fraction of researchers choosing L-projects, hence cannot affect the average $\mathcal{M}_L^1(\cdot)$ to a large extent. By contrast, as they constituted a large fraction of those who were choosing H-projects, successful completion of H-projects was attributed to them to a great extent (despite they were the less likely to complete such projects), hence $\mathcal{M}_H^1(\cdot)$ significantly increases after their switching.

Thus, under relatively mild conditions, the RHS of (4) is increasing in $\widehat{\theta}$. Yet, this result does not guarantee the existence of interior equilibria. This is because the LHS of (4), which is increasing in $\widehat{\theta}$ as well, is larger than the RHS both at $\widehat{\theta} = \underline{\widehat{\theta}}$ and as $\widehat{\theta} \to \overline{\theta}$ (see the Appendix). Unfortunately, it is not possible to provide general existence results for generic functions $F(\cdot)$ and $p_P(\cdot)$, for $P = L, H$. Hence, I will assume existence in the remainder of the general analysis, and then provide existence conditions in Section 3.7 for a particular specification of these functions.

2.2.2 Main results

Building on the above results, it is easy to prove what follows.

Proposition 1. *The game exhibits strategic complementarities — i.e.,* $\frac{\partial}{\partial \widehat{\theta}}[u_H(\theta) - u_L(\theta)]|_{\theta=\widehat{\theta}} < 0$.

If more researchers are expected to choose incremental research projects in equilibrium, then each individual researcher would have herself stronger incentives to undertake a L-project. This result follows from the properties of the reputations characterized above. If most researchers choose ambitious projects ($\widehat{\theta}$ is small), then publishing incremental research confers little *honour* — i.e., $\mathcal{M}_L^1(\cdot)$ is low, since only very low ability types self-select into such projects — whereas having no publication conveys little *stigma* — i.e., $\mathcal{M}^0(\cdot)$ is not too low, since many failures come from relatively good types failing high-profile projects. Hence, for given ability, any researcher will have relatively strong incentives to undertake an ambitious project. If, on the contrary, most researchers are expected to choose low-profile projects in equilibrium ($\widehat{\theta}$ is large), then completing any such project conveys a much better signal than having no publication. As a consequence, selecting a low-profile projects conveys little stigma in case of success and reduces the risk of incurring the much larger stigma associated to failures; therefore, researchers have weak incentives to be ambitious. Note that $\mathcal{M}_H^1(\cdot)$ being increasing in $\widehat{\theta}$ plays a countervailing role in the above arguments, but this role is second-order given that, as explained above, the reputation from successfully completing a H-project is less responsive to the equilibrium cutoff compared to the reputation from an accomplished low-profile project.

Strategic complementarities imply that multiple equilibria can exist:

Proposition 2. *Suppose second-order derivatives terms do not outweigh first-order terms. Then, provided interior equilibria exist, the game admits two interior equilibria $\widehat{\theta}_1 < \widehat{\theta}_2$, with $\widehat{\theta}_1$ being unstable and $\widehat{\theta}_2$ being stable.*

In 'well-behaved' model specifications — i.e., when both sides of (4) do not change concavity over the relevant domain — two interior equilibria coexist: see Figure 1 for an example.

To see why only the equilibrium characterized by the largest prevalence of incremental research ($\widehat{\theta} = \widehat{\theta}_2$) is stable, in a standard, *tâtonnement* sense, suppose the academic research market is initially in the other equilibrium ($\widehat{\theta} = \widehat{\theta}_1$), and then some researchers $\theta \in [\widehat{\theta}_1, \widehat{\theta}_1 + \Delta)$, with $\Delta > 0$ small

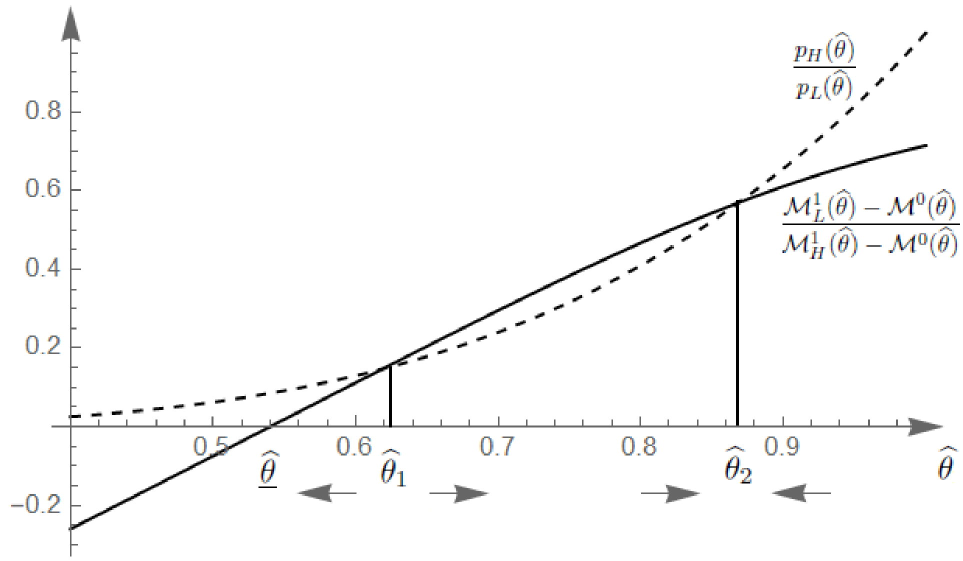

Figure 1: Equilibria of the game with $\theta \sim \mathcal{U}(0,1)$, $p_L(\theta) = \theta^4$ and $p_H(\theta) = \theta^8$.

enough, switch to L-projects. After this switching, choosing a L-project becomes more attractive for higher types $\theta > \widehat{\theta}_1 + \Delta$ as well because: *(i)* conditional on succeeding, it yields more prestige ($\mathcal{M}^1_L(\cdot)$ is larger); and *(ii)* it reduces the chances of failing, which is now more costly as it is associated with a worse reputation ($\mathcal{M}^0(\cdot)$ is smaller).[8] Hence, further types $\theta > \widehat{\theta}_1 + \Delta$ will turn to incremental research projects as well, which will finally lead the research community to the equilibrium $\widehat{\theta} = \widehat{\theta}_2$.

This equilibrium can be referred to as a *publish-or-perish equilibrium*: the first-order concern for researchers is to publish, that is to minimize the chances of failure; quality of research output is just a second-order concern. The very low payoff associated with failing a project (i.e., having no publication) leads even some of the highest-ability researchers to work on incremental research projects.

Note that this result arises in equilibrium as a byproduct of researchers' signalling/career concerns in an 'ideal' setting where successfully pursuing extensive research conveys the strongest signal of high-ability. As pointed out above, this presupposes that the community always recognizes a successful piece of disruptive research and/or academic journals are perfect quality certifiers. Several scholars have argued that an explicit and formal reward system, in which individual and measurable research performance is rewarded, may hinder extensive research (e.g., Van Dalen and Henkens, 2012). Yet, their arguments typically resort to various inefficiencies/malfunction of the publishing process (see Carson et al., 2013, for an overview), and/or to hiring/tenure rules rewarding productivity more than quality (e.g., de Rond and Miller, 2005). This model shows that such outcome is more intrinsically related to research output, which (given the uncertainties involved in any research activity) is stochastic in itself, being the proxy employed by the market to assess researchers' quality.

Before moving to consider several extensions and further implications of the baseline analysis, the two following paragraphs present other, more technical, results on the equilibrium characterization

[8] Once again, even though $\mathcal{M}^1_H(\cdot)$ increases as a consequence of this switching, by the results above this effect is second-order relative to the two outlined effects on $\mathcal{M}^1_L(\cdot)$ and $\mathcal{M}^0(\cdot)$.

(the uninterested reader can move to Section 3.5).

Equilibrium multiplicity and stability. A more general result than the one in Proposition 2, which does not require imposing further restrictions besides A1-A2, is the following.

Proposition 3. *Provided the game admits interior equilibria, an even number of interior equilibria* $\widehat{\theta}_1 < \widehat{\theta}_2 < \widehat{\theta}_3 < \widehat{\theta}_4 < \ldots$ *exist, with* $\widehat{\theta}_1$ *being unstable,* $\widehat{\theta}_2$ *stable,* $\widehat{\theta}_3$ *unstable,* $\widehat{\theta}_4$ *stable, and so on.*

Thus, even in more general environments, the largest equilibrium cutoff, that corresponds to the *publish-or-perish equilibrium*, constitutes a stable equilibrium.

While in the remainder of the paper I will often assume existence of a unique stable (interior) equilibrium, all the results apply more generally to all stable equilibria.

Pooling equilibria. To conclude the equilibrium characterization of the game, it remains to consider pooling equilibria — i.e., equilibria in which all types choose the same project category $P \in \{L, H\}$. In such equilibria, the reputations $\mathcal{M}_P^1$ and $\mathcal{M}^0$ are computed using Bayes rule as in the previous analysis,[9] but Bayes rule has no bite when it comes to specify the payoff of a (deviating) researcher who successfully completes the other project $P' \neq P$, as such outcome should never be observed in equilibrium. Adopting the standard D1 refinement of PBE for signalling games (Banks and Sobel, 1987), the following results hold.

Proposition 4. *The only pooling equilibrium satisfying the D1 criterion is that in which all types choose* H*-projects.*

Intuitively, the highest type, being able to complete any project, has always strict incentives to choose a H-project under D1 to be recognized as such, which destroys a candidate equilibrium in which all types choose L-projects. As, by contrast, low types have weaker incentive to choose H-projects, D1 implies that any deviation from a pooling equilibrium in which only extensive research is carried out is attributed to the lowest type $\theta = \underline{\theta} < \mathcal{M}^0(\underline{\theta})$, which makes the deviation unprofitable for any type.

Yet, if, in this candidate equilibrium, the market has *less extreme beliefs* than under D1 — i.e., attributes positive probability to the deviation coming from several types — then, upon observing success on a L-project, it would infer that on average the deviating type is not too low, because she successfully completed the project. If these beliefs are such that the reputation of the 'successful' deviating researcher exceeds $\mathcal{M}^0(\underline{\theta})$, then a positive-measure set of (relatively low) types would optimally deviate to L-projects, which rules out this candidate H-pooling equilibrium. See the Appendix for an example.

A further (perhaps more important) reason to ignore this pooling equilibrium is that it is not a D1-equilibrium in most of the extensions of the model that will be developed below — e.g., when considering imperfect certification technologies, research effort costs, or monetary publication-based incentives. Based on these considerations, in the remainder of the paper I keep focusing on interior equilibria, and relegate to the Appendix the analysis of pooling equilibria (using the D1 refinement).

[9] Specifically, if all researchers choose L-projects, then $\mathcal{M}_L^1 = \mathcal{M}_L^1(\overline{\theta})$ and $\mathcal{M}^0 = \mathcal{M}^0(\overline{\theta})$; if instead all researchers choose H-projects, then $\mathcal{M}_H^1 = \mathcal{M}_H^1(\underline{\theta})$ and $\mathcal{M}^0 = \mathcal{M}^0(\underline{\theta})$.

3 Extensions and implications

3.1 Academic journals as certifiers

3.1.1 Imperfect quality certification

The foregoing analysis assumed that the market is perfectly able to ascertain the quality of successful projects — i.e., to distinguish L- and H-projects. This is the case if the scientific community totally agrees on the relevance of any contribution. While this may be a reasonable approximation of reality for hard sciences, in social sciences there often seems to be lack of such consensus (see, e.g., Martini and Boumans, 2014). Consequently, and also due to increased specialization, the relevance of a contribution is increasingly assessed looking at the publication outlet — i.e., evaluation of successfully completed projects is *de facto* 'delegated' to academic journals. For instance, in economics, "decisions about promotions, recognitions, and even salaries are tied to publication counts in the Top-5"(Heckman and Moktan, 2020).[10] Assuming that such delegation is in place, the baseline model presupposes that academic journals are *perfect quality certifiers*: successful H-projects and L-projects are published in 'top-tier' and 'second-tier' journals, respectively.

Yet, in reality the screening operated by editorial boards of academic journals seems far from being perfect. For instance, Heckman and Moktan (2020) empirically demonstrate the inadequacy of the Top-5 in predicting the quality of an article (measured by citations). How do imperfections in journals' quality certification technology impact researchers' incentives to undertake incremental vs extensive research? To address this question in the present framework, suppose that, conditional on choosing a L- project and successfully completing it, the market observes *correctly* the outcome $(s = 1, P = L)$ with probability $\alpha \in (1/2, 1]$, and *mistakenly* $(s = 1, P = H)$ with complementary probability $1 - \alpha$. Similarly, if a H-project is completed, the market observes $(s = 1, P = H)$ with probability $\beta \in (1/2, 1]$ and $(s = 1, P = L)$ with probability $1 - \beta$. In words, top journals mistakenly accept (reject) incremental (extensive) research papers with probability $1 - \alpha$ $(1 - \beta)$, hence the base model corresponds to the case $\alpha = \beta = 1$. Given these imperfections and assuming away any friction (e.g., time constraints or submission fees), all researchers will optimally submit their papers to top journals first, and then, in case of rejection, to second-tier journals.[11]

Accordingly, researchers' expected payoffs from choosing a L- and a H-project are given by

$$u_L(\theta) \triangleq p_L(\theta) \left[(1-\alpha)\mathcal{M}_L^1(\widehat{\theta}) + \alpha\mathcal{M}_H^1(\widehat{\theta})\right] + (1 - p_L(\theta))\mathcal{M}^0(\widehat{\theta}),$$

[10] The Top-5 are the most prestigious academic journals in economics: *The American Economic Review*, *Econometrica*, the *Journal of Political Economy*, the *Quarterly Journal of Economics*, and the *Review of Economic Studies.* Heckman and Moktan (2020) find that candidates with one or two Top-5 articles experience increases in the rate of receiving tenure of 80% and 230% respectively, compared to those with the same number of non-T5 publications. They point out that "there is a strong case for relying on the Top-5 signal. The profession has grown in size and has become more specialized. There is a demand for certification of quality which publication in the Top-5 is used to meet. Publication in a highly-rated general interest journal is now considered a proxy for the likelihood that a candidate publishes highly cited general interest papers".

[11] In other words, researchers 'move down the certification pecking order' in equilibrium. See Farhi et al. (2013) for a similar result. Of course, the probabilities of each single journal's editorial decisions must be specified in such a way that, given the number of top-journals, α $(1-\beta)$ is the overall probability that an incremental (extensive) research paper is accepted by one of the top journals. Moreover, provided $s = 1$, all papers are accepted by the second-tier journals. Thus, in this setting, successful project outcomes are still perfectly screened from failures.

and

$$u_H(\theta) \triangleq p_H(\theta)\left[\beta \mathcal{M}_H^1(\widehat{\theta}) + (1-\beta)\mathcal{M}_L^1(\widehat{\theta})\right] + (1-p_H(\theta))\mathcal{M}^0(\widehat{\theta}),$$

respectively. Since in equilibrium $\mathcal{M}_H^1(\cdot) > \mathcal{M}_L^1(\cdot)$ for all $\widehat{\theta}$, $u_L(\cdot)$ is decreasing in α and $u_H(\cdot)$ is increasing in β. The reason is simple: if α falls, undertaking incremental research projects becomes more rewarding, as there are higher chances that these can be published in top-journals; if β falls, being successful in extensive research projects does not guarantee a top publication. As a consequence, holding reputations fixed, the 'direct effect' of inaccuracies in the certification technology (i.e., of a decrease in α or β, or both) is to boost the relative attractiveness of incremental research projects.

However, reputations conditional on success are themselves affected by the accuracy of the certification technology. In particular, $\mathcal{M}_H^1(\cdot)$ is increasing in α and non-decreasing in β, $\mathcal{M}_L^1(\cdot)$ is decreasing in β and non-increasing in α (see the Appendix).[12] Intuitively, a top-publication is a weaker signal of high ability if some less talented researchers undertaking L-projects can achieve it. By contrast, the relative prestige of second-tier journals improves when they end up publishing some pieces of extensive research erroneously rejected by top-journals. These 'indirect effects', through reputations, of imperfections in journals' quality certification thus push in the same direction of the 'direct effect' discussed above, making extensive research projects even less appealing to researchers.

Proposition 5. *The stable equilibrium cutoff increases as the certification technology becomes less accurate — i.e., $\widehat{\theta}(\cdot)$ is decreasing in α and β.*

Several scholars believe that "editors and reviewers often limit journal content to that which supports prevailing theoretical and methodological orthodoxies" (Miller et al., 2011). Moreover, it is well-documented that journals in economics tend to publish work by authors who are connected with the journal's editors (see, e.g., Laband and Piette, 1994, and Colussi, 2018). These and other inefficiencies and malfunction of the academic publishing process can of course deter some researchers from pursuing extensive research. Proposition 5 shows a more general, hence in a sense more worrisome, result: in an academic job market where the publication record is the primary driver of researchers' career prospects, any imperfection in journals' editorial decisions is bound do hamper to some extent extensive research.

Notably, the same result holds even when journals' editorial boards are perfectly able to ascertain papers' quality, but face (or commit to) a *space constraint* whereby they can publish up to a maximal number of articles per year. There is suggestive evidence that space constraints on top journals may be binding: Card and DellaVigna (2013) document that, during the period 1990-2012, the amount of space available in Top-5 journals in economics has remained roughly constant, while the number of submissions they receive and the length of submitted papers have greatly increased. If, due to these space constraints, there is a positive probability that an extensive research piece will find no home on top journals, then, by Proposition 5, some researchers will be deterred from undertaking ambitious projects.[13]

[12] The reputation $\mathcal{M}^0(\cdot)$ from having no publication does not depend on α nor on β, given that the certification technology is still perfect when it comes to ascertain whether a research project was successful or not.

[13] In this case, $\beta < 1 = \alpha$. If, by contrast, the space available on top-journals exceeds the amount of extensive research papers obtained in equilibrium so that they publish some successful L-projects to fill this space, then $\beta = 1 > \alpha$, which again hinders extensive research.

3.1.2 Publication of null/negative results

In the model above, successful project outcomes were still always successfully identified (i.e., published somewhere). I now turn to consider a case where successful project completion does not guarantee a publication. The following exercise is relevant in light of the debate on publication of null and/or negative results. A lack of papers containing null and negative results has been noticed in innumerable fields, and has been attributed to journal bias against such results, because they attract fewer readers and citations: see, e.g., Fanelli (2012). It is also possible that papers with negative results are excluded from top-journals but find their way into second-tier journals (Franco et al., 2014).

Suppose that, conditional on successfully completing any project, a researcher finds a positive/significant result with probability $\eta \in (0,1)$, and a null/negative result with complementary probability $1-\eta$.[14] Then, there are three relevant cases to consider:

- *All journals publish negative results.* In this case, as journals are now assumed perfectly able to assess project quality, the baseline analysis obtains. Let $\widehat{\theta}$ denote the corresponding stable equilibrium cutoff obtained from (4).

- *Negative results are not published by any journal.* In this case, for all projects negative results cannot be distinguished from failures, so a researcher's payoff from choosing project $P \in \{L, H\}$ is
$$u_P(\theta) \triangleq \eta p_P(\theta)\mathcal{M}^1_P(\widehat{\theta}) + (1-\eta p_P(\theta))\mathcal{M}^0(\widehat{\theta}).$$
Comparing the payoffs for $P \in \{L, H\}$ immediately yields that in equilibrium the cutoff type is still pinned down by (4). Moreover, project quality being perfectly assessed (for papers containing significant results) implies that journals' common policy towards publication of negative results does not affect the market evaluation of publications — i.e., $\mathcal{M}^1_P(\cdot)$, for $P \in \{L, H\}$, do not depend on η. By contrast, $\mathcal{M}^0(\cdot)$ is decreasing in η (see the Appendix): the stigma from having no publication is mitigated if a share of researchers who successfully complete their project, but are just unlucky and find negative results, cannot publish it. Let $\widehat{\theta}^*(\eta)$ denote the stable equilibrium cutoff in this scenario.

- *Negative results are published only by second-tier journals.* In this case, a researcher's payoff from choosing a H-project is
$$u_H(\theta) \triangleq \eta p_H(\theta)\mathcal{M}^1_H(\widehat{\theta}) + (1-\eta)p_H(\theta)\mathcal{M}^1_L(\widehat{\theta}) + (1-p_H(\theta))\mathcal{M}^0(\widehat{\theta}),$$
because, whenever a successful H-project completion yields a negative result, it is published in a second-tier journal.[15] Since all successfully completed L-projects (i.e., those yielding positive as well as negative results) are published in second-tier journals, the expected payoff from choosing L-projects writes as in the base model. Note that reputations $\mathcal{M}^1_H(\cdot)$ and $\mathcal{M}^0(\cdot)$ are unaffected

[14] I rule out asymmetries between L- and H-projects as far as the probability of obtaining negative results is concerned, to avoid that findings are driven by the direction of such asymmetries.

[15] Of course, as $\mathcal{M}^1_L(\cdot) > \mathcal{M}^0(\cdot)$ in equilibrium, upon obtaining a negative result from the chosen H-project it is optimal to submit the paper for publication in a second-tier journal rather than leaving it unpublished.

by η, respectively because top-journals are perfect certifiers (i.e., all articles published on top-journals are extensive research pieces) and any successful project is published somewhere (i.e., $s = 0$ is still observed only in case of failure). By contrast, $\mathcal{M}_L^1(\cdot)$ is decreasing in η (see the Appendix). This is because second-tier journals also publish high-quality articles, written by talented researchers, containing negative results. Let $\widehat{\theta}^{**}(\eta)$ denote the stable equilibrium cutoff in this case.

Comparing the stable equilibrium cutoffs in the three scenarios yields the following results.

Proposition 6. *For all* $\eta \in (0, 1)$*:* $\widehat{\theta}^{*}(\eta) < \widehat{\theta} < \widehat{\theta}^{**}(\eta)$.

Interestingly, the impact of journals' bias against negative results on researchers' incentives to carry out extensive research crucially depends on which outlets are willing to publish such results. If all negative results, regardless of papers' quality, can be published only on second-tier journals, then researchers will have weak incentives to undertake ambitious projects. This is because high-quality papers containing negative results won't published by top-journals, but 'pooled' with all successful L-projects. As a consequence: *(i)* the higher risk of failure associated to H-projects is not always compensated by a higher-prestige publication; and *(ii)* second-tier publications confer a better reputation compared to the cases where all or no journal publishes negative results. The relative prestige of top- vs second-tier journals is actually the same in these two polar opposite cases. However, failing is less costly (having no publication conveys less stigma) when negative results are never published, which makes extensive research projects relatively more attractive compared to the base model in which significant and negative results are treated by journals' editors in the same way.

Yet, the present analysis neglects socially harmful p-hacking and publication bias practices (e.g., Brodeur et al., 2020), as well as *dynamic inefficiencies*, in the form of wasteful duplication efforts (Rosenthal's (1979) 'file drawer problem'), associated to not publishing negative results. Hence, perhaps a better way to think of Proposition 6 is that it makes a strong case for publishing negative results (appearing in high-quality papers) on top journals.

3.2 Additional information

The baseline analysis was conducted under the assumption that a researcher's reputation is entirely based on her project outcome. This is consistent with the motivating evidence that, in the academic job market, a researcher's publication record is the most important signal of her scientific value, thereby constituting, more or less explicitly, the primary determinant of hiring, promotion and tenure decisions. Yet, hiring committees have of course access to further relevant information to evaluate applicants — e.g., in the job market for fresh PhD graduates, the prestige of the Alma mater and recommendation letters.

An important reason why these sources of information play a significant role in hiring decisions, and especially so for junior researchers, can be seen through the lenses of this model. During the PhD, a candidate undertakes only one (as in this model) or, at most, a few projects. Given that each project's outcome contains an element of randomness, there is value in conditioning her evaluation on further information (even though noisy and/or imprecise) about her talent. The value of this extra information is lower when it comes to senior researchers, given that the idiosyncratic randomness involved in each research project tends to wash out when a researcher has already worked on a large number of projects: at that point, the publication record provides a very precise estimate of her ability.[16] Indeed, in many countries, associate and/or full professorship positions are awarded based mostly on the applicants' publication records.

Coming back to junior researchers, knowing that their career prospects do not entirely depend on the chosen project outcome may affect their project choices. To shed light on the impact of additional market information on researchers' choices in equilibrium, suppose that an exogenous source of information (truthfully) reveals whether the researcher's type is below or above a given threshold $\theta_0 \in [\underline{\theta}, \overline{\theta}]$. Formally, the market observes (on top of project outcome, and quality conditional on success) a signal $\sigma(\theta; \theta_0) \in \{0, 1\}$, with $\sigma(\theta; \theta_0) = 1$ ($\sigma(\theta; \theta_0) = 0$) if and only if $\theta \geq \theta_0$ ($\theta < \theta_0$). This deterministic information structure corresponds, e.g., to the case where (all and only) good enough students do their PhD in top universities and/or have strong reference letters (regardless of their project outcome).

In this setting, researchers are *de facto* split in two groups — i.e., types $\theta \in [\underline{\theta}, \theta_0)$, for whom $\sigma(\cdot) = 0$, and $\theta \in [\theta_0, \overline{\theta}]$, for whom $\sigma(\cdot) = 1$, with signalling concerns being relevant only intra-group. As a consequence, for any researcher, the game when this extra information is provided is identical to the baseline one, except for the distribution of types. Specifically, each researcher for whom $\sigma(\cdot) = 0$ ($\sigma(\cdot) = 1$) plays the same signalling game of the base analysis, but now only against researchers receiving the same $\sigma(\cdot)$, that is in a population of researchers obtained from the right-truncation (left-truncation) of $F(\cdot)$ at θ_0. Hence, to understand the equilibrium consequences of this extra information, it is useful to start with the following result.

Lemma 5. *A left-truncation (right-truncation) of the distribution of types decreases (increases) the stable equilibrium cutoff.*

The intuition is rather simple. The additional information whereby the market knows that $\theta > \theta_0$ acts as an insurance for these relatively high types: if they fail their project, they won't be pooled with low types $\theta < \theta_0$, who, being likely to fail any project, are given a large weight in the computation of $\mathcal{M}^0(\cdot)$.[17] By mitigating the stigma associating to failures, extra information fosters extensive research among types for whom $\sigma(\cdot) = 1$. On the contrary, extra information dampens incentives to be ambitious for types such that $\sigma(\cdot) = 0$. This is because they cannot be pooled with higher types $\theta > \theta_0$ by completing a H-project, nor (to some extent) in case of failure. Consequently, failing is more costly and successful extensive research is less rewarding, which makes incremental research more attractive to types $\theta < \theta_0$ compared to the baseline model.

Building on these results, the following proposition shows the equilibrium impact of the considered additional market information.

[16] Formally, if infinitely many projects are undertaken, then, by the (strong) law of large numbers, the frequency of successful outcomes (a.s.) equals $p_P(\theta)$, which implies that the type is perfectly identified.

[17] The fact that successful L-projects are not attributed to $\theta < \theta_0$ increases the payoff associated to these projects as well. Yet, this effect is second-order as low types (being more likely to fail) are given a small weight in the computation of $\mathcal{M}_L^1(\cdot)$.

Proposition 7. *For all $\theta_0 \in [\underline{\theta}, \overline{\theta}]$, there exists a stable equilibrium in which $P^*(\theta) = L$ for all $\theta < \widehat{\theta}(\theta_0)$ and $P^*(\theta) = H$ for all $\theta \geq \widehat{\theta}(\theta_0)$, where the cutoff $\widehat{\theta}(\theta_0) \in (\underline{\theta}, \overline{\theta})$ is non-monotone in θ_0. Specifically, there are two thresholds $\underline{\theta}_0$ and $\overline{\theta}_0$, with $\underline{\theta} < \underline{\theta}_0 < \widehat{\theta}_2 < \overline{\theta}_0 < \overline{\theta}$, such that:*

- *For $\theta_0 \in [\underline{\theta}, \underline{\theta}_0]$: $\widehat{\theta}(\theta_0) > \theta_0$ and $\widehat{\theta}'(\cdot) < 0$;*
- *For $\theta_0 \in (\underline{\theta}_0, \overline{\theta}_0)$: $\widehat{\theta}(\theta_0) = \theta_0$;*
- *For $\theta_0 \in [\overline{\theta}_0, \overline{\theta}]$: $\widehat{\theta}(\theta_0) \leq \theta_0$, with equality at $\theta_0 = \overline{\theta}_0$ only, and $\widehat{\theta}'(\cdot) < 0$.*[18]

Hence, $\widehat{\theta}(\theta_0) < \widehat{\theta}_2$ if and only if $\theta_0 < \widehat{\theta}_2$.

The mechanisms behind these results are as follows. From Lemma 5 it follows that, for any θ_0, all types $\theta < (\geq)\theta_0$ have weaker (stronger) incentives to choose ambitious projects when $\sigma(\cdot)$ is observed compared to the base model, which corresponds to either $\theta_0 = \underline{\theta}$ and $\sigma(\theta; \underline{\theta}) = 1$ for all θ,[19] or $\theta_0 = \overline{\theta}$ and $\sigma(\theta; \overline{\theta}) = 0$ for all θ (indeed, $\widehat{\theta}(\underline{\theta}) = \widehat{\theta}(\overline{\theta}) = \widehat{\theta}_2$, the latter being the stable interior equilibrium of the baseline model).

Suppose $\theta_0 < \widehat{\theta}_2$: in this case, in the (stable) equilibrium of the base model all types for whom $\sigma(\cdot) = 0$ choose L-projects. Hence, these types will *a fortiori* choose L-projects when σ is observed.[20] By contrast, some of the types $\theta \in [\theta_0, \widehat{\theta}_2)$ will turn to H-projects when $\sigma(\cdot) = 1$ is observed: hence, $\widehat{\theta}(\theta_0) < \theta_0 < \widehat{\theta}_2$. Lemma 5 shows that, the larger θ_0, the more the researchers that will do so: increasing θ_0 will then foster extensive research ($\widehat{\theta}'(\cdot) < 0$). If, however θ_0 is sufficiently large — i.e., for all $\theta_0 \in (\underline{\theta}_0, \widehat{\theta}_2)$ — then there is no interior equilibrium among types for whom $\sigma(\cdot) = 1$: the unique equilibrium is the pooling one in which they all choose H-projects: $\widehat{\theta}_0(\cdot) = \theta_0$. Next consider $\theta_0 \geq \widehat{\theta}_2$. In this case, types $\theta \geq \theta_0$ choose H-projects regardless of whether $\sigma(\cdot) = 1$ is observed or not, but the observability of $\sigma(\cdot) = 0$ may lead some types $\theta \in [\widehat{\theta}_2, \theta_0)$ to turn to incremental research projects: hence, $\widehat{\theta}(\theta_0) \geq \theta_0 \geq \widehat{\theta}_2$. By the results of Lemma 5, they have strong incentives to do so if θ_0 is relatively small: as a consequence, for all $\theta_0 \in [\widehat{\theta}_2, \overline{\theta}_0)$ all types for whom $\sigma(\cdot) = 0$ still choose L-projects, hence $\widehat{\theta}_0(\cdot) = \theta_0$; for larger values of θ_0, instead, $\widehat{\theta}_0(\cdot) < \theta_0$ is decreasing in θ_0.

Thus, the impact of additional market information on the extent of extensive research carried out in equilibrium is in general ambiguous. *Raising the bar* for admissions in top PhD programs and/or for writing strong recommendation letters fosters extensive research as long as receiving the 'good signal', by reducing the stigma from failing the project, induces some researchers to be more ambitious, and all those receiving the 'bad signal' would choose L-projects also absent additional information (i.e., if and only if $\theta_0 < \widehat{\theta}_2$). If good signals become *too exclusive*, then their only effect is to discourage extensive research among researchers who are not good enough to obtain them.

Yet, given that, absent further information, incremental research prevails in equilibrium, for most (stochastic) signal distributions the first-order effect of making extra information available to the

[18]Thus, $\widehat{\theta}(\cdot)$ is a.e. differentiable and has a (downward) jump discontinuity at $\theta_0 = \underline{\theta}_0$ only.

[19]Actually, given the definition of $\sigma(\cdot)$: $\sigma(\underline{\theta}; \underline{\theta}) = 0$, but this does not change the equilibrium.

[20]Note that this corresponds to the L-pooling equilibrium of the signalling game played by types $\theta \in [\underline{\theta}, \theta_0]$. This coexists with the other pooling equilibrium, in which all chooses H-projects. In this case, it seems natural to select the equilibrium that is supported by the largest set of off-path beliefs. In this game, the L-pooling equilibrium exists for every possible off-path belief, whereas the existence of the H-pooling equilibrium requires imposing restrictions (e.g., D1) on beliefs. This selection criterion of course dictates to disregard the H-pooling equilibrium also when it coexists with an interior equilibrium. All details are in the Appendix.

market is to improve the reputation of good researchers who fail their projects. Hence, they will be less afraid of being pooled with very low types in case of failure, and so more willing to take risks (i.e., to choose more ambitious projects) to be pooled with higher types in case of success. As a consequence, one shall expect extra information to most likely foster extensive research in equilibrium.[21] The bottom line is as follows. The increased specialization, which is unavoidable when a field becomes mature, by making other sources of information on researchers' ability (in absolute and/or relative terms) harder to obtain or less reliable, entails that scholars' evaluation is mostly based on their publication records. This may *per se* deter extensive research.

3.3 Researchers' effort and opportunity costs

Albert Einstein used to say that "Genius is 1% talent and 99% hard work". The chances to successfully pursue any research project depend not only on the researcher's talent but also on the level of effort she exerts. While most (if not all) researchers enjoy doing research, undoubtedly carrying out research activities entails effort costs as well as opportunity costs, given that the time spent doing research could be alternatively employed in lucrative activities, both within (e.g., teaching) and outside (e.g., consulting) academia. Thus, besides selecting projects to work on, researchers also choose how much time and effort to spend doing research. The aim of this section is to disentangle the effects of researchers' talent and effort in the probability of project completion, and analyse endogenous effort choices.

I make the standard assumptions that effort is costly and cannot be observed by the market. To keep the analysis tractable, I consider a binary effort choice $e \in \{0, 1\}$. If $e = 1$, then the probabilities of projects' completion are as in the baseline model, and the researcher bears an effort cost $\psi > 0$. If $e = 0$, then any project fails with probability one. Equivalently, by not doing research, a researcher enjoys a private benefit ψ (e.g., remuneration from other activities). Thus, $\Pr[s = 1|P, \theta, e] = e\, p_P(\theta)$. This model specification captures in the simplest way the idea that effort and talent are complements: high-ability researchers, being more productive, have stronger incentives to work hard.

In this setting, a researcher finds it optimal to exert effort in any project $P \in \{L, H\}$ if and only if $\mathcal{M}_P^1 > \mathcal{M}^0$ and

$$p_P(\theta)\mathcal{M}_P^1 + (1 - p_P(\theta))\mathcal{M}^0 - \psi \geq \mathcal{M}^0 \iff p_P(\theta) \geq \frac{\psi}{\mathcal{M}_P^1 - \mathcal{M}^0}. \tag{5}$$

As the probability of success on any project (conditional on exerting effort) is increasing in the ability-type, only relatively high types have incentives to sink the effort cost. Given that such cost is constant across projects and types, conditional on sinking it, the choice between undertaking a L- or a H-project is as in the base model. Hence:[22]

[21] A signalling model with additional, stochastic, information observed by the market has been studied by Feltovich et al. (2002). Unlike in their model, here no *countersignalling* incentives are at play, given that high types can separate themselves from intermediate types by choosing and succeeding in H-projects, and intermediate types can in turn separate themselves from low types by succeeding in L-projects. Hence, the equilibrium is always characterized by a cutoff type above (below) which researchers choose H-(L)-projects, and additional stochastic information just affects (most likely, decreases) the equilibrium cutoff.

[22] Once again, I restrict attention to interior equilibria, where all reputations are obtained using Bayes rule. As a tie-breaking condition, it is assumed that researchers prefer exerting effort in case of indifference (this assumption is

Lemma 6. *In any interior equilibrium, there are two cutoffs* $\widehat{\theta}_L$ *and* $\widehat{\theta}_H$*, with* $\underline{\theta} < \widehat{\theta}_L < \widehat{\theta}_H < \overline{\theta}$*, such that:* $e^*(\theta) = 0$ *for all* $\theta \in [\underline{\theta}, \widehat{\theta}_L)$*;* $e^*(\theta) = 1$ *and* $P^*(\theta) = L$ *for all* $\theta \in [\widehat{\theta}_L, \widehat{\theta}_H)$*;* $e^*(\theta) = 1$ *and* $P^*(\theta) = H$ *for all* $\theta \in [\widehat{\theta}_H, \overline{\theta}]$*.*

In the Appendix it is shown that, in any interior equilibrium, reputations have the following properties:

- $\mathcal{M}_L^1$ is increasing in $\widehat{\theta}_L$ and $\widehat{\theta}_H$;
- $\mathcal{M}_H^1$ is increasing in $\widehat{\theta}_H$;
- $\mathcal{M}^0$ is U-shaped in $\widehat{\theta}_L$ and inverted U-shaped in $\widehat{\theta}_H$.

Given the structure of equilibria, $\widehat{\theta}_H$ plays the same role of the equilibrium cutoff $\widehat{\theta}$ in the base model. To gain intuition for the comparative statics concerning $\widehat{\theta}_L$, suppose types $\theta \in [\widehat{\theta}_L, \widehat{\theta}_L + \Delta]$ (with $\Delta > 0$ small enough) switch from working on L-projects to shirking. Given that these types were the lowest ones working on L-projects, their switching improves the pool of researchers who exert effort on, hence can complete, these projects: the average $\mathcal{M}_L^1(\cdot)$ thus increases following their switching. Unlike when they were exerting effort, the switching types now fail with probability one. Hence, they will be given more weight when computing the average ability of types who fail. If the marginal types are lower (higher) than the average — i.e., (for $\Delta \to 0$) $\widehat{\theta}_L < (>) \mathcal{M}^0(\cdot)$, which holds for $\widehat{\theta}_L$ small (large) enough — this switching causes a drop (an increase) in the average — i.e., $\frac{\partial \mathcal{M}^0(\cdot)}{\partial \widehat{\theta}_L} < (>) 0$.

Having described the qualitative features of any interior equilibrium, I next examine how effort/opportunity costs affect the (stable) equilibrium.

Proposition 8. *In the interior stable equilibrium, both cutoffs* $\widehat{\theta}_L$ *and* $\widehat{\theta}_H$ *are increasing in* ψ*.*

Since the baseline model corresponds to the case where $\psi = 0$, hence $\widehat{\theta}_L = \underline{\theta}$, this result shows that considering effort/opportunity costs associated to undertake any research project further amplifies the prevalence of incremental research in equilibrium.[23] The reason is as follows. From (5) it is clear that, as ψ grows larger, low-ability types, who undertake L-projects when this is costless, will prefer to shirk (i.e., $\widehat{\theta}_L > \underline{\theta}$). This unambiguously makes L-projects more attractive relative to H-projects for higher types, because: *(i)* self-selecting into L-projects signals that $\theta > \widehat{\theta}_L$, hence the payoff $\mathcal{M}_L^1(\cdot)$ associated to successful completion of a L-project grows larger, whereas $\mathcal{M}_H^1(\cdot)$ is unaffected by the increase in $\widehat{\theta}_L$; and *(ii)* failures being attributed with larger probability to low types $\theta < \widehat{\theta}_L$ (who now do not complete any project with probability one) increases the stigma from having no publication.

An important implication of this result is the following. In many cases, opportunity costs associated to research activities arise because of alternative tasks, in which researchers can employ their time, that are beneficial to their employees (e.g., administrative duties) or to society (e.g., teaching activities). As long as such opportunity costs are orthogonal to research ability, they deter only relatively low-ability researchers from doing research. As these researchers would otherwise focus on incremental

immaterial to the results).

[23] Of course, the incentives to undertake extensive research would be further dampened if the corresponding effort/opportunity costs were higher than those associated to incremental research projects — e.g., because working on high-profile projects requires more time.

projects and, on top of this, would also fail with large probability, one may argue that it is socially optimal imposing significant teaching and/or administrative duties. Yet, an important drawback of such policies is that, through the explained mechanisms driven by researchers' career concerns, they deter high-ability researchers from pursuing ambitious projects.

3.4 Research quantity vs quality

Up until now I assumed that all researchers undertake one project only. Yet, in reality they build 'research portfolios'. This implies that they face an additional trade-off besides the one between high-risk/high-quality and low-risk/low-quality projects analysed so far. That is, a trade-off between research quantity and quality. Pursuing a low-profile project in fact requires less time compared to a high-profile one, thereby researchers must choose (given their time constraint) whether to undertake a small number of high-profile projects or a higher number of incremental research projects.

To capture this additional trade-off in the framework at hand in the simplest possible way, hereafter I analyse the model supposing that researchers' face a (type-invariant) time constraint such that each of them can either undertake two independent L-projects, or just one H-project. Hence, the expected payoff from choosing low-profile projects is

$$u_L(\theta) \triangleq p_L^2(\theta)\mathcal{M}_L^{1,1}(\widehat{\theta}) + 2p_L(\theta)(1-p_L(\theta))\mathcal{M}_L^{1,0}(\widehat{\theta}) + (1-p_L(\theta))^2\mathcal{M}^{0,0}(\widehat{\theta}),$$

where $\mathcal{M}_L^{1,1}(\cdot)$ and $\mathcal{M}_L^{1,0}(\widehat{\theta})$ denote reputations following successful completion of both chosen L-projects and of one L-project only, respectively. In the Appendix it is shown that $\mathcal{M}_L^{1,1}(\cdot) > \mathcal{M}_L^{1}(\cdot) > \mathcal{M}_L^{1,0}(\cdot)$: compared to the base model, successfully pursuing one extra L-project allows to signal higher ability, but the reputation from having one L-publication is now worse because the market knows that the researcher undertook two projects, hence she failed one of them. The reputation achieved having no publication — i.e., either by failing two L-projects or one H-project — is denoted (slightly abusing notation) by $\mathcal{M}^{0,0}(\cdot)$, with $\mathcal{M}^{0,0}(\cdot) < \mathcal{M}^{0}(\cdot)$, because no publication here entails that types $\theta < \widehat{\theta}$ have failed two projects, rather than only one. The expected payoff $u_H(\theta)$ from undertaking a (single) H-project then writes as

$$u_H(\theta) \triangleq p_H(\theta)\mathcal{M}_H^{1}(\widehat{\theta}) + (1-p_H(\theta))\mathcal{M}^{0,0}(\widehat{\theta}),$$

where the reputation from a high-profile publication $\mathcal{M}_H^{1}(\cdot)$, being of course unaffected by the possibility of undertaking two low-profile projects, is as in the base model. The following result holds.

Proposition 9. *The stable equilibrium cutoff is larger if researchers can undertake two (independent) L-projects, rather than only one.*

A simple way to grasp the intuition behind this result is to examine how the incentives of the cutoff type in the base version of the model are affected by the possibility of undertaking two L-projects, rather than only one. There are two effects that push her towards L-projects. First, the stigma from having no publication worsens ($\mathcal{M}^{0,0}(\cdot) < \mathcal{M}^{0}(\cdot)$), and being less ambitious minimizes the chances of incurring it, even to a larger extent than in the base model — since, conditional on focusing on incremental research, the probability of having no publication is $(1-p_L(\theta))^2 < 1-p_L(\theta)$. Second, she can now separate herself from lower types by succeeding in both projects: $\mathcal{M}_L^{1,1}(\cdot) > \mathcal{M}_L^1(\cdot)$ — and, being a relatively good type, such outcome is more likely than $\mathcal{M}_L^{1,0}(\cdot)$.

These results provide a rationale for the concerns expressed by several scholars (e.g., De Rond and Miller, 2005) that the emphasis put on the number of published articles in promotion and tenure decisions may lead many talented researchers to focus on incremental research projects. By doing so, they can signal their ability to the market, separating themselves from lower types, through their *productivity* rather than through their *creativity*. This analysis thus suggests that policies aimed at promoting the commitment by hiring/tenure committees to evaluate candidates only based on their best pieces of research (e.g., by capping the number of publications they can submit when applying for a position) are likely to stimulate more extensive research.

3.5 Explicit incentives

In the previous analysis, researchers' project choice was only driven by 'implicit incentives': career and/or image concerns. Yet, it is often the case that publications more directly affect researchers' monetary payoffs. For instance, a primary determinant of management (and other business-related disciplines) faculty pay is the number of articles they have published in top-tier journals (see, e.g., Miller et al., 2011, and references therein). Moreover, substantial individual cash bonuses contingent on publications have been introduced, especially in emerging economies like China and South Korea (Franzoni et al., 2011).

How do these publication-based 'explicit incentives' affect researchers' project choice? To answer this question, in this section I extend the model to account for monetary payoffs directly linked to successful project completion.

Suppose a researcher obtains a bonus $\pi_L \geq 0$ for completing a L-project and $\pi_H \geq \pi_L$ for completing a H-project. Letting $\delta > 0$ denote the weight of career concerns relative to these monetary payoffs, the expected payoff from choosing a project $P \in \{L, H\}$ is

$$u_P(\theta) \triangleq p_P(\theta)[\pi_P + \delta\mathcal{M}_P^1(\widehat{\theta})] + (1-p_P(\theta))\delta\mathcal{M}^0(\widehat{\theta}).$$

Denoting by $\widehat{\theta}(\pi_L, \pi_H)$ the stable interior equilibrium cutoff given bonuses (π_L, π_H) — so that $\widehat{\theta}(0,0)$ coincides with the stable equilibrium $\widehat{\theta}_2$ of the baseline model — it is easy to prove the following results.

Proposition 10. *The stable equilibrium cutoff $\widehat{\theta}(\pi_L, \pi_H)$ is increasing in π_L and decreasing in π_H. If instead bonuses are not contingent on project quality — i.e., $\pi_L = \pi_H \equiv \pi$ — then $\widehat{\theta}(\pi, \pi)$ is increasing in π.*

By altering the relative payoff associated to successful completion of low-profile and high-profile projects, explicit incentives tailored to the relevance of the contribution affect the amount of extensive research in equilibrium in an obvious way: all else equal, an increase in the bonus granted for an extensive (incremental) research paper leads more (less) researchers to be ambitious. However, if monetary bonuses cannot be contingent on the papers' quality, or are not too differentiated for extensive and incremental research papers,[24] then their introduction is bound to reduce the amount of extensive research carried out in equilibrium. The reason is that the likelihood of obtaining the bonus is maximized choosing an incremental research project, as these are more likely to succeed. In reality, the amount of bonuses is contingent on metrics (such as the impact factor) of the publication outlet.[25] Given that quality certification by academic journals is imperfect, it is not clear whether such bonuses effectively stimulate high-quality research.[26]

3.6 Further discussions and robustness

3.6.1 Welfare

Social welfare in this model is simply given by the total value of successfully completed projects. This is because researchers' reputational payoffs define a zero-sum game, hence are welfare-neutral. For $P \in \{L, H\}$, let $v_P > 0$ denote the social value of any successful completed project P, with $v_H > v_L$: extensive research is generally more valuable than incremental research. Then, it is socially optimal that a researcher with ability θ undertakes a H-project if and only if

$$p_H(\theta)v_H \geq p_L(\theta)v_L.$$

Hence, under the monotonicity assumption A2, the social optimum features a cutoff type $\widehat{\theta}^{\text{FB}} \in (\underline{\theta}, \overline{\theta})$, defined by

$$\frac{p_H(\widehat{\theta}^{\text{FB}})}{p_L(\widehat{\theta}^{\text{FB}})} = \frac{v_L}{v_H} \in (0,1), \tag{6}$$

such that all types $\theta < \widehat{\theta}^{\text{FB}}$ choose L-projects and all types $\theta \geq \widehat{\theta}^{\text{FB}}$ undertake H-projects. Thus, it is socially optimal that high-ability researchers self-select into ambitious projects, as it happens in equilibrium. Yet, project choice is just a signalling device from researchers' viewpoint: they do not internalize the value of their research. Consequently, the equilibrium cutoff type of the base model in general differs from the socially optimal one.

This remains the case even if researchers could appropriate exactly the social value of their research output. Formally, consider the model with explicit incentives of Section 3.5, and assume that monetary bonuses coincide with the social value of research: $\pi_P = v_P$ for $P \in \{L, H\}$. Then, for all $\delta > 0$, either $\widehat{\theta}^{\text{FB}} \geq \widehat{\theta}(v_L, v_H) \geq \widehat{\theta}(0,0)$, or $\widehat{\theta}(0,0) > \widehat{\theta}(v_L, v_H) > \widehat{\theta}^{\text{FB}}$.[27]

[24] By a simple continuity argument, the results of Proposition 10 imply $\widehat{\theta}(\pi, \pi + \epsilon) > \widehat{\theta}(0,0)$ for $\epsilon > 0$ small enough relative to π.

[25] See, e.g., https://www.universityworldnews.com/post.php?story=20170713161438362.

[26] For a discussion of concerns that "incentives drive quantity but not quality", see, e.g., https://theconversation.com/paying-commission-to-academics-reduces-the-value-of-research-146498.

[27] Comparing the RHS of (6) and (22) for $\pi_P = v_P, P \in \{L, H\}$ (the latter defining equilibria in the model with monetary bonuses) yields $\widehat{\theta}^{\text{FB}} > \widehat{\theta}(v_L, v_H)$ if and only if

$$\frac{v_L}{v_H} > \frac{v_L + \delta\left[\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})\right]}{v_H + \delta\left[\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})\right]} \iff \frac{v_L}{v_H} > \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}.$$

As the LHS and the RHS of the latter inequality correspond to the RHS of (6) and (4), respectively, it follows that this inequality is equivalent to $\widehat{\theta}^{\text{FB}} > \widehat{\theta}(0,0)$. It can be easily checked that, under the exact same condition, the RHS of (22)

Thus, even though researchers can self-select into high-value projects to signal their ability to the market and can fully appropriate the higher social value of successful extensive research compared to incremental research, the (stable) equilibrium can feature an inefficiently low amount of extensive research. In this case, guaranteeing full appropriability improves welfare compared to the equilibrium where choices are only driven by implicit career incentives. Yet, attaining first best would require over-rewarding (in relative terms) successful pieces of extensive research, so to induce more researchers to bear the high 'reputational risk' associated to failures.[28] While assuming full appropriability of the research social value is no more than a thought experiment when it comes to basic research, which is the case for most academic research, these results have broader implications for IPR policies. In particular, they suggest that, in R&D markets where successful innovations have a signalling value — e.g., to attract venture capital (Conti et al., 2013a,b) — efficient IPR laws need to be tailored to the value of innovation — i.e., more lenient IPR laws (e.g., longer patent duration or wider patent breadth) may be needed for higher-value innovations than for incremental innovations.

3.6.2 Entry costs and outside options

Entering the academic research world entails relevant entry costs, which are at least in part specific (sunk costs), as well as opportunity costs. Let $\psi > 0$ denote the entry cost or, equivalently, the outside option value from another job, assumed for simplicity type-independent. Then, any agent optimally enters the academic job market, choosing a project $P \in \{L, H\}$, if and only if $u_P(\theta) \geq \psi$. Conditional on entry, optimal project choice is as in the base model. Following the same steps of the analysis of Section 3.3 yields that any interior equilibrium is characterized by two thresholds $\widehat{\theta}_L < \widehat{\theta}_H$, which solve

$$\begin{cases} p_L(\widehat{\theta}_L) = \dfrac{\psi - \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)}{\mathcal{M}^1_L(\widehat{\theta}_L, \widehat{\theta}_H) - \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)} \\ \\ \dfrac{p_H(\widehat{\theta}_H)}{p_L(\widehat{\theta}_H)} = \dfrac{\mathcal{M}^1_L(\widehat{\theta}_L, \widehat{\theta}_H) - \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)}{\mathcal{M}^1_H(\widehat{\theta}_H) - \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)} \end{cases} \tag{7}$$

and is such that: types $\theta \in [\underline{\theta}, \widehat{\theta}_L)$ do not enter the academic research market; $\theta \in [\widehat{\theta}_L, \widehat{\theta}_H)$ enter it and choose L-projects; $\theta \in [\widehat{\theta}_H, \overline{\theta}]$ enter it and choose H-projects. As the market correctly infers entry decisions, the relevant distribution of types is a left-truncation of $F(\cdot)$ at $\widehat{\theta}_L$. Accordingly, reputations are as in (the left-truncation case in) Lemma 5, given in the Appendix, for $\theta_0 = \widehat{\theta}_L$ and $\widehat{\theta} = \widehat{\theta}_H$. The first indifference condition in (7) implies that, as ψ grows larger, $\widehat{\theta}_L$ must increase. Then, from the second indifference condition and the results in Lemma 5, it follows that the increase in $\widehat{\theta}_L$ will induce a decrease in $\widehat{\theta}_H$.

Higher entry costs and/or better outside opportunities, through their selection effect, improve the pool of agents entering the academic job market. Consequently, failures cannot be attributed to very low types, as those are not in the market. This makes failing less costly, thereby strengthening

(for $\pi_P = v_P, P \in \{L, H\}$) is larger than the RHS of (4), which implies $\widehat{\theta}(\pi_L, \pi_H) > \widehat{\theta}(0, 0)$. Hence, the results follow.

[28] In principle, an optimal incentive scheme may also involve rewarding failures — i.e., granting positive bonuses if the project fails. However, this cannot be optimal in the presence of moral hazard — e.g., with unobservable research effort costs as in Section 3.3.

incentives towards extensive research. Note that the opposite result arises in Proposition 8, because there low-ability researchers who are not willing to sunk the effort cost are still in the market, and effort is unobservable.

3.6.3 Cross-projects externalities

In the analysis developed so far only 'reputational externalities' are in play among researchers. Direct payoff externalities, related to the demand-side of the academic job market, will be analysed in detail in Section 4 below. Here I briefly discuss another channel of externalities, driven by the probability of success on any project being potentially affected by other researchers' project choices. In practice, both negative and positive externalities may prevail. On the one hand, preemption mechanisms (e.g., Bobtcheff et al., 2017) may imply negative externalities within each project category. If more researchers choose H-projects, then the individual probability of success in any of these projects drops because more researchers end up working on the same topic, and only the first one to obtain a result gets it published. On the other hand, positive knowledge spillover effects imply that completing any H-project is easier when many other researchers work on related H-projects. Such spillovers may also be at play across project categories.

Besides the fact that these positive and negative externalities can somehow balance each other out on aggregate, thereby taking $p_P(\theta)$ independent of $\widehat{\theta}$ may be a reasonable approximation, there is a further reason why the impact of cross-project externalities in equilibrium is likely to be quantitatively modest. Namely, their 'direct effect' on the probability of project completion is often offset, at least in part, by their 'indirect effect' through reputations.

To see this, suppose for simplicity that externalities are only in play across H-projects: the probability of any such project's completion is $p_H(\theta;\widehat{\theta})$. In case of negative externalities, $\frac{\partial p_H(\cdot)}{\partial \widehat{\theta}} > 0$: if more researchers are expected to choose such projects (i.e., $\widehat{\theta}$ decreases), then their completion becomes harder. All else equal, this discourages extensive research. Yet, this also means that failures will be attributed to a larger extent to the relatively high types who did not complete such hard projects. By reducing the stigma from having no publication, and increasing the honour from H-projects' completion, the reputational channel counteracts the direct effect.

On the contrary, in case of positive externalities, $\frac{\partial p_H(\cdot)}{\partial \widehat{\theta}} < 0$ gives researchers more incentives to choose H-projects when they expect most of their fellows to do the same. Yet, precisely because accomplishing H-projects becomes easier, the honour from completing them is mitigated and the stigma from failing amplified. Once again the 'direct' and 'indirect' effect of cross-project externalities go in opposite directions, thereby their overall impact on the equilibrium is not too large.

3.6.4 Multiple projects' categories

While considering two project categories $P \in \{L, H\}$ greatly simplifies the analysis, the main insights of the paper are not driven by this assumption. To see this, suppose there are $n > 2$ project categories $P \in \{P_1, P_2, \ldots, P_n\}$, ordered by increasing level of project quality and difficulty. Again, high types are more likely to complete any project, especially the harder ones. Formally, denoting by $p_k(\theta) \triangleq \Pr[s = 1|P_k, \theta]$, for all k and θ: *(i)* $p_k(\theta) \geq p_{k+1}(\theta)$; *(ii)* $p'_k(\theta) > 0$; and *(iii)* $\frac{\mathrm{d}}{\mathrm{d}\theta}\left(\frac{p_{k+1}(\theta)}{p_k(\theta)}\right) > 0$, with

$\lim_{\theta \to \underline{\theta}} \dfrac{p_{k+1}(\theta)}{p_k(\theta)} = 0$ and $\dfrac{p_{k+1}(\overline{\theta})}{p_k(\overline{\theta})} = 1$.

Denote by $\mathcal{M}_k^1 \triangleq \mathbb{E}[\tilde{\theta}|s = 1, P_k]$ and $\mathcal{M}^0 \triangleq \mathbb{E}[\tilde{\theta}|s = 0]$ researchers' reputations. Suppose $\mathcal{M}^0 < \mathcal{M}_1^1 < \mathcal{M}_2^1 < \ldots < \mathcal{M}_n^1$. Then, a researcher θ favours P_{k+1}-projects over P_k-projects if and only if

$$\frac{p_{k+1}(\theta)}{p_k(\theta)} \geq \frac{\mathcal{M}_k^1 - \mathcal{M}^0}{\mathcal{M}_{k+1}^1 - \mathcal{M}^0} \in (0, 1).$$

By the above assumptions, this implies that there exists a cutoff type $\widehat{\theta}_k \in (\underline{\theta}, \overline{\theta})$ who is indifferent between these two projects, and all types $\theta < \widehat{\theta}_k$ strictly favour P_k-projects over P_{k+1}-projects, and vice versa for $\theta > \widehat{\theta}_k$. Interior equilibria (where all project types are chosen by a positive-measure set of researchers) are characterized by a vector of cutoff types $(\widehat{\theta}_k)_{k\in\{1,\ldots,n-1\}}$, with $\widehat{\theta}_0 \equiv \underline{\theta} < \widehat{\theta}_1 < \ldots < \widehat{\theta}_{n-1} < \widehat{\theta}_n \equiv \overline{\theta}$, such that types $\theta \in [\widehat{\theta}_{k-1}, \widehat{\theta}_k)$ choose P_k-projects.[29] In these equilibria, reputations are as follows:

$$\mathcal{M}_k^1 = \mathcal{M}_k^1(\widehat{\theta}_{k-1}, \widehat{\theta}_k) \triangleq \mathbb{E}[\theta|\theta \in [\widehat{\theta}_{k-1}, \widehat{\theta}_k), s = 1] = \frac{\int_{\widehat{\theta}_{k-1}}^{\widehat{\theta}_k} \theta p_k(\theta) \mathrm{d}F(\theta)}{\int_{\widehat{\theta}_{k-1}}^{\widehat{\theta}_k} p_k(\theta) \mathrm{d}F(\theta)} \in (\widehat{\theta}_{k-1}, \widehat{\theta}_k),$$

which are increasing in $\widehat{\theta}_{k-1}$ and $\widehat{\theta}_k$,[30] and

$$\mathcal{M}^0 = \mathcal{M}^0(\widehat{\theta}_1, \ldots, \widehat{\theta}_{n-1}) \triangleq \mathbb{E}[\theta|s = 0] = \frac{\sum_{k=1}^n \int_{\widehat{\theta}_{k-1}}^{\widehat{\theta}_k} \theta(1 - p_k(\theta)) \mathrm{d}F(\theta)}{\sum_{k=1}^n \int_{\widehat{\theta}_{k-1}}^{\widehat{\theta}_k} (1 - p_k(\theta)) \mathrm{d}F(\theta)},$$

which is decreasing in all $\widehat{\theta}_k$ (for $k = 1, \ldots, n-1$), at equilibrium.[31]

It can be argued that the strategic complementarity forces at play in the game are strengthened

[29] The sequence $(\widehat{\theta}_k)_{k\in\{1,\ldots,n-1\}}$ of indifference types being increasing implies that $\widehat{\theta}_k$ strictly prefers P_k- and P_{k+1}-projects over all other projects. To see this, it is sufficient to notice that

$$\frac{p_{k+1}(\widehat{\theta}_k)}{p_k(\widehat{\theta}_k)} > \frac{p_k(\widehat{\theta}_{k-1})}{p_{k-1}(\widehat{\theta}_{k-1})} = \frac{\mathcal{M}_{k-1}^1 - \mathcal{M}^0}{\mathcal{M}_k^1 - \mathcal{M}^0},$$

where the inequality follows from the monotonicity assumption *(iii)* and the equality from the indifference condition between P_k- and P_{k-1}-projects. To show that the sequence $(\widehat{\theta}_k)_{k\in\{1,\ldots,n-1\}}$ must be increasing, suppose by contradiction it is not. Then there exists some k such that $\widehat{\theta}_k < \widehat{\theta}_{k-1}$. In this case, no one would choose P_k-projects, which is not compatible with the definition of interior equilibria: by construction, types $\theta < \widehat{\theta}_k < \widehat{\theta}_{k-1}$ prefer P_{k-1}-projects, types $\theta > \widehat{\theta}_{k-1} > \widehat{\theta}_k$ prefer P_{k+1}-projects, and types $\theta \in (\widehat{\theta}_k, \widehat{\theta}_{k-1})$ also prefer both P_{k-1}- and P_{k-+1}-projects to P_k-projects.

[30] Indeed,

$$\frac{\partial \mathcal{M}_k^1(\cdot)}{\partial \widehat{\theta}_{k-1}} = \frac{p_k(\widehat{\theta}_{k-1}) f(\widehat{\theta}_{k-1})(\mathcal{M}_k^1(\cdot) - \widehat{\theta}_{k-1})}{\int_{\widehat{\theta}_{k-1}}^{\widehat{\theta}_k} p_k(\theta) \mathrm{d}F(\theta)} > 0, \quad \frac{\partial \mathcal{M}_k^1(\cdot)}{\partial \widehat{\theta}_k} = \frac{p_k(\widehat{\theta}_k) f(\widehat{\theta}_k)(\widehat{\theta}_k - \mathcal{M}_k^1(\cdot))}{\int_{\widehat{\theta}_{k-1}}^{\widehat{\theta}_k} p_k(\theta) \mathrm{d}F(\theta)} > 0.$$

[31] The comparative statics is as follows

$$\frac{\partial \mathcal{M}^0(\cdot)}{\partial \widehat{\theta}_k} = -\frac{f(\widehat{\theta}_k)(p_{k+1}(\widehat{\theta}_k) - p_k(\widehat{\theta}_k))(\widehat{\theta}_k - \mathcal{M}^0(\cdot))}{\int_{\widehat{\theta}_{k-1}}^{\widehat{\theta}_k} (1 - p_k(\theta)) \mathrm{d}F(\theta)} < 0,$$

at any interior equilibrium, given that $\widehat{\theta}_k > \mathcal{M}_k^1(\cdot) > \mathcal{M}^0(\cdot)$.

in this more general version of the model, which consequently features stable equilibria characterized by prevalence of low-profile (i.e., low-k) projects. To see this, take any candidate equilibrium, and suppose some types $\theta \in [\widehat{\theta}_k, \widehat{\theta}_k + \Delta]$ (for $\Delta > 0$ small enough) switch from more ambitious P_{k+1}-projects to less ambitious P_k-projects. As a consequence: *(i)* $\mathcal{M}^1_k(\cdot)$ increases; *(ii)* $\mathcal{M}^1_{k+1}(\cdot)$ increases; and *(iii)* $\mathcal{M}^0(\cdot)$ decreases. As in the base model, the joint effect of *(i)* and *(iii)* most likely outweighs the one in *(ii)*. Hence, following this switching, P_k-projects become more appealing P_{k+1}-projects to higher types $\theta > \widehat{\theta}_k + \Delta$. But here *(ii)* and *(iii)* also imply that P_{k+1}-projects become more appealing relative to more ambitious P_{k+2}-projects. This is because P_{k+1}-projects are less risky than P_{k+2}-projects, which is now more valuable since failing is more costly, and the gain in reputation in case of success $(\mathcal{M}^1_{k+2}(\cdot) - \mathcal{M}^1_{k+1}(\cdot))$ is smaller. As a result, also $\widehat{\theta}_{k+1}$ will increase. By induction, these mechanisms imply that the market converges to a stable *publish-or-perish* equilibrium where all higher-profile projects $P_{k+2}, \ldots, P_n$ are chosen by less researchers.

3.7 Parametric example

Consider the following specification of the baseline model: $[\underline{\theta}, \overline{\theta}] \equiv [0, 1]$, $F(\theta) \equiv \theta^x$, with $x > 0$, $p_L(\theta) \equiv \theta^l$ and $p_H(\theta) \equiv \theta^h$, with $0 < l < h$. Under this fairly natural and general specification, it is possible (using numerical simulations) to study conditions concerning existence and multiplicity of interior equilibria, and to perform comparative statics exercises with interesting implications.

Existence and multiplicity of interior equilibria. *The game admits two interior equilibria if h is large enough relative to l, and no interior equilibria otherwise.*

The intuition for the existence result is straightforward: in order for interior equilibria to exist, L-projects must be substantially less risky than H-projects, so to be attractive for enough researchers, as required by the existence of interior equilibria. In these circumstances, the LHS and RHS of (4) are globally convex and concave, respectively. Since the LHS is larger than the RHS at $\widehat{\theta} = \underline{\theta}$ and as $\widehat{\theta} \to \overline{\theta}$, this implies that they intersect twice (see Figure 1).

Comparative statics: Probabilities of project completion. *The stable equilibrium cutoff is increasing in h and inverted U-shaped in l.*

As h grows larger, H-projects become riskier ($p_H(\cdot)$ decreases), hence less appealing for all types. This 'direct effect' dominates the 'indirect effects' of h through reputations, discouraging extensive research. More surprisingly, the relation between the stable equilibrium cutoff and l is non-monotone. As l grows larger, accomplishing a L-project becomes harder ($p_L(\cdot)$ decreases), which however implies that the reputation contingent on successful completion of any such project $\mathcal{M}^1_L(\cdot)$ increases as well. These two effects somehow compensate each other, thereby the shape of the relation at hand reflects the impact of a larger l on $\mathcal{M}^0(\cdot)$.[32] For any candidate equilibrium cutoff $\widehat{\theta}$, as l grows larger, L-projects being more likely to fail brings out two opposite effects on $\mathcal{M}^0(\cdot)$: on the one hand, the probability with which failures are attributed to types $\theta < \widehat{\theta}$ increases, which, all else equal, implies that $\mathcal{M}^0(\cdot)$ drops; on the other hand, those failing L-projects are on average better types, which,

[32] Of course, $\mathcal{M}^1_H(\cdot)$ does not depend on $p_L(\cdot)$, hence is independent of l.

instead, would imply that $\mathcal{M}^0(\cdot)$ increases. The former effect dominates when l is low, whereas the latter prevails for larger values of l. As a result, $\mathcal{M}^0(\cdot)$ is U-shaped with respect to l, which results in the RHS of (4), and in turn the stable equilibrium cutoff, being inverted U-shaped in l. Thus, an increase in the difficulty of accomplishing incremental research projects (when those are initially relatively easy for most types), by exacerbating the stigma from failures, may actually hinder, rather than foster, extensive research.

These comparative statics results have important implications for the dynamics of scientific progress (see Bramoullé and Saint-Paul, 2010, and Garfagnini and Strulovici, 2016, for dynamic models along these lines). It can be argued that, as a research field becomes more mature, successfully producing novel disruptive research in that field gets harder. The first comparative statics result implies that this deters the next generation of researchers from pursuing ambitious projects, leading most of them to focus on incremental research. The consequent lack of novel approaches, as well as the exploitation of existing approaches to carry out intensive research, in turn makes it more difficult for future generations of researchers to pursue incremental research projects as well. The second comparative statics result above implies that this further hinders extensive research, up to the point where successful completion even of low-profile projects becomes hard enough. At that point, more researchers optimally turn to extensive research, which brings new lifeblood to the field, and so on. This dynamic process is broadly consistent with the well established evidence on 'technological cycles' characterizing innovation and R&D markets: see, e.g., Kleinknecht (1987) for early empirical evidence, and Jovanovic and Rob (1990) for a growth model through intensive and extensive research.

Comparative statics: Distribution of types. *The stable equilibrium cutoff is decreasing in x.*

Thus, a shift in the distribution of types in the sense of first-order stochastic dominance (from $F(\theta) = \theta^{x_1}$ to $F(\theta) = \theta^{x_2}$, with $x_2 > x_1$) implies that more extensive research is carried out in equilibrium ($\widehat{\theta}_2|_{x=x_2} < \widehat{\theta}_2|_{x=x_1}$).[33] This result generalizes, under this model specification, those proved (with general functions) in Lemma 5, since the 'original' distribution of types first-order stochastically dominates (is dominated by) any distribution obtained via its right-truncation (left-truncation). The intuition thus goes along the same lines: the extent to which failing entails being pooled with very low types is small (large) if there are few (many) such low types in the 'population', which makes researchers less (more) risk averse.

An implication of this result is that disruptive research mostly originates from good research environments, such as top universities or industrial districts, not only because they are able to attract more talented researchers or more innovative start-ups, and to a larger extent than what this pure *selection effects* would imply. While peer effects and/or innovation spillovers are well-known explanations for this phenomenon, the present model highlights that, in presence of signalling/career concerns, mere reputational externalities imply that innovators have stronger incentives to undertake extensive research in better environments.

[33] Since $\frac{\partial F(\cdot)}{\partial x} < 0$ for all $\theta \in (0, 1)$:

$$x_2 > x_1 \iff F_{x_2}(\theta) \equiv \theta^{x_2} \text{ FOSD } F_{x_1}(\theta) \equiv \theta^{x_1}.$$

4 The academic job market

Following the bulk of the literature on signalling and career-concerns model, so far researchers' payoff was simply their average type inferred by the market. This section extends the model endogenising the demand side of the academic job market. This allows to analyse how demand-side and, more broadly, labour market characteristics, through their effect on equilibrium wages, affect researchers' project choices.

To this aim, I build a *matching tournament* model (Cole et al., 1992, 1998). Consider a unit mass of employers (universities), which are differentiated in quality. Quality is a vertical attribute, denoted by $z \in [\underline{z}, \overline{z}]$, distributed according to a continuous cumulative distribution function $G(z)$, with strictly positive and bounded density $g(z)$. The employers' type is common knowledge: everyone knows what are the more and less prestigious universities; by contrast, the researchers' type is their private information, and the market only observes publications: as in the base model, researchers choose a project $P \in \{L, H\}$ whose quality is observed only conditional on success. After project outcomes realize, matching takes place, with one researcher matching with each employer (i.e., each university is on the job market with one open position). A match between a researcher of type θ and a university of type z produces value $\Pi(\theta, z)$.[34] Consider for tractability a multiplicative match value $\Pi(\theta, z) = \theta z$. This specification entails that researchers' and universities' vertical types are complement: the value of working in more prestigious universities is higher for more talented researchers — who, e.g., make a more productive use of research funds and benefit more from lively intellectual environments compared to lower ability fellows.[35]

An equilibrium of this matching tournament has two components: a strategy for the researchers $P^*(\theta)$, that specifies project choice as a function of her type; and a matching scheme Φ, that assigns researchers to universities. For an equilibrium: *(i)* the matching scheme must be *stable* given observable project outcomes and the strategy $P^*(\theta)$; and *(ii)* no researcher can have an incentive to deviate given the strategies of her fellow researchers and the matching scheme in place.[36] Formally, a matching is a function $\Phi : [0, 1] \to [0, 1]$ such that a researcher with *rank* $F(\theta_i)$ is matched with an employer of rank $G(z_j)$: $\Phi(F(\theta_i)) = G(z_j)$. The matching function Φ is measure-preserving and one-to-one on $\Phi([0, 1])$ — i.e., for all measurable subsets $A \subset [0, 1]$, $\Phi^{-1}(A)$ is measurable and $\mu(\Phi^{-1}(A)) = \mu(A)$, where μ denotes Lebesgue measure.[37] A matching is stable if there does not exist $i \neq i'$ such that $\Phi(i') \succ_i \Phi(i)$ and $i \succ_{\Phi(i')} i'$. In words, for a stable matching, it should not be possible to find a researcher and an employer who would prefer to match with each other in place of their current matches. Note that an employer must choose a researcher on the basis of observable project outcome, because her type θ is hidden. In equilibrium, firms' beliefs must be consistent with researchers' strategies. Thus, in this setting, there will be only three *observable types*, and the relevant match values at the matching stage

[34] Note that in this setting successful project completion does not increase the match value — i.e., it is a valueless signal.

[35] There are several reasons why universities benefit from hiring talented researchers, who are able to consistently publish top-papers. For instance, as documented by Carson et al. (2013), many OECD countries use Performance-Based Research Funding Systems (PBFS), which entail funding universities on the basis of their research performance.

[36] Note that, as in Hopkins (2012), the second stage of the tournament is treated as a cooperative game, in that it requires stability in the matching process, whereas the project-choice stage is non-cooperative.

[37] This is just a feasibility condition: it is the equivalent in a continuum to the assumption with finite players that exactly one researcher is matched to one employer.

will accordingly be $\pi_P(z) \triangleq \mathbb{E}[\Pi(\tilde{\theta}, z)|s = 1, P]$, with $P = L, H$, and $\pi_0(z) \triangleq \mathbb{E}[\Pi(\tilde{\theta}, z)|s = 0]$, where expectations are taken given researchers' equilibrium strategies at the project-choice stage.

There are two cases to consider: transferable utility (TU), and non-transferable utility (NTU). Under TU, the product of the match is freely divisible — i.e., wages are fully flexible. On the contrary, under NTU the benefits $\Pi(\cdot)$ arising from the match are in some way indivisible and/or non-excludable.

4.1 TU case

Consider a candidate equilibrium in which: at the project selection stage, $\theta \in [\underline{\theta}, \widehat{\theta})$ choose L-projects and types $\theta \in [\widehat{\theta}, \overline{\theta}]$ select H-projects; in the matching phase, researchers succeeding in H-projects get matched with highest university types, researchers succeeding in L-projects get matched with intermediate university types, and researchers who fail their project get matched with lowest university types. In the Appendix it is shown that the restriction to such equilibria is without loss of generality as far as interior equilibria, in which a positive-measure set of researchers choose both project categories, are concerned (directly focusing on this kind of equilibria greatly simplifies the exposition).

In this candidate equilibrium, the expected match values conditional on observed project outcomes and university type are $\pi_P(z) = \mathcal{M}^1_P(\widehat{\theta})z$, for $P = L, H$, and $\pi_0(z) = \mathcal{M}^0(\widehat{\theta})z$, where $\mathcal{M}^1_P(\cdot)$ and $\mathcal{M}^0(\cdot)$ are the researchers' *reputations* derived in the baseline career-concerns model. Define $z_L(\widehat{\theta}) > 0$ and $z_H(\widehat{\theta}) \in (z_L(\widehat{\theta}), \overline{z})$ such that

$$G(z_H(\widehat{\theta})) = 1 - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta), \tag{8}$$

and

$$G(z_H(\widehat{\theta})) - G(z_L(\widehat{\theta})) = \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) \Longrightarrow G(z_L(\widehat{\theta})) = 1 - \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta). \tag{9}$$

In words, $z_H(\cdot)$ and $z_L(\cdot)$ are the lowest university types that are matched with a researcher who successfully completed a H-project and a L-project, respectively. As the mass of researchers entering the job market with H- and L-publications depend on the equilibrium project choices, these thresholds will be function of the equilibrium cutoff $\widehat{\theta}$. Then, normalizing to zero each university's and researcher's outside option value, the following holds.

Lemma 7. *If $\widehat{\theta} > \underline{\theta}$, then, in any stable matching:*

- *Universities $z \in [\underline{z}, z_L(\widehat{\theta}))$ hire researchers with no publication and pay them a "base wage" $w_0(\widehat{\theta}) \in [0, \underline{z}\mathcal{M}^0(\widehat{\theta})]$;*
- *Universities $z \in [z_L(\widehat{\theta}), z_H(\widehat{\theta}))$ hire researchers with a L-publication at a wage $w_L(\widehat{\theta}) \triangleq w_0(\widehat{\theta}) + (\mathcal{M}^1_L(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta}))z_L(\widehat{\theta}) > w_0(\widehat{\theta})$;*
- *Universities $z \in [z_H(\widehat{\theta}), \overline{z}]$ hire researchers with a H-publication at a wage $w_H(\widehat{\theta}) \triangleq w_L(\widehat{\theta}) + (\mathcal{M}^1_H(\widehat{\theta}) - \mathcal{M}^1_L(\widehat{\theta}))z_H(\widehat{\theta}) > w_L(\widehat{\theta})$.*

As seen in the base model, if relatively good types choose L-projects in equilibrium (i.e., $\widehat{\theta} > \underline{\widehat{\theta}}$), then $\mathcal{M}_L^1(\widehat{\theta}) > \mathcal{M}_0(\widehat{\theta})$. As a consequence, from each university viewpoint, researchers with a L-publications generate higher expected match value than those with no publications. Under complementarity between researchers' and universities' types, as in Hopkins (2012), stability of matching implies that better universities are matched to researchers with higher average type. Note that this matching does not coincide *stricto sensu* with positive assortative matching, because good researchers types $\theta \geq \widehat{\theta}$ who fail are matched to worse universities than worse types $\theta < \widehat{\theta}$ who successfully complete L-projects. This is because there are only three observable signals in this model, thereby full separation of types is not attainable, and matching can only be based on the average type given project outcome.[38]

Moving backwards to the project-choice stage, the expected payoff of a researcher θ from choosing project P, for $P = L, H$, is

$$u_P(\theta) \triangleq p_P(\theta) w_P(\widehat{\theta}) + (1 - p_P(\theta)) w_0(\widehat{\theta}).$$

Hence, a researcher θ chooses a H-project if and only if $w_H(\cdot) > w_0(\cdot)$ and

$$\frac{p_H(\theta)}{p_L(\theta)} \geq \frac{w_L(\widehat{\theta}) - w_0(\widehat{\theta})}{w_H(\widehat{\theta}) - w_0(\widehat{\theta})}. \tag{10}$$

By Assumptions A1-A2, interior equilibria can exist if and only if the RHS of (10) is in $(0, 1)$, that is $w_H(\cdot) > w_L(\cdot) > w_0(\cdot)$, which is satisfied by the wages given in Lemma 7. The following results then can be established.

Proposition 11. *In any interior equilibrium,*[39] *there exists a cutoff* $\widehat{\theta} > \underline{\widehat{\theta}}$, *which solves*

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{(\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})) z_L(\widehat{\theta})}{(\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})) z_L(\widehat{\theta}) + (\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}_L^1(\widehat{\theta})) z_H(\widehat{\theta})}, \tag{11}$$

such that, at the project-choice stage, types $\theta \geq \widehat{\theta}$ ($\theta < \widehat{\theta}$) *choose H-(L-)projects. For any such equilibrium cutoff, the stable matching is then given in Lemma 7.*

Under some regularity conditions, there are two interior equilibria, $\widehat{\theta}_1^{TU} < \widehat{\theta}_2^{TU}$, *with* $\widehat{\theta}_1^{TU}$ *being unstable and* $\widehat{\theta}_2^{TU}$ *stable,*[40] *and* $\widehat{\theta}_2^{TU} < \widehat{\theta}_2$.

The equilibrium characterization thus mirrors the one in the baseline career-concerns model. Indeed, if universities were homogeneous, $z_L(\cdot) = z_H(\cdot)$, and consequently equation (11) would be identical to (4), so that the equilibria would be the same in the two models. With employers' heterogeneity, however, having a H-publication implies a better match compared to having a L-publication.

[38] The evidence in Abramo et al. (2014) seems consistent with these features: they find that, while new associate professors, selected mainly based on their publication records, are on average more productive than the incumbents, there are some non-winner candidates that are more productive than the winners.

[39] There always exists a pooling D1-equilibrium in which: *(i)* all researchers choose H-projects; *(ii)* universities $z \in [z_H(\underline{\theta}), \overline{z}]$ hire researchers with a H-publication at a wage $w_H = w_0 + (\mathcal{M}_H^1(\underline{\theta}) - \mathcal{M}^0(\underline{\theta})) z_H(\underline{\theta})$, and all lower university types hire researchers with no publications and pay them the base wage $w_0 \in [0, \underline{z}\mathcal{M}^0(\underline{\theta})]$. Details are in the Appendix.

[40] More generally, provided an interior equilibrium exists, there is an even number of equilibria $\widehat{\theta}_1^{\mathrm{TU}} < \widehat{\theta}_2^{\mathrm{TU}} < \widehat{\theta}_3^{\mathrm{TU}} < \widehat{\theta}_4^{\mathrm{TU}} < \ldots$, with $\widehat{\theta}_1^{\mathrm{TU}}$ being unstable, $\widehat{\theta}_2^{\mathrm{TU}}$ stable, $\widehat{\theta}_3^{\mathrm{TU}}$ unstable, $\widehat{\theta}_4^{\mathrm{TU}}$ stable, and so on: see the Appendix.

This implies that the relative value of choosing ambitious projects is larger when also demand-side heterogeneity is accounted for.

Having characterized the equilibria of the game, it is possible to examine how demand-side characteristics of the academic job market affect the extent of incremental vs extensive research carried out in equilibrium. Letting $\widehat{\theta}^{\mathrm{TU}}[G]$ denote, with a slight abuse of notation, the stable interior equilibrium cutoff when the distribution of university type z is $G(\cdot)$, the following result can be established.

Corollary 1. *If $G_2(\cdot)$ FOSD $G_1(\cdot)$, then $\widehat{\theta}^{TU}[G_2] > \widehat{\theta}^{TU}[G_1]$.*

Thus, an increase in the distribution of university types, in the sense of first-order stochastic dominance, weakens researchers' incentives towards extensive research. The reason is that, if most available matches are relatively good from researchers' viewpoint, only those failing their projects will have a quite bad match, whereas completion of a H-project vs a L-project does not affect much the expected match value. If, on the contrary, most university types are relatively low, then a L-publication won't improve much the match compared to a failure, whereas completing a H-project allows to be matched with one of the few top-places. An implication of this result is that a 'more competitive' the academic job market, featuring fierce competition for a few prestigious placements, unambiguously pushes young scholars towards extensive research. Yet, this clear-cut result crucially hinges on the assumption of full wage flexibility (i.e., transferable utility), as it will be clear in Section 4.2 below.

4.2 NTU case

The TU case analysed above presupposes that researchers and their employers bargain over wages, so that those are fully flexible. Yet, in reality, academic wages are often fixed by national agreement (this is usually the case in Europe, where most universities are public institutions), thereby the job market features the NTU property. Since all universities pay the same wage $\hat{w} \geq 0$, researchers simply prefer to be employed by more prestigious institutions. Thus, let the researcher's benefit from matching be $\hat{w} + z$, with the hiring university obtaining $\Pi(\theta, z) - \hat{w}$.[41]

Defining

$$w_0(\widehat{\theta}) \triangleq \mathbb{E}[z|z \leq z_L(\widehat{\theta})], \quad w_L(\widehat{\theta}) \triangleq \mathbb{E}[z|z \in [z_L(\widehat{\theta}), z_H(\widehat{\theta}))], \quad w_H(\widehat{\theta}) \triangleq \mathbb{E}[z|z \geq z_H(\widehat{\theta})], \tag{12}$$

with the thresholds $z_H(\cdot)$ and $z_L(\cdot)$ defined in (8)-(9), the following results hold.

Proposition 12. *Any interior equilibrium is characterized as follows:*

- *At the project-choice stage, there exists a threshold $\widehat{\theta} > \underline{\widehat{\theta}}$, which solves*

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{w_L(\widehat{\theta}) - w_0(\widehat{\theta})}{w_H(\widehat{\theta}) - w_0(\widehat{\theta})}, \tag{13}$$

[41] In what follows it is assumed $\pi_0(\underline{z}) \geq \hat{w}$ to accommodate all universities' participation constraints (normalizing again to zero all players' outside option value). Note that here the total value split between a researcher and its employer is actually $\Pi(\theta, z) + z$. If one wants the total value to be still $\Pi(\theta, z) = \theta z$, the university payoff has to be $\Pi(\theta, z) - z - \hat{w} = \theta(z - 1) - \hat{w}$, which is equivalent to the one considered here up to a rescaling of z.

such that types $\theta \geq \widehat{\theta}$ ($\theta < \widehat{\theta}$) choose H-(L-)projects. For $z \sim \mathcal{U}[0,1]$, (13) admits a unique solution $\widehat{\theta}^{NTU}$.[42]

- *At the matching stage, universities $z \in [\underline{z}, z_L(\widehat{\theta}))$ hire researchers with no publication; $z \in [z_L(\widehat{\theta}), z_H(\widehat{\theta}))$ hire researchers with a L-publication; and $z \in [z_H(\widehat{\theta}), \overline{z}]$ hire researchers with a H-publication.*

The strategic complementarity among researchers' project choices, which drives the main results throughout, need not be at play in this NTU-game. If more researchers choose L-projects ($\widehat{\theta}$ is larger) then, as in the base model: *(i)* the payoff from a H-publication (here the wage $w_H(\cdot)$) increases, because the fewer researchers having high-profile publications are all matched to very prestigious universities; and *(ii)* the payoff from failing (here the wage $w_0(\cdot)$) decreases, because less researchers will fail, hence those will be matched on average to worse universities. These two comparative statics results are qualitatively in line with those of the base model, though resulting from different mechanisms. However, unlike in the base model, here the payoff $w_L(\cdot)$ associated to a L-publication need not increase. The reason is that, by the above results, researchers with L-publications can aspire to better places, but also risk ending up in worse places, when they are more numerous (i.e., for $\widehat{\theta}$ large). Absence of strategic complementarity implies that this NTU-game can admit a unique interior equilibrium, which is stable (see the Appendix).[43]

Moreover, unlike in the model under TU, changes in the distribution of university types, in the sense of first-order stochastic dominance, may have a non-monotone impact on the amount of extensive research projects undertaken in equilibrium. To show this *possibility result*, I consider, for the sake of tractability, a left-truncation of a uniform university type distribution. Letting

$$G(z; z_0) = \begin{cases} 0 & \text{if } z \in [0, z_0] \\ z & \text{if } z \in (z_0, 1] \end{cases}$$

and normalizing $\hat{w} = 0$, the following holds.

Corollary 2. *The stable equilibrium cutoff $\widehat{\theta}^{NTU}$ is inverted U-shaped in z_0.*

A natural way of interpreting this exercise is to suppose that a fraction z_0 of job market candidates will not find an academic position. In this case, their outside option value is lower than the payoff they can obtain from any job in academia (most of the readers probably agree with this assumption). When z_0 is relatively small, only researchers failing their project will not find an academic job. As a consequence, researchers are mostly concerned about minimizing the chances of failures, and so most of them will choose incremental research projects. If, on the contrary, z_0 is large enough, then the academic job market is so tight that low-profile publications do not guarantee a job. This pushes more candidates towards extensive research. This result provides a partial counterpart for the one in

[42] If the solution(s) to (13) is (are) lower than $\underline{\widehat{\theta}}$, then the unique equilibrium of the game is the pooling D1-equilibrium in which: *(i)* all researchers choose H-projects; *(ii)* universities $z \in [z_H(\underline{\theta}), \overline{z}]$ hire researchers with H-publications, and all lower university types hire researchers with no publications. All details are in the Appendix.

[43] As the nature of strategic interactions here is substantially different than in the base model, the comparison between the corresponding equilibrium cutoffs is in general ambiguous and is not particularly meaningful.

Proposition 1 above: in markets featuring important wage rigidities, it is not *a priori* clear whether extensive research is fostered in 'more competitive' environments.

Finally, note that the equilibrium of Proposition 12, when it exists, also arises in a (fully) non-cooperative game setting. Suppose universities (all offering the same wages but with varying prestige) open one position each, awarded through a *publication-based contest*: they all commit to a hiring rule whereby a candidate with a H-publication wins over a candidate with a L-publication, who in turn wins over a candidate with no publication.[44] Then, it is straightforward to see that, assuming away frictions (application costs, coordination problems, etc.), the equilibrium of the project-choice stage is obtained from (13), and the universities' hiring rule then yields the same outcome of the cooperative (stable-matching) solution. Importantly, the adopted contest rule is ex-post optimal, given that $\widehat{\theta} > \underline{\widehat{\theta}}$ implies that researchers with L-publications are on average better than those with no publications. Thus, the *publish-or-perish* system induced by hiring rules which penalize researchers with no publications is hard to dismantle, and more so precisely when it generates inefficiently large prevalence of incremental research: if all universities stick to the considered hiring rule, the higher the equilibrium cutoff $\widehat{\theta}$ this induces, the higher the average quality difference $\mathcal{M}_L^1(\cdot) - \mathcal{M}^0(\cdot)$ between applicants with L-publications and those without publications, hence the weaker the incentives for any university to implement different hiring rules.

5 Concluding remarks and future research directions

This paper has shed some light on the widespread concerns that evaluating researchers based on research output performance measures may deter them from undertaking more innovative research approaches. Through the lenses of a simple signalling model, it has also been possible to examine how several policies by scholarly journals and academic institutions affect researchers' incentives towards incremental vs extensive research projects. I conclude by briefly discussing some directions for future research.

Collaborations. This model *de facto* supposes that each researcher engages in a *solo* project. While this is often the case for JMPs, collaborations play an important role in scientific research. Allowing for coauthored projects brings out an additional trade-off: on the one hand, succeeding a project is easier when working with a coauthor; on the other hand, coauthored papers convey less information on each single author's ability. Both aspects are especially relevant when junior researchers, who have strong signalling concerns, collaborate with well-established senior scholars. How do collaboration opportunities affect incentives towards extensive research? Do these collaborations improve welfare? Addressing these questions may be an interesting avenue for future research.

Dynamics. How do scholars build their reputation over time? They may find it optimal to first show enough ability to complete regular projects, and later on (after separating from the lowest types) trying to pool with higher types by undertaking a more ambitious project. Yet, if the market can

[44] To complete the description of the contest rule, say that two candidates with the same publication record win with equal probability (though the tie-breaking rule is immaterial to the results).

observe the time profile of project choice, doing so may signal she is not a too high type to start with. Hence, it may be a better idea to do the reverse. That is, to first try to signal high ability by choosing a high-profile project, hoping to succeed, and then revert to incremental research projects: in case of failure, as an insurance against being pooled with the worst types, and/or in case of success, to avoid the risk of big reputational losses. A dynamic version of the model could be introduced to examine the dynamics of project choice.

Contests. As observed above, the academic job market may end up in an equilibrium where all universities rank applicants with low-profile publications higher than those with no publications, which may give researchers excessive incentives towards incremental research projects. Yet, there always exists another D1-equilibrium in which low-profile publications are not taken into consideration by any university, and accordingly no researcher undertakes such projects. In more realistic settings, some places (e.g., top-institutions) may only value high-quality research, so to only attract top-scholars; lower-ranked universities instead can be mostly concerned of hiring someone who is good enough to consistently publish, even though only in second-tier journals. Moreover, further (exogenous or even endogenous) information about the researcher's type may play a role in the hiring process. How do different hiring rules affect researchers' incentives? What is the optimal contest design, and how is it affected by demand-side and supply-side characteristics of the academic job market? Tackling these questions is also left for future research.

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Appendix

Proof of Lemma 1. There are six possible cases to distinguish:

1. Suppose $\mathcal{M}_H^1 > \mathcal{M}_L^1 > \mathcal{M}^0$. Then rearranging (2) gives

$$\frac{p_H(\theta)}{p_L(\theta)} \geq \frac{\mathcal{M}_L^1 - \mathcal{M}^0}{\mathcal{M}_H^1 - \mathcal{M}^0}. \tag{14}$$

As the LHS is increasing in θ, whereas the RHS is a constant in $(0, 1)$, it follows that any candidate interior equilibrium of the game is such that $P^*(\theta) = L$ for all $\theta < \widehat{\theta}$ and $P^*(\theta) = H$ for all $\theta \geq \widehat{\theta}$, for some cutoff type $\widehat{\theta} \in (\underline{\theta}, \overline{\theta})$. As proved in Lemma 2, $\mathcal{M}_H^1 > \mathcal{M}_L^1$ and also $\mathcal{M}_L^1 > \mathcal{M}^0$ for sufficiently large values of $\widehat{\theta}$, so that such equilibria can exist.

2. Suppose $\mathcal{M}_H^1 > \mathcal{M}^0 > \mathcal{M}_L^1$. Then one gets again (14), which however is satisfied for all θ (i.e., all researchers would choose a H-project) as the LHS is positive and the RHS is negative. Hence, there are no interior equilibria with such reputations.

3. Suppose $\mathcal{M}_L^1 > \mathcal{M}_H^1 > \mathcal{M}^0$. Then one gets again (14), which however is violated for all θ (i.e., all researchers would choose a L-project) as the LHS is lower than one, whereas the RHS is larger than one. Hence, there are no interior equilibria with such reputations.

4. Suppose $\mathcal{M}_L^1 > \mathcal{M}^0 > \mathcal{M}_H^1$. Then from (2) it immediately follows that there are no interior equilibria as all types would choose a L-project (the LHS and RHS of (2) being negative and positive, respectively).

5. Suppose $\mathcal{M}^0 > \mathcal{M}_H^1 > \mathcal{M}_L^1$. Then rearranging (2) gives

$$\frac{p_H(\theta)}{p_L(\theta)} \leq \frac{\mathcal{M}^0 - \mathcal{M}_L^1}{\mathcal{M}^0 - \mathcal{M}_H^1}. \tag{15}$$

The RHS being larger than one implies that all types would choose H-projects, thereby there are no interior equilibria with such reputations.

6. Suppose $\mathcal{M}^0 > \mathcal{M}_L^1 > \mathcal{M}_H^1$. Then one gets again (15), which in principle (the LHS and RHS being both positive and lower than one) can lead to an equilibrium characterized by a cutoff type $\widehat{\theta}$ such that $P^*(\theta) = H$ for all $\theta \leq \widehat{\theta}$ and $P^*(\theta) = L$ for all $\theta > \widehat{\theta}$. However, using Bayes rule gives

$$\mathcal{M}_L^1 = \mathbb{E}[\theta|\theta > \widehat{\theta}, s = 1] > \mathbb{E}[\theta|\theta > \widehat{\theta}, s = 0] > \mathbb{E}[\theta|s = 0] = \mathcal{M}^0,$$

where the first inequality follows from success being positively correlated to the researcher's type, and the second inequality is trivial. This of course implies that any such candidate equilibrium cannot exist.

Hence, any interior equilibrium must fall within case 1. □

Proof of Lemma 2. As shown in the text, for all $\widehat{\theta}$: $\mathcal{M}^1_H(\widehat{\theta}) > \widehat{\theta} > \mathcal{M}^1_L(\widehat{\theta})$, and $\mathcal{M}^1_H(\widehat{\theta}) > \mathcal{M}^0_H(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$. Next, in (3),

$$\gamma(\widehat{\theta}) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}}(1 - p_L(\theta))\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}}(1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}}(1 - p_H(\theta))\mathrm{d}F(\theta)}.$$

Hence, for $\widehat{\theta} \to \underline{\theta}$: $\gamma(\cdot) \to 0$, and $\mathcal{M}^0(\cdot) \to \mathcal{M}^0_H(\cdot) > \mathcal{M}^1_L(\cdot)$; for $\widehat{\theta} \to \overline{\theta}$: $\gamma(\cdot) \to 1$ and $\mathcal{M}^0(\cdot) \to \mathcal{M}^L_0(\cdot) < \mathcal{M}^1_L(\cdot)$. This shows that there exists at least one threshold $\widehat{\underline{\theta}}$ such that $\mathcal{M}^1_L(\widehat{\theta}) = \mathcal{M}^0(\widehat{\theta})$. Uniqueness follows from the monotonicity properties of $\mathcal{M}^1_L(\widehat{\theta})$ and $\mathcal{M}^0(\widehat{\theta})$ shown in Lemma 3, hence will be established below. □

Proof of Lemma 3. Differentiating $\mathcal{M}^1_L(\widehat{\theta})$ and $\mathcal{M}^1_H(\widehat{\theta})$ gives, respectively,

$$[\mathcal{M}^1_L(\widehat{\theta})]' = \frac{p_L(\widehat{\theta})f(\widehat{\theta})\left[\widehat{\theta} - \mathcal{M}^1_L(\widehat{\theta})\right]}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)} > 0,$$

and

$$[\mathcal{M}^1_H(\widehat{\theta})]' = \frac{p_H(\widehat{\theta})f(\widehat{\theta})\left[\mathcal{M}^1_H(\widehat{\theta}) - \widehat{\theta}\right]}{\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)} > 0.$$

Similarly, differentiating $\mathcal{M}^0(\widehat{\theta})$ gives

$$[\mathcal{M}^0(\widehat{\theta})]' = \frac{(p_L(\widehat{\theta}) - p_H(\widehat{\theta}))f(\widehat{\theta}))\left[\mathcal{M}^0(\widehat{\theta}) - \widehat{\theta}\right]}{\int_{\underline{\theta}}^{\widehat{\theta}}(1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}}(1 - p_H(\theta))\mathrm{d}F(\theta)} > 0 \iff \widehat{\theta} < \mathcal{M}^0(\widehat{\theta}).$$

The latter inequality is satisfied at $\theta \to \underline{\theta}$ (as $\underline{\theta} < \mathcal{M}^0(\underline{\theta})$) and violated at $\theta \to \overline{\theta}$ (as $\overline{\theta} > \mathcal{M}^0(\overline{\theta})$). This implies that there exists at least one threshold $\widehat{\theta}_0 \in (\underline{\theta}, \overline{\theta})$ such that $\widehat{\theta}_0 = \mathcal{M}^0(\widehat{\theta}_0)$. To show that this threshold is unique, suppose $\widehat{\theta}_0$ is the smallest root of $\widehat{\theta} = \mathcal{M}^0(\widehat{\theta})$ — i.e., for all $\widehat{\theta} < \widehat{\theta}_0$: $\widehat{\theta} < \mathcal{M}^0(\widehat{\theta})$ and $[\mathcal{M}^0(\widehat{\theta})]' > 0$. Then, as $[\mathcal{M}^0(\widehat{\theta}_0)]' = 0$, it follows that at $\widehat{\theta} \to \widehat{\theta}_0^+$: $\widehat{\theta} > \mathcal{M}^0(\widehat{\theta})$, hence $[\mathcal{M}^0(\widehat{\theta})]' < 0$, which implies $\widehat{\theta} > \mathcal{M}^0(\widehat{\theta})$ and $[\mathcal{M}^0(\widehat{\theta})]' < 0$ for all $\widehat{\theta} \in (\widehat{\theta}_0, \overline{\theta})$. This establishes that $\widehat{\theta}_0$ is the unique root of $\widehat{\theta} = \mathcal{M}^0(\widehat{\theta})$, and the global maximum point of $\mathcal{M}^0(\widehat{\theta})$.

Finally, note that, at $\widehat{\theta} = \widehat{\theta}_0$: $\widehat{\theta}_0 > \mathcal{M}^1_L(\widehat{\theta}_0) = \mathcal{M}^0(\widehat{\theta}_0)$, and for all $\widehat{\theta} > \widehat{\theta}_0$, $\mathcal{M}^1_L(\cdot)$ and $\mathcal{M}^0(\cdot)$ are increasing and decreasing, respectively. Recalling that $\mathcal{M}^0(\overline{\theta}) < \mathcal{M}^1_L(\overline{\theta})$, this shows that, as claimed in Lemma 2, there exists a unique threshold $\widehat{\underline{\theta}} > \widehat{\theta}_0$ such that $\mathcal{M}^0(\cdot) < \mathcal{M}^1_L(\cdot)$ if and only if $\widehat{\theta} > \widehat{\underline{\theta}}$. □

Proof of Lemma 4. The RHS of (4) is increasing in $\widehat{\theta}$ if and only if

$$[\mathcal{M}^1_L(\widehat{\theta})]'[\mathcal{M}^1_H(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})] - [\mathcal{M}^1_H(\widehat{\theta})]'[\mathcal{M}^1_L(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})] - [\mathcal{M}^0(\widehat{\theta})]'[\mathcal{M}^1_H(\widehat{\theta}) - \mathcal{M}^1_L(\widehat{\theta})] > 0.$$

As, for all $\widehat{\theta} > \widehat{\underline{\theta}}$: $\mathcal{M}^1_H(\widehat{\theta}) > \mathcal{M}^1_L(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$ and $[\mathcal{M}^0(\cdot)]' < 0$, it follows that $[\mathcal{M}^1_L(\cdot)]' \geq [\mathcal{M}^1_H(\cdot)]'$ is a sufficient condition for the above inequality to hold.

Differentiating twice $\mathcal{M}_L^1(\cdot)$ yields

$$[\mathcal{M}_L^1(\widehat{\theta})]'' = \frac{p_L(\widehat{\theta})f(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)} \left[1 - 2[\mathcal{M}_L^1(\widehat{\theta})]'\right] + \frac{[\mathcal{M}_L^1(\widehat{\theta})]'}{p_L(\widehat{\theta})f(\widehat{\theta})} \frac{\mathrm{d}[p_L(\theta)f(\theta)]}{\mathrm{d}\theta}\bigg|_{\theta=\widehat{\theta}}.$$

Hence, if the product $p_L(\theta)f(\theta)$ is an increasing function, $[\mathcal{M}_L^1(\cdot)]'' > 0$ — i.e., $[\mathcal{M}_L^1(\cdot)]'$ is increasing — at any $\widehat{\theta}$ such that $[\mathcal{M}_L^1(\cdot)]' = \frac{1}{2}$. Using l'Hopital rule, it is easy to find $\lim_{\widehat{\theta}\to\underline{\theta}}[\mathcal{M}_L^1(\widehat{\theta})]' = \frac{1}{2}$, from which it follows that $[\mathcal{M}_L^1(\cdot)]'$ cannot fall below $\frac{1}{2}$ for any $\widehat{\theta}$ — i.e.,

$$\frac{\mathrm{d}[p_L(\theta)f(\theta)]}{\mathrm{d}\theta} > 0 \Longrightarrow \frac{\mathrm{d}\mathcal{M}_L^1(\cdot)}{\mathrm{d}\widehat{\theta}} \geq \frac{1}{2}.$$

Similarly, differentiating twice $\mathcal{M}_H^1(\cdot)$ gives

$$[\mathcal{M}_H^1(\widehat{\theta})]'' = \frac{p_H(\widehat{\theta})f(\widehat{\theta})}{\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)} \left[2[\mathcal{M}_H^1(\widehat{\theta})]' - 1\right] + \frac{[\mathcal{M}_H^1(\widehat{\theta})]'}{p_H(\widehat{\theta})f(\widehat{\theta})} \frac{\mathrm{d}[p_H(\theta)f(\theta)]}{\mathrm{d}\theta}\bigg|_{\theta=\widehat{\theta}}.$$

Hence, if the product $p_H(\theta)f(\theta)$ is an increasing function, $[\mathcal{M}_H^1(\cdot)]'' > 0$ — i.e., $[\mathcal{M}_H^1(\cdot)]' > 0$ is increasing — at any $\widehat{\theta}$ such that $[\mathcal{M}_H^1(\cdot)]' = \frac{1}{2}$. Using l'Hopital rule, it is easy to find $\lim_{\widehat{\theta}\to\overline{\theta}}[\mathcal{M}_H^1(\widehat{\theta})]' = \frac{1}{2}$, from which it follows that $[\mathcal{M}_H^1(\cdot)]'$ cannot rise above $\frac{1}{2}$ for any $\widehat{\theta}$ — i.e.,

$$\frac{\mathrm{d}[p_H(\theta)f(\theta)]}{\mathrm{d}\theta} > 0 \Longrightarrow \frac{\mathrm{d}\mathcal{M}_H^1(\cdot)}{\mathrm{d}\widehat{\theta}} \leq \frac{1}{2}.$$

If $f'(\theta) > 0$, then (by A1-A2) both $p_L(\theta)f(\theta)$ and $p_H(\theta)f(\theta)$ are clearly increasing. If instead $f'(\theta) < 0$, then

$$\frac{\mathrm{d}[p_H(\theta)f(\theta)]}{\mathrm{d}\theta} > \frac{\mathrm{d}[p_L(\theta)f(\theta)]}{\mathrm{d}\theta} \iff (p_H'(\theta) - p_L'(\theta))f(\theta) > (p_L(\theta) - p_H(\theta))f'(\theta),$$

which is always satisfied as the LHS is positive (since A2 clearly implies $p_H'(\theta) > p_L'(\theta)$, and $f(\theta) > 0$) and the RHS is negative (since $f'(\theta) < 0$ and $p_L(\theta) \geq p_H(\theta)$). Taken together, these results establish that $p_L(\theta)f(\theta)$ being an increasing function implies $[\mathcal{M}_L^1(\cdot)]' \geq [\mathcal{M}_H^1(\cdot)]'$. □

Proof of Proposition 1. It holds

$$\frac{\partial}{\partial\widehat{\theta}}[u_H(\theta) - u_L(\theta)] = p_H(\theta)\left[[\mathcal{M}_H^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'\right] - p_L(\theta)\left[[\mathcal{M}_L^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'\right],$$

this expression being positive if and only if

$$\frac{p_H(\theta)}{p_L(\theta)} < \frac{[\mathcal{M}_L^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'}{[\mathcal{M}_H^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'}.$$

Note that

$$\frac{\mathrm{d}}{\mathrm{d}\theta}\left[\frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}\right] > 0 \iff \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})} < \frac{[\mathcal{M}_L^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'}{[\mathcal{M}_H^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'}. \tag{16}$$

Therefore, the RHS of (4) being increasing implies

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})} < \frac{[\mathcal{M}_L^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'}{[\mathcal{M}_H^1(\widehat{\theta})]' - [\mathcal{M}^0(\widehat{\theta})]'},$$

which establishes strategic complementarity. □

Proof of Proposition 2. Differentiating twice the LHS of (4) yields that it is a convex function if and only if

$$2p_L'(\widehat{\theta})\left[p_H'(\widehat{\theta})p_L(\widehat{\theta}) - p_H(\widehat{\theta})p_L'(\widehat{\theta})\right] + p_L(\widehat{\theta})\left[p_H''(\widehat{\theta})p_L(\widehat{\theta}) - p_H(\widehat{\theta})p_L''(\widehat{\theta})\right] > 0.$$

As, by A2, the first summand is positive, it follows that, if the effect of second-order derivatives terms (those in the second summand) does not outweigh that of first-order terms, the LHS of (4) is globally convex over $[\widehat{\underline{\theta}}, \overline{\theta}]$.

Similarly, differentiating twice the RHS of (4) yields that it is a concave function if and only if (the argument $\widehat{\theta}$ is omitted to ease notation)

$$2([\mathcal{M}_H^1]' - [\mathcal{M}^0]')\left[(\mathcal{M}_L^1 - \mathcal{M}^0)([\mathcal{M}_H^1]' - [\mathcal{M}^0]') - (\mathcal{M}_H^1 - \mathcal{M}^0)([\mathcal{M}_L^1]' - [\mathcal{M}^0]')\right] +$$

$$-(\mathcal{M}_H^1 - \mathcal{M}^0)\left[(\mathcal{M}_H^1 - \mathcal{M}^L)[\mathcal{M}^0]'' + (\mathcal{M}_L^1 - \mathcal{M}^0)[\mathcal{M}_H^1]'' - (\mathcal{M}_H^1 - \mathcal{M}^0)[\mathcal{M}_L^1]''\right] < 0,$$

The first line contains first-order terms. From Lemma 3, in the relevant interval — i.e., for all $\widehat{\theta} > \widehat{\underline{\theta}}$ — $[\mathcal{M}_H^1(\cdot)]' > 0 > [\mathcal{M}^0(\cdot)]'$ and the term in square brackets is negative, the RHS being increasing (recall (16)). Hence, provided that the effect of second-order derivatives terms (those in the second line) does not outweigh that of first-order terms, the RHS of (4) is globally concave over $[\widehat{\underline{\theta}}, \overline{\theta}]$.

Two increasing functions, one being globally convex (the LHS of (4)) and the other globally concave (the RHS of (4)), can intersect at most twice.

Next, note that the LHS of (4) is larger than the RHS at $\widehat{\theta} = \widehat{\underline{\theta}}$ and as $\widehat{\theta} \to \overline{\theta}$. Indeed, at $\widehat{\theta} = \widehat{\underline{\theta}}$:

$$\frac{p_H(\widehat{\underline{\theta}})}{p_L(\widehat{\underline{\theta}})} > 0 = \frac{\mathcal{M}_L^1(\widehat{\underline{\theta}}) - \mathcal{M}^0(\widehat{\underline{\theta}})}{\mathcal{M}_H^1(\widehat{\underline{\theta}}) - \mathcal{M}^0(\widehat{\underline{\theta}})},$$

given that $\mathcal{M}_L^1(\widehat{\underline{\theta}}) = \mathcal{M}^0(\widehat{\underline{\theta}})$. At $\widehat{\theta} \to \overline{\theta}$:

$$\frac{p_H(\overline{\theta})}{p_L(\overline{\theta})} = 1 > \lim_{\widehat{\theta} \to \overline{\theta}} \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})},$$

given that $\lim_{\widehat{\theta} \to \overline{\theta}} \mathcal{M}_H^1(\widehat{\theta}) = \overline{\theta} > \mathcal{M}_L^1(\overline{\theta}) > \mathcal{M}^0(\overline{\theta})$.

Hence, provided that an interior equilibrium exists, assuming regularity conditions whereby the LHS (RHS) is globally convex (concave), the game admits two interior equilibria, denoted by $\widehat{\theta}_1$ and $\widehat{\theta}_2$, with $\widehat{\underline{\theta}} < \widehat{\theta}_1 < \widehat{\theta}_2 < \overline{\theta}$.

Moreover, the RHS crosses the LHS from below at $\widehat{\theta} = \widehat{\theta}_1$. Therefore,

$$\lim_{\widehat{\theta} \to (\widehat{\theta}_1)^-} \frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} > \lim_{\widehat{\theta} \to (\widehat{\theta}_1)^-} \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})} \Longrightarrow \lim_{\widehat{\theta} \to (\widehat{\theta}_1)^-} u_H(\widehat{\theta}) > \lim_{\widehat{\theta} \to (\widehat{\theta}_1)^-} u_L(\widehat{\theta}),$$

and

$$\lim_{\widehat{\theta} \to (\widehat{\theta}_1)^+} \frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} < \lim_{\widehat{\theta} \to (\widehat{\theta}_1)^+} \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})} \Longrightarrow \lim_{\widehat{\theta} \to (\widehat{\theta}_1)^+} u_H(\widehat{\theta}) < \lim_{\widehat{\theta} \to (\widehat{\theta}_1)^+} u_L(\widehat{\theta}).$$

Hence, $\widehat{\theta}_1$ is an unstable equilibrium (in a standard, tâtonnement sense). On the contrary, the RHS crosses the LHS from above at $\widehat{\theta} = \widehat{\theta}_2$. Hence, the LHS of (4) is lower (larger) than the RHS at $\widehat{\theta} \to (\widehat{\theta}_2)^-$ ($\widehat{\theta} \to (\widehat{\theta}_2)^+$), and hence

$$\lim_{\widehat{\theta} \to (\widehat{\theta}_2)^-} u_H(\widehat{\theta}) < \lim_{\widehat{\theta} \to (\widehat{\theta}_2)^-} u_L(\widehat{\theta}), \quad \lim_{\widehat{\theta} \to (\widehat{\theta}_2)^+} u_H(\widehat{\theta}) > \lim_{\widehat{\theta} \to (\widehat{\theta}_2)^+} u_L(\widehat{\theta}).$$

This shows that $\widehat{\theta}_2$ is a stable equilibrium. □

Proof of Proposition 3. As seen above, the LHS of (4) is larger than the RHS at $\widehat{\theta} = \underline{\widehat{\theta}}$ and as $\widehat{\theta} \to \overline{\theta}$. This implies that these two functions can only intersect an even number of times. Therefore, provided that an interior equilibrium exists (i.e., that the two functions intersect once), the game admits an even number of equilibria, which can be denoted by pairs $(\widehat{\theta}_{2n-1}, \widehat{\theta}_{2n})$, with $n = 1, 2, \ldots, N$, with $\underline{\widehat{\theta}} < \widehat{\theta}_1$ and $\widehat{\theta}_N < \overline{\theta}$. Finally, the RHS crosses the LHS from below (above) at all $\widehat{\theta} = \widehat{\theta}_{2n-1}$ ($\widehat{\theta} = \widehat{\theta}_{2n}$), which (by the steps in the previous proof) implies that these equilibria are unstable (stable). □

Proof of Proposition 4. To see that a pooling equilibrium in which all researchers choose L-projects does not survive D1, let $\widetilde{\mathcal{M}}_H^1$ denote the off-path reputation of a researcher who completes a H-project. Reputations contingent on successful completion of L-projects and failure are $\mathcal{M}_L^1(\overline{\theta})$ and $\mathcal{M}^0(\overline{\theta})$, respectively. Then, a type θ has incentive to deviate from this L-pooling equilibrium if and only if $\widetilde{\mathcal{M}}_H^1 > \mathcal{M}^0(\overline{\theta})$ and

$$\frac{p_H(\theta)}{p_L(\theta)} > \frac{\mathcal{M}_L^1(\overline{\theta}) - \mathcal{M}^0(\overline{\theta})}{\widetilde{\mathcal{M}}_H^1 - \mathcal{M}^0(\overline{\theta})}.$$

As the LHS is increasing in θ, it follows that, for any $\widetilde{\mathcal{M}}_H^1$, if a type $\widetilde{\theta}$ is indifferent between deviating or not, any higher type $\theta > \widetilde{\theta}$ has strict incentives to deviate. Hence, the D1 criterion implies $\widetilde{\mathcal{M}}_H^1 = \overline{\theta}$. Then, the above inequality is satisfied at $\theta = \overline{\theta}$ (as the LHS equals one whereas the RHS is smaller than one, given that $\overline{\theta} > \mathcal{M}_L^1(\overline{\theta}) > \mathcal{M}^0(\overline{\theta})$), which destroys this candidate equilibrium.

On the contrary, a pooling equilibrium in which all types choose H-projects survives the D1 criterion. To establish this result, let $\widetilde{\mathcal{M}}_L^1$ denote the off-path reputation of a researcher who completes a L-project. Reputations contingent on successful completion of H-projects and failure are $\mathcal{M}_H^1(\underline{\theta})$ and $\mathcal{M}^0(\underline{\theta})$, respectively. Then, a type θ has incentive to deviate from this H-pooling equilibrium if and only if

$$\frac{p_H(\theta)}{p_L(\theta)} < \frac{\widetilde{\mathcal{M}}_L^1 - \mathcal{M}^0(\underline{\theta})}{\mathcal{M}_H^1(\underline{\theta}) - \mathcal{M}^0(\underline{\theta})}.$$

As the LHS is increasing in θ, it follows that, for any $\widetilde{\mathcal{M}}_L^1$, if a type $\widetilde{\theta}$ is indifferent between deviating or not, any lower type $\theta < \widetilde{\theta}$ has strict incentives to deviate. Hence, the D1 criterion implies $\widetilde{\mathcal{M}}_L^1 = \underline{\theta} < \mathcal{M}^0(\underline{\theta})$, thereby the above inequality is never satisfied (as the LHS is weakly positive whereas the RHS is negative).

Finally, I consider a different, fairly natural, off-path beliefs' specification, which rules out the H-pooling equilibrium as well. Suppose that each type is believed to play according to the (candidate) equilibrium strategy — i.e., to choose a H-project — with probability $\rho \in (0,1)$, and to (mistakenly) deviate to a L-project (or to randomly select a project) with complementary probability (for a similar beliefs' specification, see, e.g., Bisceglia, 2023.) Then, for $\rho \to 0$, Bayes rule implies that the market belief $\widetilde{\mathcal{M}}_L^1$ upon observing a L-publication exceeds the reputation contingent on no publication:

$$\widetilde{\mathcal{M}}_L^1 = \mathbb{E}[\theta] + \frac{\mathrm{Cov}[\theta, p_L(\theta)]}{\mathbb{E}[p_L(\theta)]} > \mathbb{E}[\theta] > \mathcal{M}^0(\underline{\theta}) = \frac{\mathbb{E}[\theta(1 - p_H(\theta))]}{\mathbb{E}[1 - p_H(\theta)]}.$$

Therefore, all types $\theta < \theta_d$, with $\theta_d \in (\underline{\theta}, \overline{\theta})$ being the unique solution of

$$\frac{p_H(\theta_d)}{p_L(\theta_d)} = \frac{\widetilde{\mathcal{M}}_L^1 - \mathcal{M}^0(\underline{\theta})}{\mathcal{M}_H^1(\underline{\theta}) - \mathcal{M}^0(\underline{\theta})},$$

have strict incentives to deviate, which implies that under this system of beliefs there are no pooling equilibria.[45] □

Proof of Proposition 5. Given the considered imperfect certification technology, reputations conditional on a publication are[46]

$$\mathcal{M}_L^1(\widehat{\theta}) = \frac{\alpha \int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta) \mathrm{d}F(\theta) + (1-\beta) \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta) \mathrm{d}F(\theta)}{\alpha \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta) \mathrm{d}F(\theta) + (1-\beta) \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta) \mathrm{d}F(\theta)},$$

and

$$\mathcal{M}_H^1(\widehat{\theta}) = \frac{(1-\alpha) \int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta) \mathrm{d}F(\theta) + \beta \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta) \mathrm{d}F(\theta)}{(1-\alpha) \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta) \mathrm{d}F(\theta) + \beta \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta) \mathrm{d}F(\theta)},$$

whereas the reputation conditional on failure $\mathcal{M}^0(\widehat{\theta})$ is as in the baseline model.

Define

$$X(\widehat{\theta}) \triangleq \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta) \mathrm{d}F(\theta) \cdot \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta) \mathrm{d}F(\theta) - \int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta) \mathrm{d}F(\theta) \cdot \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta) \mathrm{d}F(\theta),$$

[45] Indeed it is immediate to see that also the pooling equilibrium in which all researchers choose L-project does not exist, as all types sufficiently close to $\overline{\theta}$ would have incentives to deviate.

[46] By the very same steps of the proof of Lemma 1, it can be shown that, also under the assumptions on the certification technology considered here and in Proposition 6, all interior equilibria are characterized by a cutoff type above (below) which researchers choose H-(L-)projects.

this value being positive since

$$\mathcal{M}_H^1(\widehat{\theta})|_{\alpha=\beta=1} = \frac{\int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)}{\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)} > \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)} = \mathcal{M}_L^1(\widehat{\theta})|_{\alpha=\beta=1}.$$

Then, the derivatives of reputations with respect to α and β are

$$\begin{aligned}
\frac{\partial \mathcal{M}_L^1(\cdot)}{\partial \alpha} &= -\frac{(1-\beta)X(\widehat{\theta})}{\left(\alpha \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + (1-\beta)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)^2} \leq 0, \\
\frac{\partial \mathcal{M}_L^1(\cdot)}{\partial \beta} &= -\frac{\alpha X(\widehat{\theta})}{\left(\alpha \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + (1-\beta)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)^2} < 0 \\
\frac{\partial \mathcal{M}_H^1(\cdot)}{\partial \alpha} &= \frac{\beta X(\widehat{\theta})}{\left((1-\alpha) \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \beta\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)^2} > 0, \\
\frac{\partial \mathcal{M}_H^1(\cdot)}{\partial \beta} &= \frac{(1-\alpha) X(\widehat{\theta})}{\left((1-\alpha) \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \beta\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)^2} \geq 0.
\end{aligned}$$

Recall that, in order for an interior equilibrium to exist, it must be $\mathcal{M}_L^1(\cdot) > \mathcal{M}^0(\cdot)$, which, given these comparative statics results, requires $\widehat{\theta}$ to be larger than a threshold $\underline{\widehat{\theta}}(\alpha,\beta)$, with $\frac{\partial \underline{\widehat{\theta}}(\cdot)}{\partial \alpha} > 0$ and $\frac{\partial \underline{\widehat{\theta}}(\cdot)}{\partial \beta} > 0$. Then, any interior equilibrium cutoff $\widehat{\theta}$ solves

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{\alpha \mathcal{M}_L(\widehat{\theta}) + (1-\alpha)\mathcal{M}_H(\widehat{\theta}) - \mathcal{M}_0(\widehat{\theta})}{\beta \mathcal{M}_H(\widehat{\theta}) + (1-\beta)\mathcal{M}_L(\widehat{\theta}) - \mathcal{M}_0(\widehat{\theta})}.$$

Since in the interior stable equilibria the RHS crosses the LHS from above, any stable equilibrium $\widehat{\theta}$ is increasing in α (β) if the RHS increases with α (β). After simple algebra, it follows that the RHS is increasing in α if and only if

$$\left[\left(\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)\mathcal{M}^0(\cdot) - \left(\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)\right)\right] \cdot$$

$$\cdot(\alpha+\beta-1)\left[(1-\beta+\alpha(2\beta-1))\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + 2(1-\beta)\beta\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right] \cdot X(\widehat{\theta}) > 0.$$

Substituting the expression for $\mathcal{M}^0(\cdot)$, the term in the first line is positive if and only if $\mathcal{M}^0(\cdot) < \mathbb{E}[\theta]$, which is always the case in equilibrium. This is because the reputation game is zero sum — i.e., $\mathcal{M}_L^1(\theta)\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \mathcal{M}_H^1(\theta)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta) + \mathcal{M}^0(\theta)\left[1 - \left(\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)\right] = \mathbb{E}[\theta]$ — and $\mathcal{M}^0(\cdot)$ is the lowest reputation in equilibrium. As also the terms in the second line are all positive for all $\alpha \geq \frac{1}{2}, \beta \geq \frac{1}{2}$, it follows that $\widehat{\theta}(\cdot)$ is increasing in α for all $\beta \in (\frac{1}{2}, 1]$.

Similarly, the RHS is increasing in β if and only if

$$\left[\left(\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)\mathcal{M}^0(\cdot) - \left(\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)\right)\right]\cdot$$

$$\cdot\left[2(1-\alpha)\alpha\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + (1-\alpha-\beta+2\alpha\beta)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right]\cdot X(\widehat{\theta}) > 0,$$

which again holds for all $\alpha \geq \frac{1}{2}$ and $\beta \geq \frac{1}{2}$. Hence, $\widehat{\theta}$ is increasing in β for all $\alpha \in (\frac{1}{2}, 1]$. $\square$

Proof of Proposition 6. First consider the case in which negative results are not published by any journal. Then, as argued in the text, interior equilibria are still pinned down by (4), where $\mathcal{M}_L^1(\cdot)$ and $\mathcal{M}_H^1(\cdot)$ are as in the baseline model, whereas reputation conditional on failure is given by

$$\mathcal{M}^0(\widehat{\theta}) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta(1-\eta p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta(1-\eta p_H(\theta))\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} (1-\eta p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1-\eta p_H(\theta))\mathrm{d}F(\theta)}.$$

Differentiating it with respect to η gives

$$\frac{\partial \mathcal{M}^0(\cdot)}{\partial \eta} = \frac{\mathcal{M}^0(\cdot)\left[\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right] - \left[\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)\right]}{\int_{\underline{\theta}}^{\widehat{\theta}} (1-\eta p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1-\eta p_H(\theta))\mathrm{d}F(\theta)},$$

this value being negative if and only if

$$\mathcal{M}^0(\cdot) < \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)} \iff \mathbb{E}[\theta] < \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)}. \quad (17)$$

To see that this inequality is always satisfied, recall that, in order for an interior equilibrium to exist, $\mathcal{M}_L^1(\cdot) > \mathcal{M}^0(\cdot)$ — i.e.,

$$\mathbb{E}[\theta]\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) < \int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta)\left[1-\eta\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right] + \eta\int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta),$$

and $\mathcal{M}_H^1(\cdot) > \mathcal{M}^0(\cdot)$ — i.e.,

$$\mathbb{E}[\theta]\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta) < \int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)\left[1-\eta\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)\right] + \eta\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta).$$

Summing up these two inequalities and rearranging yields exactly (17): hence, $\frac{\partial \mathcal{M}^0(\widehat{\theta})}{\partial \eta} < 0$. This implies that the RHS of (4) in increasing in η, hence $[\widehat{\theta}^*(\eta)]' > 0$. Since $\widehat{\theta}^*(1) = \widehat{\theta}$, it follows $\widehat{\theta}^*(\eta) < \widehat{\theta}$ for all $\eta < 1$.

Next consider the case in which all negative results are published by second-tier journals. Given the corresponding expected payoffs from L- vs H-projects, the equation that pins down interior equilibria in this case is

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\eta\mathcal{M}_H^1(\widehat{\theta}) + (1-\eta)\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}, \tag{18}$$

where $\mathcal{M}_H^1(\cdot)$ and $\mathcal{M}^0(\cdot)$ are as in the base model, whereas

$$\mathcal{M}_L^1(\widehat{\theta}) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta) + (1-\eta)\int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + (1-\eta)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)}$$

is decreasing in η:

$$\frac{\partial\mathcal{M}_L^1(\widehat{\theta})}{\partial\eta} \propto \left(\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta) + (1-\eta)\int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)\right)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta) +$$

$$-\left(\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) + (1-\eta)\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)\int_{\widehat{\theta}}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta) < 0 \iff \mathcal{M}_H^1(\widehat{\theta}) > \mathcal{M}_L^1(\widehat{\theta}).$$

Then, differentiating the RHS of (18) with respect to η gives

$$\frac{\frac{\partial\mathcal{M}_L^1(\widehat{\theta})}{\partial\eta}\left[\eta\mathcal{M}_H^1(\widehat{\theta}) + (1-\eta)\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})\right] - \left(\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})\right)\left(\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}_L^1(\widehat{\theta})\right)}{\left[\eta\mathcal{M}_H^1(\widehat{\theta}) + (1-\eta)\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})\right]^2} < 0,$$

since $\mathcal{M}_H^1(\widehat{\theta}) > \mathcal{M}_L^1(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$ in equilibrium. Hence, $[\widehat{\theta}^{**}(\eta)]' < 0$. Since $\widehat{\theta}^{**}(1) = \widehat{\theta}$, it follows $\widehat{\theta}^{**}(\eta) > \widehat{\theta}$ for all $\eta < 1$. □

Proof of Lemma 5. In the case of a left-truncation, as the market knows that all researchers' types are $\theta \geq \theta_0$, the conditional PDF given this information becomes

$$f(\theta|\theta \geq \theta_0) = \begin{cases} \frac{f(\theta)}{1-F(\theta_0)} & \text{if } \theta \in [\theta_0, \overline{\theta}] \\ 0 & \text{if } \theta \in [\underline{\theta}, \theta_0) \end{cases}$$

Using this density, reputations write as[47]

$$\mathcal{M}_L^1(\widehat{\theta}|\theta \geq \theta_0) = \frac{\int_{\theta_0}^{\widehat{\theta}} \theta p_L(\theta)\mathrm{d}F(\theta)}{\int_{\theta_0}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)},$$

$$\mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0) = \frac{\int_{\theta_0}^{\widehat{\theta}} \theta(1-p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta(1-p_H(\theta))\mathrm{d}F(\theta)}{\int_{\theta_0}^{\widehat{\theta}} (1-p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1-p_H(\theta))\mathrm{d}F(\theta)},$$

[47] Truncations of the distribution of types are of course immaterial to the results of Lemma 1.

and $\mathcal{M}^1_H(\widehat{\theta}|\theta \geq \theta_0) = \mathcal{M}^1_H(\widehat{\theta})$ is as in the base model, thereby it does not depend on θ_0. Hence,

$$\frac{\partial \mathcal{M}^1_L(\cdot)}{\partial \theta_0} = \frac{p_L(\theta_0)f(\theta_0)(\mathcal{M}^1_L(\cdot) - \theta_0)}{\int_{\theta_0}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)} > 0,$$

and

$$\frac{\partial \mathcal{M}^0(\cdot)}{\partial \theta_0} = \frac{(1 - p_L(\theta_0))f(\theta_0)(\mathcal{M}^0(\cdot) - \theta_0)}{\int_{\theta_0}^{\widehat{\theta}}(1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}}(1 - p_H(\theta))\mathrm{d}F(\theta)} > 0.$$

As the equation which pins down interior equilibria is still (4), to obtain the comparative statics of the stable equilibrium cutoff with respect to θ_0 one must compute

$$\frac{\partial}{\partial \theta_0}\left[\frac{\mathcal{M}^1_L(\cdot) - \mathcal{M}^0(\cdot)}{\mathcal{M}^1_H(\cdot) - \mathcal{M}^0(\cdot)}\right] < 0 \iff \frac{\mathcal{M}^1_L(\cdot) - \mathcal{M}^0(\cdot)}{\mathcal{M}^1_H(\cdot) - \mathcal{M}^0(\cdot)} < 1 - \frac{\frac{\partial \mathcal{M}^1_L(\cdot)}{\partial \theta_0}}{\frac{\partial \mathcal{M}^0(\cdot)}{\partial \theta_0}},$$

which is satisfied as $\theta_0 \to \underline{\theta}$, given that $\frac{\partial \mathcal{M}^1_L(\cdot)}{\partial \theta_0}|_{\theta_0 \to \underline{\theta}} = 0$ and the LHS is lower than one, which implies that the RHS of (4) decreases for all θ_0. As a consequence, given that the monotonicity properties of reputations with respect to $\widehat{\theta}$ are unaffected by θ_0, any stable equilibrium cutoff is decreasing in θ_0.

Next consider the case of a right-truncation. The PDF conditional on $\theta \leq \theta_0$ is given by

$$f(\theta|\theta \leq \theta_0) = \begin{cases} \frac{f(\theta)}{F(\theta_0)} & \text{if } \theta \in [\underline{\theta}, \theta_0] \\ 0 & \text{if } \theta \in (\theta_0, \overline{\theta}] \end{cases}$$

Using this density, reputations write as

$$\mathcal{M}^1_H(\widehat{\theta}|\theta \leq \theta_0) = \frac{\int_{\widehat{\theta}}^{\theta_0} \theta p_H(\theta)\mathrm{d}F(\theta)}{\int_{\widehat{\theta}}^{\theta_0} p_H(\theta)\mathrm{d}F(\theta)},$$

$$\mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta(1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\theta_0} \theta(1 - p_H(\theta))\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}}(1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\theta_0}(1 - p_H(\theta))\mathrm{d}F(\theta)},$$

and $\mathcal{M}^1_L(\widehat{\theta}|\theta \leq \theta_0) = \mathcal{M}^1_L(\widehat{\theta})$ is as in the base model, thereby it does not depend on θ_0. Hence,

$$\frac{\partial \mathcal{M}^1_H(\cdot)}{\partial \theta_0} = \frac{p_H(\theta_0)f(\theta_0)(\theta_0 - \mathcal{M}^1_H(\cdot))}{\int_{\widehat{\theta}}^{\theta_0} p_H(\theta)\mathrm{d}F(\theta)} > 0,$$

and

$$\frac{\partial \mathcal{M}^0(\cdot)}{\partial \theta_0} = \frac{(1 - p_H(\theta_0))f(\theta_0)(\theta_0 - \mathcal{M}^0(\cdot))}{\int_{\underline{\theta}}^{\widehat{\theta}}(1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\theta_0}(1 - p_H(\theta))\mathrm{d}F(\theta)} > 0.$$

As the equation which pins down interior equilibria is still (4), and the monotonicity properties of reputations with respect to $\widehat{\theta}$ are unaffected by θ_0, both $\frac{\partial \mathcal{M}^1_H(\cdot)}{\partial \theta_0} > 0$ and $\frac{\partial \mathcal{M}^0(\cdot)}{\partial \theta_0} > 0$ imply that, as θ_0 decreases, the RHS of (4) (in the relevant range of $\widehat{\theta}$) increases. In turn, this implies that any stable equilibrium cutoff increases as well. $\square$

Proof of Proposition 7. In what follows, I keep assuming regularity conditions whereby the signalling game among types receiving each signal $\sigma(\theta) \in \{0,1\}$ admits either none or two interior equilibria, only the highest one being stable. Moreover, whenever multiple equilibria exist, I select the stable equilibrium which survives D1 and is supported by the largest set of off-path beliefs. Of course, as off-path beliefs are immaterial to the existence of interior equilibria, the stable interior equilibrium is always selected when it exists. Suppose instead that the two coexisting equilibria are the two pooling equilibria. In the game among researchers receiving $\sigma(\theta) = 1$ (i.e., $\theta \in [\theta_0, \overline{\theta}]$), by the steps in Proposition 4, it follows that only the H-pooling equilibrium survives D1.[48] By contrast, in the game among researchers receiving $\sigma(\theta) = 0$ (i.e., $\theta \in [\underline{\theta}, \theta_0]$) also the L-pooling equilibrium can survive D1, and in this case it is selected over the H-pooling equilibrium.[49] Indeed, D1 implies that any observed deviation from a L-pooling equilibrium is attributed to the highest type, that is (given $\sigma(\theta) = 0$) $\theta = \theta_0$. This gives any researcher the strongest possible incentive to deviate from this equilibrium. Therefore, if the L-pooling equilibrium is a D1-equilibrium, then it is a PBE under any specification of off-path beliefs. As $p_H(\theta)/p_L(\theta)$ is increasing in θ, it follows that the type with the strongest incentives to deviate is the highest type $\theta = \theta_0$. Hence, the L-pooling equilibrium is a D1-equilibrium if and only if

$$\frac{p_H(\theta_0)}{p_L(\theta_0)} \leq \frac{\mathcal{M}_L^1(\theta_0|\theta \leq \theta_0) - \mathcal{M}^0(\theta_0|\theta \leq \theta_0)}{\theta_0 - \mathcal{M}^0(\theta_0|\theta \leq \theta_0)} \in (0,1), \tag{19}$$

which is satisfied for θ_0 small enough. As in Proposition 4, the H-pooling equilibrium is always a D1-equilibrium, since any observed deviation is attributed to $\theta = \underline{\theta}$, which gives no type incentives to deviate. Yet, it is not a PBE of the game under different beliefs' specifications — e.g., if deviations are attributed to all types with the same probability, then, as in the base model, the reputation contingent on observing completion of L-projects exceeds $\mathbb{E}[\theta|\theta < \theta_0] > \mathcal{M}^0(\underline{\theta}|\theta < \theta_0)$, thereby low enough types have strict incentives to deviate.

Under this selection criterion, from the results in Lemma 5 it follows that, for any $\theta_0 \in (\underline{\theta}, \overline{\theta})$:

- The signalling game among researchers for whom $\sigma(\theta) = 1$ admits a stable interior equilibrium $\widehat{\theta}(\theta_0|\theta \geq \theta_0)$ in which types $\theta \in [\theta_0, \widehat{\theta}(\theta_0|\theta \geq \theta_0))$ choose L-projects and types $\theta \in [\widehat{\theta}(\theta_0|\theta \geq \theta_0), \overline{\theta}]$ choose H-projects, where the cutoff $\widehat{\theta}(\theta_0|\theta \geq \theta_0) \in (\theta_0, \overline{\theta})$ is decreasing in θ_0, as long as θ_0 is not too large. For larger values of θ_0, there are no interior equilibria, and the unique D1-equilibrium is the H-pooling equilibrium: $\widehat{\theta}(\theta_0|\theta \geq \theta_0) = \theta_0$. Hence, there exists a threshold $\underline{\theta}_0 \in (\underline{\theta}, \overline{\theta})$ such that, among types $\theta \in [\theta_0, \overline{\theta}]$, the (selected) equilibrium is as follows: $\widehat{\theta}(\theta_0|\theta \geq \theta_0) > \theta_0$ and $\widehat{\theta}'(\theta_0|\theta \geq \theta_0) < 0$ for all $\theta_0 < \underline{\theta}_0$; and $\widehat{\theta}(\theta_0|\theta \geq \theta_0) = \theta_0$ — hence, $\widehat{\theta}'(\theta_0|\theta \geq \theta_0) > 0$ — for all $\theta_0 \geq \underline{\theta}_0$.[50]

[48] In the L-pooling equilibrium, D1 implies that any observed deviation (i.e., successful completion of H-projects) is attributed to $\theta = \overline{\theta} > \mathcal{M}_L^1(\overline{\theta}|\theta \geq \theta_0) > \mathcal{M}^0(\overline{\theta}|\theta \geq \theta_0)$. This implies that the highest types have incentives to deviate to H-projects, which destroys the L-pooling equilibrium. By contrast, in the H-pooling equilibrium, D1 implies that any observed deviation (i.e., successful completion of L-projects) is attributed to the lowest type $\theta = \theta_0 < \mathcal{M}^0(\theta_0|\theta \geq \theta_0) < \mathcal{M}_H^1(\theta_0|\theta \geq \theta_0)$, thereby no type has incentives to deviate.

[49] In what follows, to simplify the exposition it is assumed that types $\theta = \theta_0$ receive both signals with the same probability, rather than signal $\sigma(\cdot) = 1$ with probability one. As these are a zero-measure set of types, this is immaterial to the results.

[50] This is because, as θ_0 grows larger, all types $\theta \geq \theta_0$ are high-ability types, so strictly prefer H-projects (this can be

- The signalling game among researchers for whom $\sigma(\theta) = 0$ admits a stable interior equilibrium where types $\theta \in [\underline{\theta}, \widehat{\theta}(\theta_0|\theta \leq \theta_0))$ choose L-projects and types $\theta \in [\widehat{\theta}(\theta_0|\theta \leq \theta_0), \theta_0]$ choose H-projects, where the cutoff $\widehat{\theta}(\theta_0|\theta \leq \theta_0) \in (\underline{\theta}, \theta_0)$ is decreasing in θ_0, as long as θ_0 is not too small. For lower values of θ_0, there are no interior equilibria, and the D1-equilibrium which is supported by the largest set of off-path beliefs is the pooling equilibrium in which all types choose L-projects: $\widehat{\theta}(\theta_0|\theta \leq \theta_0) = \theta_0$.[51] Hence, there exists a threshold $\overline{\theta}_0 \in (\underline{\theta}, \overline{\theta})$ such that, among types $\theta \in [\underline{\theta}, \theta_0]$, the (selected) equilibrium is as follows: $\widehat{\theta}(\theta_0|\theta \leq \theta_0) < \theta_0$ and $\widehat{\theta}'(\theta_0|\theta \leq \theta_0) < 0$ for all $\theta_0 > \overline{\theta}_0$; and $\widehat{\theta}(\theta_0|\theta \leq \theta_0) = \theta_0$ (hence, $\widehat{\theta}'(\theta_0|\theta \leq \theta_0) > 0$) for all $\theta_0 \leq \overline{\theta}_0$.

I next prove that $\underline{\theta}_0 < \overline{\theta}_0$. Suppose, for the sake of contradiction, that $\underline{\theta}_0 \geq \overline{\theta}_0$. Then, the previous results imply that, for all $\theta_0 \in (\overline{\theta}_0, \underline{\theta}_0)$, both the signalling games for $\sigma \in \{0, 1\}$ admit interior equilibria, and types $\theta \in (\widehat{\theta}(\theta_0|\theta \leq \theta_0), \theta_0)$ choose H-projects whereas higher types $\theta \in (\theta_0, \widehat{\theta}(\theta_0|\theta \geq \theta_0))$ choose L-projects, that is[52]

$$\frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)} \leq \frac{p_H(\theta_0)}{p_L(\theta_0)} \leq \frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)}. \tag{20}$$

However, from the results of Lemma 5,

$$\frac{\partial}{\partial \theta_0}\left[\frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)}\right] < 0 \quad \text{and} \quad \left.\frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)}\right|_{\theta_0 = \underline{\theta}} = \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})},$$

and

$$\frac{\partial}{\partial \theta_0}\left[\frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}\right] < 0 \quad \text{and} \quad \left.\frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}\right|_{\theta_0 = \overline{\theta}} = \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}.$$

Hence,

$$\frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)} < \frac{\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta})} < \frac{\mathcal{M}_L^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}{\mathcal{M}_H^1(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}.$$

This implies that (20) can never hold, and hence it must be $\underline{\theta}_0 < \overline{\theta}_0$.

Taken together, these results imply that, for all $\theta_0 \in (\underline{\theta}, \overline{\theta})$, there exists a unique cutoff type $\widehat{\theta}(\theta_0) \in (\underline{\theta}, \overline{\theta})$ such that, under the above mentioned selection criterion, $P^*(\theta) = L$ for all $\theta < \widehat{\theta}(\theta_0)$ and $P^*(\theta) = H$ for all $\theta \geq \widehat{\theta}(\theta_0)$. Indeed:

- For $\theta_0 \leq \underline{\theta}_0$: the game among $\theta \in [\underline{\theta}, \theta_0]$ features the L-pooling equilibrium ($\widehat{\theta}(\theta_0|\theta \leq \theta_0) = \theta_0$), whereas, among types $\theta \in [\theta_0, \overline{\theta}]$, there is an interior cutoff type $\widehat{\theta}(\theta_0|\theta \geq \theta_0) \in (\theta_0, \overline{\theta})$, with $\widehat{\theta}'(\theta_0|\theta \geq \theta_0) < 0$. Hence, $\widehat{\theta}(\theta_0) = \widehat{\theta}(\theta_0|\theta \geq \theta_0)$.

easily seen taking $\theta_0 \to \overline{\theta}$); moreover, it is shown below that $\widehat{\theta}_2 > \underline{\theta}_0$.

[51] Under the assumed regularity conditions, existence (under D1) of the L-pooling equilibrium (which, as seen above, occurs for θ_0 small enough) rules out existence of an interior stable equilibrium. This is because $\mathcal{M}_H^1(\widehat{\theta}|\theta \leq \theta_0) \to \theta_0$ as $\widehat{\theta} \to \theta_0$, hence (19) implies that the RHS of the equilibrium equation intersects the LHS only once, and from below: the unique interior equilibrium is thus unstable.

[52] In what follows, to ease notation, $\mathcal{M}_L^1(\widehat{\theta}|\theta \leq \theta_0) \triangleq \mathcal{M}_L^1((\widehat{\theta}|\theta \leq \theta_0)|\theta \leq \theta_0)$, and so on.

- For $\theta_0 \in (\underline{\theta}_0, \overline{\theta}_0)$: the game among types $\theta \in [\underline{\theta}, \theta_0]$ features the L-pooling equilibrium ($\widehat{\theta}(\theta_0|\theta \leq \theta_0) = \theta_0$), whereas the game among types $\theta \in [\theta_0, \overline{\theta}]$ features the H-pooling equilibrium ($\widehat{\theta}(\theta_0|\theta \geq \theta_0) = \theta_0$). Hence, the cutoff type is $\widehat{\theta}(\theta_0) = \theta_0$.

- For $\theta_0 \geq \overline{\theta}_0$: among types $\theta \in [\underline{\theta}, \theta_0]$ there is an interior cutoff type $\widehat{\theta}(\theta_0|\theta \leq \theta_0) \in (\underline{\theta}, \theta_0)$, with $\widehat{\theta}'(\theta_0|\theta \leq \theta_0) < 0$, whereas the game among types $\theta \in [\theta_0, \overline{\theta}]$ features the H-pooling equilibrium ($\widehat{\theta}(\theta_0|\theta \geq \theta_0) = \theta_0$). Hence, the cutoff type is $\widehat{\theta}(\theta_0) = \widehat{\theta}(\theta_0|\theta \leq \theta_0)$.

Note that $\widehat{\theta}(\theta_0)$ has a jump discontinuity at $\theta_0 = \underline{\theta}_0$. This is because any interior equilibrium in the game among types $\theta \in [\theta_0, \overline{\theta}]$ must be such that $\mathcal{M}^1_L(\widehat{\theta}|\theta \geq \theta_0) > \mathcal{M}^0(\widehat{\theta}|\theta \geq \theta_0)$, which is not satisfied at $\widehat{\theta} \to \theta_0$. Hence, the equilibrium cutoff cannot converge continuously to θ_0.

Finally, for all $\theta_0 < \overline{\theta}$:

$$\frac{p_H(\widehat{\theta}_2)}{p_L(\widehat{\theta}_2)} = \frac{\mathcal{M}^1_L(\widehat{\theta}_2) - \mathcal{M}^0(\widehat{\theta}_2)}{\mathcal{M}^1_H(\widehat{\theta}_2) - \mathcal{M}^0(\widehat{\theta}_2)} > \frac{\mathcal{M}^1_L(\widehat{\theta}_2|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}_2|\theta \geq \theta_0)}{\mathcal{M}^1_H(\widehat{\theta}_2|\theta \geq \theta_0) - \mathcal{M}^0(\widehat{\theta}_2|\theta \geq \theta_0)},$$

where the equality follows from $\widehat{\theta}_2$ being a solution of (4), and the inequality uses again the results of Lemma 5. This implies that, for $\theta_0 = \widehat{\theta}_2$, all types $\theta \in [\widehat{\theta}_2, \overline{\theta}]$ choose H-projects. Similarly, for all $\theta_0 > \underline{\theta}$,

$$\frac{p_H(\widehat{\theta}_2)}{p_L(\widehat{\theta}_2)} = \frac{\mathcal{M}^1_L(\widehat{\theta}_2) - \mathcal{M}^0(\widehat{\theta}_2)}{\mathcal{M}^1_H(\widehat{\theta}_2) - \mathcal{M}^0(\widehat{\theta}_2)} < \frac{\mathcal{M}^1_L(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)}{\mathcal{M}^1_H(\widehat{\theta}|\theta \leq \theta_0) - \mathcal{M}^0(\widehat{\theta}|\theta \leq \theta_0)},$$

which implies that for $\theta_0 = \widehat{\theta}_2$, all types $\theta \in [\widehat{\theta}_2, \overline{\theta}]$ choose L-projects (i.e., the L-pooling equilibrium is the stable D1-equilibrium supported by the largest set of off-path beliefs among $\theta \in [\underline{\theta}, \widehat{\theta}_2]$). Taken together, these results establish $\widehat{\theta}_2 \in (\underline{\theta}_0, \overline{\theta}_0)$. □

Proof of Lemma 6. Assume that $\psi < \overline{\theta}$, which, by ensuring that (under D1) the highest types have incentive to exert effort, rules out an uninteresting pooling equilibrium in which all researchers shirk. Under this assumption, as in the base model, the pooling equilibrium in which all researchers choose L-projects is not a D1-equilibrium (as the highest type, with $p_H(\overline{\theta}) = 1$, has always incentive to choose a H-project to reveal herself). Moreover, in this model, regardless of the off-path beliefs' specification, there does not exist a pooling equilibrium in which all researchers choose H-projects. This is because $p_H(\underline{\theta}) = 0$ implies that the lowest types have always incentives to save the effort cost, as they obtain the same reputation $\mathcal{M}^0(\underline{\theta})$ for all $e \in \{0, 1\}$.

Next, in order for an equilibrium in which a positive-measure set of researchers choose both projects' types to exist, it must be $\mathcal{M}^1_H > \mathcal{M}^1_L > \mathcal{M}^0$. This is because, if $\mathcal{M}^0 > \mathcal{M}^1_P$ for one or both $P \in \{L, H\}$, then no one would put effort and choose a P-project as shirking would yield a larger payoff; and, given this, if $\mathcal{M}^1_L$ were larger than $\mathcal{M}^1_H$, then no one would choose a H-project.

Since project choice conditional on $e = 1$ is (for given reputations) as in the baseline model, there is a threshold, denoted by $\widehat{\theta}_H \in (\underline{\theta}, \overline{\theta})$, such that, conditional on exerting effort, all types $\theta < (\geq) \widehat{\theta}_H$ prefer L-(H-)projects. For all $\theta < \widehat{\theta}_H$: $p_L(\theta)[\mathcal{M}^1_L - \mathcal{M}^0] > p_H(\theta)[\mathcal{M}^1_H - \mathcal{M}^0]$. Among these types, those for whom $p_L(\theta)[\mathcal{M}^1_L - \mathcal{M}^0] \geq \psi$ prefer to actually exert effort and choose a L-project, and the others prefer to shirk. As the LHS of this inequality is equal to zero at $\theta = \underline{\theta}$ and increasing in θ, for all $\psi > 0$, there is a threshold $\widehat{\theta}_L$ such that all types $\theta < \widehat{\theta}_L$ prefer to shirk. Of course, $\widehat{\theta}_L < \widehat{\theta}_H$ in an interior equilibrium (so that a positive-measure set of types chooses L-projects). By contrast, for all types $\theta \geq \widehat{\theta}_H$: $p_H(\theta)[\mathcal{M}_H^1 - \mathcal{M}^0] \geq p_L(\theta)[\mathcal{M}_L^1 - \mathcal{M}^0] > \psi$, where the first inequality follows by the definition of $\widehat{\theta}_H$ and the second since all $\theta > \widehat{\theta}_L$ prefer L-projects to shirking, and $\widehat{\theta}_H > \widehat{\theta}_L$. Hence, all types $\theta > \widehat{\theta}_H$ actually choose to exert effort and undertake H-projects in equilibrium.

Any interior equilibrium is thus characterized by two cutoffs $(\widehat{\theta}_L, \widehat{\theta}_H)$, with $\underline{\theta} < \widehat{\theta}_L < \widehat{\theta}_H < \overline{\theta}$, such that $e^*(\theta) = 0$ for all $\theta \in [\underline{\theta}, \widehat{\theta}_L)$; $e^*(\theta) = 1$ and $P^*(\theta) = L$ for all $\theta \in [\widehat{\theta}_L, \widehat{\theta}_H)$; $e^*(\theta) = 1$ and $P^*(\theta) = H$ for all $\theta \in [\widehat{\theta}_H, \overline{\theta}]$.

Given this structure of interior equilibria, Bayes rule yields reputations

$$\mathcal{M}_L^1(\widehat{\theta}_L, \widehat{\theta}_H) = \frac{\int_{\widehat{\theta}_L}^{\widehat{\theta}_H} \theta p_L(\theta)\mathrm{d}F(\theta)}{\int_{\widehat{\theta}_L}^{\widehat{\theta}_H} p_L(\theta)\mathrm{d}F(\theta)},$$

$$\mathcal{M}_H^1(\widehat{\theta}_H) = \frac{\int_{\widehat{\theta}_H}^{\overline{\theta}} \theta p_H(\theta)\mathrm{d}F(\theta)}{\int_{\widehat{\theta}_H}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)},$$

and

$$\mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}_L} \theta \mathrm{d}F(\theta) + \int_{\widehat{\theta}_L}^{\widehat{\theta}_H} \theta(1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}_H}^{\overline{\theta}} \theta(1 - p_H(\theta))\mathrm{d}F(\theta)}{F(\widehat{\theta}_L) + \int_{\widehat{\theta}_L}^{\widehat{\theta}_H} (1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}_H}^{\overline{\theta}} (1 - p_H(\theta))\mathrm{d}F(\theta)}.$$

Note that for $\widehat{\theta}_L = \underline{\theta}$ these all coincide with reputations of the baseline model (with $\widehat{\theta}_H = \widehat{\theta}$).

Differentiating these functions yields

$$\frac{\partial \mathcal{M}_L^1(\cdot)}{\partial \widehat{\theta}_L} = \frac{p_L(\widehat{\theta}_L) f(\widehat{\theta}_L) \left[\mathcal{M}_L^1(\cdot) - \widehat{\theta}_L\right]}{\int_{\widehat{\theta}_L}^{\widehat{\theta}_H} p_L(\theta)\mathrm{d}F(\theta)} > 0,$$

$$\frac{\partial \mathcal{M}_L^1(\cdot)}{\partial \widehat{\theta}_H} = \frac{p_L(\widehat{\theta}_H) f(\widehat{\theta}_H) \left[\widehat{\theta}_H - \mathcal{M}_L^1(\cdot)\right]}{\int_{\widehat{\theta}_L}^{\widehat{\theta}_H} p_L(\theta)\mathrm{d}F(\theta)} > 0,$$

$$\frac{\partial \mathcal{M}_H^1(\cdot)}{\partial \widehat{\theta}_H} = \frac{p_H(\widehat{\theta}_H) f(\widehat{\theta}_H) \left[\mathcal{M}_H^1(\cdot) - \widehat{\theta}_H\right]}{\int_{\widehat{\theta}_H}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)} > 0,$$

$$\frac{\partial \mathcal{M}^0(\cdot)}{\partial \widehat{\theta}_L} = \frac{p_L(\widehat{\theta}_L) f(\widehat{\theta}_L) \left[\widehat{\theta}_L - \mathcal{M}^0(\cdot)\right]}{F(\widehat{\theta}_L) + \int_{\widehat{\theta}_L}^{\widehat{\theta}_H} (1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}_H}^{\overline{\theta}} (1 - p_H(\theta))\mathrm{d}F(\theta)} > 0 \iff \widehat{\theta}_L > \mathcal{M}^0(\cdot),$$

which is not satisfied at $\widehat{\theta}_L \to \underline{\theta}$ and satisfied at $\widehat{\theta}_L \to \overline{\theta}$, and

$$\frac{\partial \mathcal{M}^0(\cdot)}{\partial \widehat{\theta}_H} = \frac{(p_L(\widehat{\theta}_H) - p_H(\widehat{\theta}_H)) f(\widehat{\theta}_L) \left[\mathcal{M}^0(\cdot) - \widehat{\theta}_H\right]}{F(\widehat{\theta}_L) + \int_{\widehat{\theta}_L}^{\widehat{\theta}_H} (1 - p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}_H}^{\overline{\theta}} (1 - p_H(\theta))\mathrm{d}F(\theta)} > 0 \iff \widehat{\theta}_H < \mathcal{M}^0(\cdot),$$

which is satisfied at $\widehat{\theta}_H \to \underline{\theta}$ and not satisfied at $\widehat{\theta}_H \to \overline{\theta}$. By the same arguments given for the analogous results in the base model, one can conclude that $\mathcal{M}^0(\cdot)$ is U-shaped in $\widehat{\theta}_L$ and inverted U-shaped in $\widehat{\theta}_H$.

It can be immediately checked that $\mathcal{M}^0(\underline{\theta}, \widehat{\theta}_H) > \mathcal{M}^0(\widehat{\theta}_H, \widehat{\theta}_H)$. Hence (since $\mathcal{M}^0(\cdot)$ is U-shaped in $\widehat{\theta}_L$): $\mathcal{M}^0(\underline{\theta}, \widehat{\theta}_H) > \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)$ for all $\widehat{\theta}_L \in [\underline{\theta}, \widehat{\theta}_H]$. Moreover, $\mathcal{M}^1_L(\cdot)$ being increasing in $\widehat{\theta}_L$ implies $\mathcal{M}^1_L(\underline{\theta}, \widehat{\theta}_H) < \mathcal{M}^1_L(\widehat{\theta}_L, \widehat{\theta}_H)$ for all $\widehat{\theta}_L \in [\underline{\theta}, \widehat{\theta}_H]$. As a consequence, a sufficient condition for $\mathcal{M}^1_L(\cdot) > \mathcal{M}^0(\cdot)$ to hold is $\widehat{\theta}_H > \widehat{\underline{\theta}}$, with $\widehat{\underline{\theta}}$ defined in Lemma 2. Hence, for all $\widehat{\theta}_H > \widehat{\underline{\theta}}$, $\mathcal{M}^1_H(\cdot) > (\widehat{\theta}_H >)\mathcal{M}^1_L(\cdot) > \mathcal{M}^0(\cdot)$, which implies that the considered interior equilibria can exist. □

Proof of Proposition 8. From the analysis carried out in the text it follows that the two equilibrium cutoffs $(\widehat{\theta}_L, \widehat{\theta}_H)$ solve

$$\begin{cases} p_L(\widehat{\theta}_L) = \dfrac{\psi}{\mathcal{M}^1_L(\widehat{\theta}_L, \widehat{\theta}_H) - \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)} \\ \\ \dfrac{p_H(\widehat{\theta}_H)}{p_L(\widehat{\theta}_H)} = \dfrac{\mathcal{M}^1_L(\widehat{\theta}_L, \widehat{\theta}_H) - \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)}{\mathcal{M}^1_H(\widehat{\theta}_H) - \mathcal{M}^0(\widehat{\theta}_L, \widehat{\theta}_H)} \end{cases}$$

The RHS of the first equation being increasing in ψ immediately implies that, in any interior stable equilibrium, $\widehat{\theta}_L$ is increasing in ψ. Substituting the first into the second equation then yields

$$\frac{p_H(\widehat{\theta}_H)}{p_L(\widehat{\theta}_H)} = \frac{\psi}{\psi + p_L(\widehat{\theta}_L)\left[\mathcal{M}^1_H(\widehat{\theta}_H) - \mathcal{M}^1_L(\widehat{\theta}_L, \widehat{\theta}_H)\right]}.$$

The RHS being increasing in ψ then implies that, in any interior stable equilibrium, also $\widehat{\theta}_H$ is increasing in ψ. □

Proof of Proposition 9. As each researcher, conditional on not choosing a H-project, undertakes two L-projects, the reputation contingent on one successful L-project completion (and one failure) is given by

$$\mathcal{M}^{1,0}_L(\widehat{\theta}) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta p_L(\theta)(1 - p_L(\theta))\mathrm{d}\theta}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)(1 - p_L(\theta))\mathrm{d}F(\theta)},$$

whereas the reputation contingent on successful completion of both L-projects is

$$\mathcal{M}^{1,1}_L(\widehat{\theta}) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta p^2_L(\theta) f(\theta)\mathrm{d}\theta}{\int_{\underline{\theta}}^{\widehat{\theta}} p^2_L(\theta)\mathrm{d}F(\theta)},$$

where $\mathcal{M}^{1,1}_L(\widehat{\theta}) > \mathcal{M}^1_L(\widehat{\theta}) > \mathcal{M}^{1,0}_L(\widehat{\theta})$ for all $\widehat{\theta} \in (\underline{\theta}, \overline{\theta})$. To establish the first inequality, note that

$$[\mathcal{M}^{1,1}_L(\widehat{\theta})]' = \frac{p^2_L(\widehat{\theta}) f(\widehat{\theta})\left[\widehat{\theta} - \mathcal{M}^{1,1}_L(\widehat{\theta})\right]}{\int_{\underline{\theta}}^{\widehat{\theta}} p^2_L(\theta)\mathrm{d}F(\theta)}$$

is larger than $[\mathcal{M}_L^1(\widehat{\theta})]'$ (given in the proof of Lemma 3) whenever $\mathcal{M}_L^{1,1}(\widehat{\theta}) = \mathcal{M}_L^1(\widehat{\theta})$,[53] which is the case at $\widehat{\theta} \to \underline{\theta}$, since $\lim_{\widehat{\theta}\to\underline{\theta}} \mathcal{M}_L^{1,1}(\widehat{\theta}) = \lim_{\widehat{\theta}\to\underline{\theta}} \mathcal{M}_L^1(\widehat{\theta}) = \underline{\theta}$. Hence, whenever $\mathcal{M}_L^{1,1}(\widehat{\theta}) = \mathcal{M}_L^1(\widehat{\theta})$, $\mathcal{M}_L^{1,1}(\widehat{\theta})$ grows faster than $\mathcal{M}_L^1(\widehat{\theta})$, which implies (a.e.) $\mathcal{M}_L^{1,1}(\widehat{\theta}) > \mathcal{M}_L^1(\widehat{\theta})$. By the same token, $\mathcal{M}_L^1(\widehat{\theta}) > \mathcal{M}_L^{1,0}(\widehat{\theta})$ given that

$$[\mathcal{M}_L^{1,0}(\widehat{\theta})]' = \frac{p_L(\widehat{\theta})(1-p_L(\widehat{\theta}))f(\widehat{\theta})\left[\widehat{\theta} - \mathcal{M}_L^{1,0}(\widehat{\theta})\right]}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)(1-p_L(\theta))\mathrm{d}F(\theta)}$$

is smaller than $[\mathcal{M}_L^1(\widehat{\theta})]'$ whenever $\mathcal{M}_L^{1,0}(\widehat{\theta}) = \mathcal{M}_L^1(\widehat{\theta})$,[54] and $\lim_{\widehat{\theta}\to\underline{\theta}} \mathcal{M}_L^{1,0}(\widehat{\theta}) = \lim_{\widehat{\theta}\to\underline{\theta}} \mathcal{M}_L^1(\widehat{\theta}) = \underline{\theta}$.

Of course, $\mathcal{M}_H^1(\widehat{\theta})$ is as in the baseline model. Reputation contingent on no publication, given that this outcome obtains from failing either two L-projects or one H-project, is given by

$$\mathcal{M}^{0,0}(\widehat{\theta}) = \frac{\int_{\underline{\theta}}^{\widehat{\theta}} \theta(1-p_L(\theta))^2\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} \theta(1-p_H(\theta))\mathrm{d}F(\theta)}{\int_{\underline{\theta}}^{\widehat{\theta}} (1-p_L(\theta))^2\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1-p_H(\theta))\mathrm{d}F(\theta)},$$

with $\mathcal{M}^{0,0}(\widehat{\theta}) < \mathcal{M}^0(\widehat{\theta})$. To establish this inequality, note that $\mathcal{M}^{0,0}(\underline{\theta}) = \mathcal{M}^0(\underline{\theta})$, and

$$[\mathcal{M}^{0,0}(\widehat{\theta})]' = -\frac{(p_L(\widehat{\theta}) - p_H(\widehat{\theta}) + p_L(\widehat{\theta})(1-p_L(\widehat{\theta})))f(\widehat{\theta})\left[\widehat{\theta} - \mathcal{M}^{0,0}(\widehat{\theta})\right]}{\int_{\underline{\theta}}^{\widehat{\theta}} (1-p_L(\theta))^2\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1-p_H(\theta))\mathrm{d}F(\theta)} < [\mathcal{M}^0(\widehat{\theta})]',$$

whenever both reputations are equal and decreasing,[55] which must be the case at equilibrium.

Comparing $u_L(\theta)$ with $u_H(\theta)$ yields that a type θ chooses a H-project if and only if

$$\frac{p_H(\theta)}{p_L(\theta)}(\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}^{0,0}(\widehat{\theta})) \geq 2(\mathcal{M}_L^{1,0}(\widehat{\theta}) - \mathcal{M}^{0,0}(\widehat{\theta})) - p_L(\theta)[2\mathcal{M}_L^{1,0}(\widehat{\theta}) - \mathcal{M}_L^{1,1}(\widehat{\theta}) - \mathcal{M}^{0,0}(\widehat{\theta})],$$

where the term in square brackets must be positive in equilibrium as L-projects must be less attractive to higher types given the structure of equilibrium — i.e., $\mathcal{M}_L^{1,0}(\widehat{\theta}) > \frac{\mathcal{M}_L^{1,1}(\widehat{\theta})+\mathcal{M}^{0,0}(\widehat{\theta})}{2}$. Hence, any

[53]Indeed,

$$\frac{p_L^2(\widehat{\theta})f(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L^2(\theta)\mathrm{d}F(\theta)} > \frac{p_L(\widehat{\theta})f(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)} \iff \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\widehat{\theta})p_L(\theta)\mathrm{d}F(\theta) > \int_{\underline{\theta}}^{\widehat{\theta}} p_L^2(\theta)\mathrm{d}F(\theta),$$

which is true as $p_L(\widehat{\theta}) > p_L(\theta)$ for all $\theta < \widehat{\theta}$.

[54]Indeed,

$$\frac{p_L(\widehat{\theta})(1-p_L(\widehat{\theta}))f(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)(1-p_L(\theta))\mathrm{d}F(\theta)} < \frac{p_L(\widehat{\theta})f(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)} \iff \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)(1-p_L(\widehat{\theta}))\mathrm{d}F(\theta) < \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)(1-p_L(\theta))\mathrm{d}F(\theta),$$

which is true as $1-p_L(\widehat{\theta}) < 1-p_L(\theta)$ for all $\theta < \widehat{\theta}$.

[55]Indeed,

$$-\frac{(p_L(\widehat{\theta}) - p_H(\widehat{\theta}) + p_L(\widehat{\theta})(1-p_L(\widehat{\theta})))f(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} (1-p_L(\theta))^2\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1-p_H(\theta))\mathrm{d}F(\theta)} < -\frac{(p_L(\widehat{\theta}) - p_H(\widehat{\theta}))f(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} (1-p_L(\theta))\mathrm{d}F(\theta) + \int_{\widehat{\theta}}^{\overline{\theta}} (1-p_H(\theta))\mathrm{d}F(\theta)},$$

as the numerator (denominator) of the LHS is clearly larger (smaller) than the one in the RHS.

interior equilibrium cutoff $\widehat{\theta}$ solves

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = p_L(\widehat{\theta}) \cdot \frac{\mathcal{M}_L^{1,1}(\widehat{\theta}) - \mathcal{M}^{0,0}(\widehat{\theta})}{\mathcal{M}_H^{1}(\widehat{\theta}) - \mathcal{M}^{0,0}(\widehat{\theta})} + (1 - p_L(\widehat{\theta})) \cdot 2\, \frac{\mathcal{M}_L^{1,0}(\widehat{\theta}) - \mathcal{M}^{0,0}(\widehat{\theta})}{\mathcal{M}_H^{1}(\widehat{\theta}) - \mathcal{M}^{0,0}(\widehat{\theta})}, \tag{21}$$

The RHS of (21) is a convex combination of two terms, both being larger than the RHS of (4). As for the first term, this is the case since: *(i)* it is decreasing in $\mathcal{M}^{0,0}(\cdot)$, and $\mathcal{M}^{0,0}(\cdot) < \mathcal{M}^{0}(\cdot)$; and *(ii)* it is increasing in $\mathcal{M}_L^{1,1}(\cdot)$, and $\mathcal{M}_L^{1,1}(\cdot) > \mathcal{M}_L^{1}(\cdot)$. The second term is decreasing in $\mathcal{M}^{0,0}(\cdot)$ as well. Therefore, a sufficient condition in order for it to be larger than the RHS of (4) is $\mathcal{M}_L^{1,0}(\widehat{\theta}) > \frac{\mathcal{M}_L^{1}(\widehat{\theta}) + \mathcal{M}^{0,0}(\widehat{\theta})}{2}$, which holds true as $\mathcal{M}_L^{1,0}(\widehat{\theta}) > \frac{\mathcal{M}_L^{1,1}(\widehat{\theta}) + \mathcal{M}^{0,0}(\widehat{\theta})}{2}$ and $\mathcal{M}_L^{1,1}(\widehat{\theta}) > \mathcal{M}_L^{1}(\widehat{\theta})$. The RHS of (21) is thus larger than the RHS of (4), which implies that the stable equilibrium cutoff is larger in this version of the model compared to the baseline. □

Proof of Proposition 10. With contingent bonuses, the equilibrium cutoff type is obtained from[56]

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{\pi_L + \delta\left[\mathcal{M}_L^{1}(\widehat{\theta}) - \mathcal{M}^{0}(\widehat{\theta})\right]}{\pi_H + \delta\left[\mathcal{M}_H^{1}(\widehat{\theta}) - \mathcal{M}^{0}(\widehat{\theta})\right]}. \tag{22}$$

By the same steps of the proof of Proposition 4, it is easy to see that $\pi_L \leq \pi_H$ implies that the pooling equilibrium in which all researchers choose L-projects is not a D1-equilibrium. Moreover, if $\pi_L > \delta\left[\mathcal{M}^{0}(\underline{\theta}) - \underline{\theta}\right] > 0$, then also the pooling equilibrium in which all researchers choose H-projects is not a D1-equilibrium.[57] In these cases, under suitable regularity conditions, there is a unique interior equilibrium, which is stable (since the RHS crosses the LHS from above). For lower values of π_L, instead, the results are as in the baseline model: provided an interior equilibrium exists, there are two interior equilibrium cutoffs, only the largest one being stable. In both cases, let $\widehat{\theta}(\pi_L, \pi_H)$ denote the interior stable equilibrium cutoff. The RHS of (22) is clearly increasing in π_L and decreasing in π_H, which immediately implies that the cutoff $\widehat{\theta}(\pi_L, \pi_H)$ is increasing in π_L and decreasing in π_H.

If $\pi_L = \pi_H \equiv \pi$, then $\widehat{\theta}(\pi, \pi)$ solves

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{\pi + \delta\left[\mathcal{M}_L^{1}(\widehat{\theta}) - \mathcal{M}^{0}(\widehat{\theta})\right]}{\pi + \delta\left[\mathcal{M}_H^{1}(\widehat{\theta}) - \mathcal{M}^{0}(\widehat{\theta})\right]}.$$

[56] By the very same steps of the proof of Lemma 1, it can be shown that, also in the presence of publication-based monetary incentives, all interior equilibria are characterized by a cutoff type above (below) which researchers choose H-(L-)projects.

[57] To see this, recall that by D1 any deviation from such equilibrium is attributed to $\theta = \underline{\theta}$ (see the proof of Proposition 4). Hence, a type θ has incentives to deviate from the H-pooling equilibrium if and only if

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} < \frac{\pi_L + \delta\left[\underline{\theta} - \mathcal{M}^{0}(\underline{\theta})\right]}{\pi_H + \delta\left[\mathcal{M}_H^{1}(\underline{\theta}) - \mathcal{M}^{0}(\underline{\theta})\right]}.$$

Since the LHS equals zero at $\theta = \underline{\theta}$, it follows that the lowest types have incentive to deviate whenever the RHS is positive — i.e., if and only if $\pi_L + \delta\left[\underline{\theta} - \mathcal{M}^{0}(\underline{\theta})\right] > 0$. Under this condition, the H-pooling equilibrium is not a D1-equilibrium.

Differentiating the RHS with respect to π gives

$$\frac{\mathrm{d}}{\mathrm{d}\pi}\left[\frac{\pi+\delta\left[\mathcal{M}_L^1(\widehat{\theta})-\mathcal{M}^0(\widehat{\theta})\right]}{\pi+\delta\left[\mathcal{M}_H^1(\widehat{\theta})-\mathcal{M}^0(\widehat{\theta})\right]}\right]=\frac{\delta[\mathcal{M}_H^1(\widehat{\theta})-\mathcal{M}_L^1(\widehat{\theta})]}{\left(\pi+\delta[\mathcal{M}_H^1(\widehat{\theta})-\mathcal{M}^0(\widehat{\theta})]\right)^2}>0,$$

which implies that the stable interior equilibrium cutoff $\widehat{\theta}(\pi,\pi)$ increases with π. $\square$

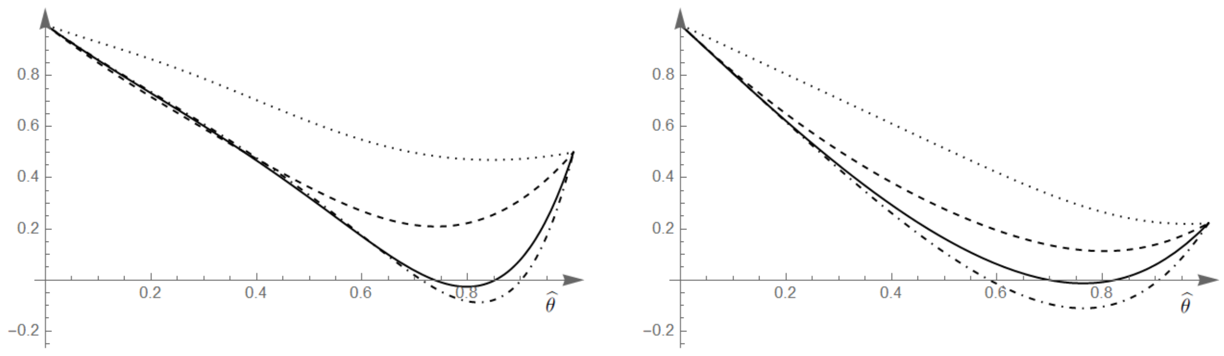
Parametric Example. Consider the following specification of the model: $\theta \in [0,1]$, $F(\theta)=\theta^x$, with $x>0$, $p_L(\theta)=\theta^l$ and $p_H(\theta)=\theta^h$, with $0<l<h$.

Under this specification, reputations are as follows:

$$\begin{aligned}
\mathcal{M}_L^1(\widehat{\theta}) &= \frac{(x+l)\widehat{\theta}}{1+x+l},\\
\mathcal{M}_H^1(\widehat{\theta}) &= \frac{(x+h)(1-\widehat{\theta}^{1+x+h})}{(1+x+h)(1-\widehat{\theta}^{x+h})},\\
\mathcal{M}^0(\widehat{\theta}) &= \frac{x(x+h)(x+l)((1+x+l)(h+(1+x)\widehat{\theta}^{1+x+h})-(1+x)(1+x+h)\widehat{\theta}^{1+x+l})}{(1+x)(1+x+h)(1+x+h)((x+l)(h+x\widehat{\theta}^{x+h})-x(x+h)\widehat{\theta}^{x+l})}.
\end{aligned}$$

It is easy to prove that $\mathcal{M}_L^1(\cdot)$ is increasing in x and l; similarly, $\mathcal{M}_H^1(\cdot)$ is increasing in x and h. Moreover, using numerical simulations it can be seen that $\mathcal{M}^0(\cdot)$ is increasing in x and h, and U-shaped in l.

Next, numerical simulations show that, for any given value of l, the game admits two interior equilibria if h is large enough relative to l, and no interior equilibria otherwise: see Figure 2 for some illustrations in the case with uniform distribution of types ($x=1$).

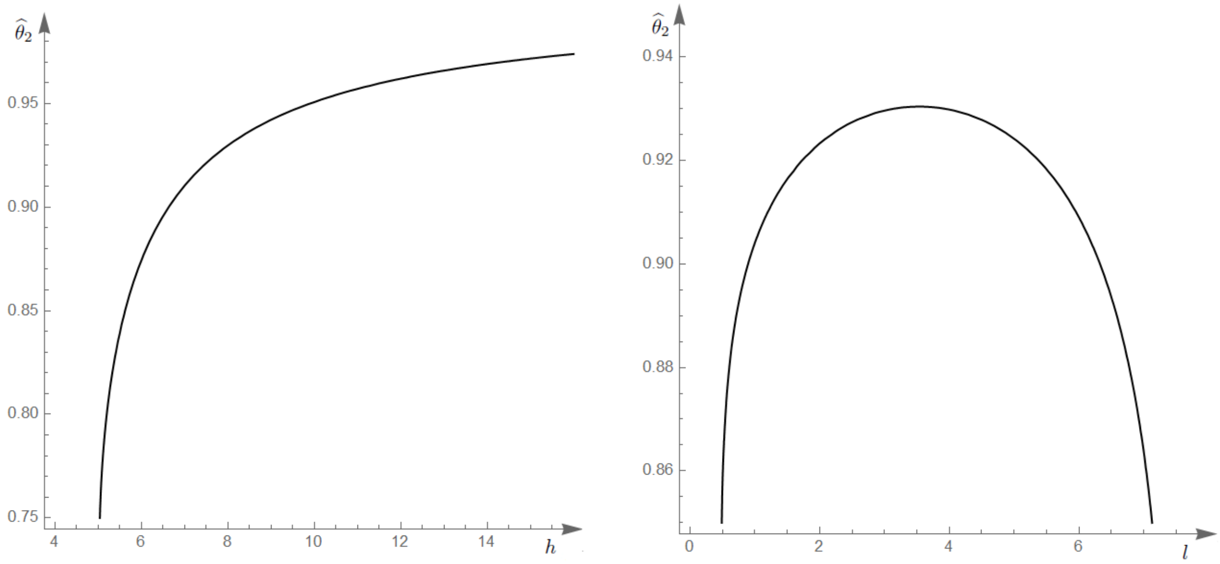


(a) $l=1$. *No interior equilibria exist for $h=2$ (dotted line) and $h=4$ (dashed line), two interior equilibria exist for $h=8$ (solid line) and $h=10$ (dot-dashed line).*

(b) $l=6$. *No interior equilibria exist for $h=7$ (dotted line) and $h=8$ (dashed line), two interior equilibria exist for $h=9$ (solid line) and $h=10$ (dot-dashed line).*

Figure 2: Function $\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})}-\frac{\mathcal{M}_L^1(\widehat{\theta})-\mathcal{M}^0(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta})-\mathcal{M}^0(\widehat{\theta})}$ under the considered model specification for $x=1$. The interior equilibria of the game are the zeros of this function.

Next, Figure 3 shows the comparative statics of the stable equilibrium cutoff $\widehat{\theta}_2$ (when it exists) with respect to h, for given l, and vice versa (for the uniform distribution case). It can be seen that $\widehat{\theta}_2$ is increasing in h and inverted U-shaped in l.



(a) *Stable equilibrium as function of h (for $l = 4$).* (b) *Stable equilibrium as function of l (for $h = 8$).*

Figure 3: Comparative statics of the stable equilibrium cutoff $\widehat{\theta}_2$ (for $x = 1$).

Finally, I perform some comparative statics exercises with respect to the distribution of types. Figure 4 shows that the stable equilibrium cutoff is decreasing in x. Since $\frac{\partial F(\cdot)}{\partial x} < 0$ for all $\theta \in (0,1)$, it follows that, denoting $F_x(\theta) \triangleq \theta^x$,

$$x_2 > x_1 \iff F_{x_2}(\theta) \text{ FOSD } F_{x_1}(\theta).$$

Thus, in this example, a shift in the distribution of types in sense of first-order stochastic dominance (i.e., from $F_{x_1}(\cdot)$ to $F_{x_2}(\cdot)$, with $x_2 > x_1$) implies that more extensive research is carried out in equilibrium. Actually, no interior equilibrium exists when x is too large (in this case, the unique equilibrium of the game is the pooling equilibrium in which all researchers choose H-projects).

Proof of Lemma 7. The proposed matching is clearly feasible. As for stability, I first prove that any stable matching involves three wages, one corresponding to each project outcome $y \in \{s = 0, (s = 1, P = L), (s = 1, P = H)\}$. Consider two researchers with the same project outcome. They generate the same expected match value when matched to any university. Suppose that, in the proposed matching, one of them, say i, is matched to a university type z and receives wage $w_i = w_y(z)$, and the other, say i', is matched to a university of type z' and receives a strictly higher wage $w_{i'} = w_y(z') > w_y(z)$. Then, university z' and researcher i can agree to any wage $w \in (w_y(z), w_y(z'))$ and both be better off (in expected terms) compared to the current matching, which implies that the proposed matching is not stable. Hence, as there are three observable types, any stable matching cannot involve more than three wages. To see that it also cannot involve less, suppose that two researchers, again i and i', with different project outcomes $y_i \neq y_{i'}$, obtain the same wage w. Then, as $\mathcal{M}^1_H(\widehat{\theta}) > \mathcal{M}^1_L(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$, for any z: $\pi_H(z) > \pi_L(z) > \pi_0(z)$. Hence, let without loss of generality $\pi_{y_{i'}}(z) > \pi_{y_i}(z)$. Then, if university z is originally matched to researcher i, it can agree to match with i' instead, offering any wage $w \in (w, w + \pi_{y_{i'}}(z) - \pi_{y_i}(z))$, which would make

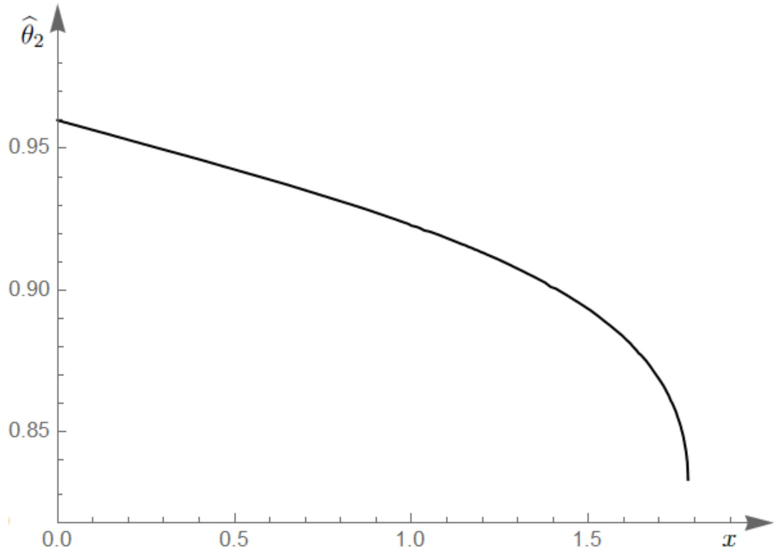


Figure 4: Comparative statics of the stable equilibrium cutoff $\widehat{\theta}_2$ with respect to x (for $l = 4, h = 8$).

both parties better off (in expectation) compared to the proposed matching.

Let (w_0, w_L, w_H) denote wages contingent on project outcome $y \in \{s = 0, (s = 1, P = L), (s = 1, P = H)\}$, respectively. The expected payoff of a university with type z from hiring a researcher with project outcome y is given by $\pi_0(z) - w_0$ if $s = 0$, and $\pi_P(z) - w_P$ if $y = (s = 1, P)$. Hence, a z-type university prefers hiring a researcher with no publication over one with a L-publication if and only if $\pi_L(z) - w_L < \pi_0(z) - w_0 \iff w_L - w_0 > \pi_L(z) - \pi_0(z)$. The LHS of the latter inequality does not depend on z, whereas the RHS is increasing in z, as $\frac{\partial[\pi_L(z) - \pi_0(z)]}{\partial z} = \mathcal{M}^1_L(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta}) > 0$. Hence, there is a cutoff type z_L such that all $z < z_L$ prefer hiring researchers with outcome $s = 0$ and all $z > z_L$ prefer hiring researchers with outcome $(s = 1, P = L)$. Similarly, a z-type university prefers hiring a researcher with a L-publication over one with a H-publication if and only if $\pi_L(z) - w_L > \pi_H(z) - w_H \iff w_H - w_L > \pi_H(z) - \pi_L(z)$. The LHS of the latter inequality does not depend on z, whereas the RHS is increasing in z, as $\frac{\partial[\pi_H(z) - \pi_L(z)]}{\partial z} = \mathcal{M}^1_H(\widehat{\theta}) - \mathcal{M}^1_L(\widehat{\theta}) > 0$. Hence, there is a cutoff type z_H such that all $z < z_H$ prefer hiring researchers with outcome $(s = 1, P = L)$ and all $z > z_H$ prefer hiring researchers with outcome $(s = 1, P = H)$.

By feasibility, as there is a measure $\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta) \mathrm{d}F(\theta)$ of researchers with H-publications and a measure $\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta) \mathrm{d}F(\theta)$ of researchers with L-publications, in equilibrium the cutoffs z_H and z_L must satisfy (8) and (9), and the indifference conditions derived from the above inequalities pin down wages — i.e., $w_L = w_0 + \pi_L(z_L) - \pi_0(z_L)$ and $w_H = w_L + \pi_H(z_H) - \pi_L(z_H)$. Feasibility thus implies that the proposed matching is the unique stable matching. The *base wage* w_0 must be non-negative and lower than the lowest match value $\underline{z}\mathcal{M}^0(\widehat{\theta})$ to accomodate $(s = 0)$-researchers' and $\underline{z}$-universities' participation constraints (it can be immediately checked that these imply all other researchers' and universities' participation constraints in the proposed matching). $\square$

Proof of Proposition 11. Suppose $\mathcal{M}_L^1(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$. Then, the stable matching is given in Lemma 7. Substituting the corresponding wages into (10) immediately yields the equation (11) that any interior equilibrium cutoff must solve. Any solution $\widehat{\theta}$ to (11) is indeed such that $\mathcal{M}_L^1(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$. To see this, note that the RHS of (11) must be positive at any equilibrium (since the LHS is always positive). If its numerator is negative — i.e., if $\widehat{\theta} < \underline{\widehat{\theta}}$, so that $\mathcal{M}_L^1(\widehat{\theta}) < \mathcal{M}^0(\widehat{\theta})$ — it can be positive if and only if also its denominator is negative — i.e.,

$$(\mathcal{M}_L^1(\widehat{\theta}) - \mathcal{M}^0(\widehat{\theta}))z_L(\widehat{\theta}) + (\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}_L^1(\widehat{\theta}))z_H(\widehat{\theta}) < 0 \iff \frac{z_H(\widehat{\theta})}{z_L(\widehat{\theta})} < \frac{\mathcal{M}^0(\widehat{\theta}) - \mathcal{M}_L^1(\widehat{\theta})}{\mathcal{M}_H^1(\widehat{\theta}) - \mathcal{M}_L^1(\widehat{\theta})},$$

which is not possible as the LHS is larger than 1 (because $z_H(\cdot) > z_L(\cdot)$) whereas the RHS is smaller than 1 (because $\mathcal{M}_H^1(\cdot) > \mathcal{M}^0(\cdot)$). As any interior equilibrium satisfies $\widehat{\theta} > \underline{\widehat{\theta}}$, it follows that the matching phase features the stable matching given in Lemma 7.

For $\widehat{\theta} = \underline{\widehat{\theta}}$, $\mathcal{M}_L^1(\widehat{\theta}) = \mathcal{M}^0(\widehat{\theta})$, hence the RHS of (11), being equal to zero, is lower than the LHS. The same is true as $\widehat{\theta} \to \overline{\theta}$ (as the LHS equals 1 whereas the RHS is strictly lower than 1). Hence, if these two functions cross — i.e., provided interior equilibria exist — they must cross an even number of times. Denoting by $\widehat{\theta}_1^{\mathrm{TU}} < \widehat{\theta}_2^{\mathrm{TU}} < \ldots$ the interior equilibria, they can be grouped into pairs $(\widehat{\theta}_{2n-1}^{\mathrm{TU}}, \widehat{\theta}_{2n}^{\mathrm{TU}})$, with $n = 1, 2, \ldots, N$, where $\underline{\widehat{\theta}} < \widehat{\theta}_1^{\mathrm{TU}}$ and $\widehat{\theta}_N^{\mathrm{TU}} < \overline{\theta}$. Note that the RHS crosses the LHS from below (above) at all $\widehat{\theta} = \widehat{\theta}_{2n-1}^{\mathrm{TU}}$ ($\widehat{\theta} = \widehat{\theta}_{2n}^{\mathrm{TU}}$), for $n = 1, 2, \ldots, N$, which (by the steps in the proof of Proposition 2) implies that these equilibria are unstable (stable). Hence, similar to the base model, under suitable regularity conditions whereby both sides of (11) do not change concavity over $(\underline{\widehat{\theta}}, \overline{\theta})$, there are two interior equilibria, only the largest one being stable.

Dividing by $z_L(\cdot)$ both the numerator and the denominator of the RHS of (11), it is straightforward to see that $\mathcal{M}_L^1(\cdot) > \mathcal{M}^0(\cdot)$ implies that this RHS is decreasing in the ratio $z_H(\cdot)/z_L(\cdot)$. As it coincides with the RHS of equation (4), which pins down equilibria in the base model, if $z_H(\cdot)/z_L(\cdot) = 1$, but here $z_H(\cdot)/z_L(\cdot) > 1$, it immediately follows that the RHS of (11) is smaller than the RHS of (4) for all $\widehat{\theta} > \underline{\widehat{\theta}}$. This shows that $\widehat{\theta}_2^{\mathrm{TU}} < \widehat{\theta}_2$.

Note that the game does not admit other interior equilibria. As in the base model, from the specification of u_P, for $P = L, H$, it follows that interior equilibria can exist if either $w_H > w_L > w_0$ or $w_0 > w_L > w_H$. Yet, this last case can never occur. This is because, as shown in the base model, the average type who fails can never be higher than both the average types that complete projects $P \in \{L, H\}$. As they generate lower expected match value, by the arguments in the proof of Lemma 7, the researchers who fail cannot be matched to the top-universities in a stable matching. If instead $w_H > w_L > w_0$, from (10) it follows that there exists a threshold $\widehat{\theta}$ such that types $\theta \geq \widehat{\theta}$ ($\theta < \widehat{\theta}$) choose H-(L-)projects, as it was supposed to start with.

Finally, let me consider pooling equilibria under the D1 criterion. This selection criterion implies that any observed deviation from a candidate L-pooling equilibrium is attributed to the highest type. By deviating and being recognized as such, this type can be matched with the highest university type (as their match generate the highest possible match value, and so can make both of them better off compared to the candidate equilibrium payoff). Hence, D1-beliefs destroy a candidate L-pooling equilibrium. By contrast, the H-pooling equilibrium is always a D1-equilibrium. This is because any observed deviation is attributed to the lowest type, which implies that the deviating researcher can only be matched with the lowest university type (as the university which was supposed to be matched with her would prefer offering a slightly higher wage to attract instead any other researcher). As a consequence, under D1-beliefs, no one has incentive to deviate in the H-pooling equilibrium. If all candidates choose H-projects, then a measure $E[p_H(\theta)]$ of them will have H-publications, hence an expected match value $\mathcal{M}^1_H(\underline{\theta})z$ with an university of type z, and the remaining ones will have no publication, hence a strictly lower expected match value $\mathcal{M}^0(\underline{\theta})z$. The arguments in the proof of Lemma 7 then imply that all stable matching are such that universities $z \in [z_H(\underline{\theta}), \overline{z}]$ hire researchers with a H-publication at a wage $w_H = w_0 + (\mathcal{M}^1_H(\underline{\theta}) - \mathcal{M}^0(\underline{\theta}))z_H(\underline{\theta})$, and all lower university types hire researchers with no publications and pay them the base wage $w_0 \in [0, \underline{z}\mathcal{M}^0(\underline{\theta})]$. □

Proof of Corollary 1. First note that $z_H(\underline{\theta})/z_L(\underline{\theta}) = 1$ for all distributions $G(z)$. Next, differentiating $z_H(\cdot)/z_L(\cdot)$ with respect to $\widehat{\theta}$ gives

$$\frac{\mathrm{d}}{\mathrm{d}\widehat{\theta}}\left[\frac{z_H(\widehat{\theta})}{z_L(\widehat{\theta})}\right] = \frac{f(\widehat{\theta})}{z_L(\widehat{\theta})}\left[\frac{p_H(\widehat{\theta})}{g\left(1-\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)} + \frac{z_H(\widehat{\theta})}{z_L(\widehat{\theta})}\frac{p_L(\widehat{\theta})-p_H(\widehat{\theta})}{g\left(1-\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta)-\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)\right)}\right].$$

Hence, for any two distributions $G_1(z)$ and $G_2(z)$ such that $G_2(\cdot)$ FOSD $G_1(\cdot)$ — as $z_L(\cdot)|_{G_2(\cdot)} > z_L(\cdot)|_{G_1(\cdot)}$ — whenever $\frac{z_H(\widehat{\theta})}{z_L(\widehat{\theta})}\Big|_{G_1(\cdot)} = \frac{z_H(\widehat{\theta})}{z_L(\widehat{\theta})}\Big|_{G_2(\cdot)}$, this ratio grows faster when the distribution of types is $G_1(\cdot)$. Taken together, these results imply

$$\left.\frac{z_H(\widehat{\theta})}{z_L(\widehat{\theta})}\right|_{G_1(\cdot)} \geq \left.\frac{z_H(\widehat{\theta})}{z_L(\widehat{\theta})}\right|_{G_2(\cdot)}.$$

Finally, since the RHS of (11) depends on the distribution of z only through the ratio $z_H(\cdot)/z_L(\cdot)$, and is decreasing in this ratio, it shifts upward as this distribution changes from $G_1(\cdot)$ to $G_2(\cdot)$. As a result, $\widehat{\theta}^{\mathrm{TU}}[G_2] > \widehat{\theta}^{\mathrm{TU}}[G_1]$. □

Proof of Proposition 12. Suppose $\mathcal{M}^1_L(\widehat{\theta}) > \mathcal{M}^0(\widehat{\theta})$. As wages are fixed, all universities prefer hiring researchers with a H-publication over those with a L-publication, who are in turn preferred to those with no publications. Then, the proposed match is clearly (feasible and) stable. To see this, take a researcher i with project outcome $y \in \{s = 0, (s = 1, P = L), (s = 1, P = H)\}$ matched with a university of type z. Then, she would prefer to be matched with any type $z' > z$. Yet, any such university is currently matched to a researcher who is (in expectation) at least as good as i, thereby it prefers the current matching. By this reasoning, feasibility implies that any stable matching must be such that universities $z \in [\underline{z}, z_L(\cdot))$ hire researchers with no publication; $z \in [z_L(\cdot), z_H(\cdot))$ hire researchers with a L-publication; and $z \in [z_H(\cdot), \overline{z}]$ hire researchers with a H-publication.

Moving backwards to the project choice stage, if researchers expect this matching to take place, the utility of a researcher θ from choosing project P ($P = L, H$), is

$$u_P(\theta) \triangleq p_P(\theta)w_P(\widehat{\theta}) + (1 - p_P(\theta))w_0(\widehat{\theta}),$$

with $w_P(\cdot)$ (for $P = L, H$) and $w_0(\cdot)$ given in (12). Their comparative statics is as follows:

$$[w_0(\widehat{\theta})]' = -\frac{[p_L(\widehat{\theta}) - p_H(\widehat{\theta})]f(\widehat{\theta})\left[z_L(\widehat{\theta}) - w_0(\widehat{\theta})\right]}{1 - \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)d\mathrm{F}(\theta) - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)} < 0,$$

$$[w_H(\widehat{\theta})]' = \frac{p_H(\widehat{\theta})f(\widehat{\theta})\left[w_H(\widehat{\theta}) - z_H(\widehat{\theta})\right]}{\int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)} > 0,$$

and

$$[w_L(\widehat{\theta})]' = f(\widehat{\theta})\frac{z_H(\widehat{\theta})p_H(\widehat{\theta}) + z_L(\widehat{\theta})[p_L(\widehat{\theta}) - p_H(\widehat{\theta})] - w_L(\widehat{\theta})p_L(\widehat{\theta})}{\int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)d\mathrm{F}(\theta)} > 0 \iff \frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} > \frac{w_L(\widehat{\theta}) - z_L(\widehat{\theta})}{z_H(\widehat{\theta}) - z_L(\widehat{\theta})} \in (0,1).$$

Hence, a researcher θ favours H-projects if and only if

$$\frac{p_H(\theta)}{p_L(\theta)} \geq \frac{w_L(\widehat{\theta}) - w_0(\widehat{\theta})}{w_H(\widehat{\theta}) - w_0(\widehat{\theta})} \in (0,1).$$

Assumptions A1-A2 then imply that interior equilibria are characterized by a cutoff type $\widehat{\theta}$, obtained from (13), with types $\theta \geq \widehat{\theta}$ ($\theta < \widehat{\theta}$) choosing H-(L-)projects, as it was supposed to start with.

If $z \sim \mathcal{U}[0,1]$, (13) boils down to

$$\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} = \frac{1 - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)}{1 + \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)d\mathrm{F}(\theta)}, \tag{23}$$

where

$$\frac{\partial}{\partial\widehat{\theta}}\left[\frac{1 - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)}{1 + \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)d\mathrm{F}(\theta)}\right] = \frac{f(\widehat{\theta})\left[p_H(\widehat{\theta}) - p_L(\widehat{\theta})\frac{1 - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)}{1 + \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)d\mathrm{F}(\theta)}\right]}{1 + \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)d\mathrm{F}(\theta)} > 0 \iff \frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})} > \frac{1 - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta)}{1 + \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)d\mathrm{F}(\theta)},$$

which is not satisfied as $\widehat{\theta} \to \underline{\theta}$ (indeed, $\frac{p_H(\widehat{\theta})}{p_L(\widehat{\theta})}|_{\widehat{\theta}\to\underline{\theta}} = 0 < 1 - \mathbb{E}[p_H(\theta)]$), whereas it is satisfied at $\widehat{\theta} = \overline{\theta}$ (as $\frac{p_H(\overline{\theta})}{p_L(\overline{\theta})} = 1 > \frac{1}{1+\mathbb{E}[p_L(\theta)]}$). Hence, (23) admits a unique solution $\widehat{\theta} = \widehat{\theta}^{\mathrm{NTU}}$, which coincides with the minimum point of its RHS. Such solution, together with the proposed matching, is an equilibrium if and only if $\widehat{\theta}^{\mathrm{NTU}} > \underline{\widehat{\theta}}$. If this is the case, since the RHS of (23) crosses the LHS from above, it constitutes a stable equilibrium.

Finally, by the same arguments in the previous proof, it follows that there are no other kind of interior equilibria, and that the unique D1-pooling equilibrium features all researchers choosing H-projects, and those succeeding being matched with higher university types than those who fail. □

Proof of Corollary 2. First suppose that

$$z_0 < 1 - \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta) = z_L(\widehat{\theta}). \tag{24}$$

Then

$$w_H(\cdot)\big|_{z_0<z_L(\cdot)} = \frac{1+z_H(\cdot)}{2} \quad \text{and} \quad w_L(\cdot)\big|_{z_0<z_L(\cdot)} = \frac{z_L(\cdot)+z_H(\cdot)}{2}$$

do not depend on z_0, whereas

$$w_0(\cdot)\big|_{z_0<z_L(\cdot)} = \frac{z_L^2(\cdot)-z_0^2}{2z_L(\cdot)}$$

is decreasing in z_0. It then immediately follows that the RHS of (13), being decreasing in $w_0(\cdot)$, is increasing in z_0. Hence, in this case $\frac{\partial\widehat{\theta}^{NTU}}{\partial z_0} > 0$.

Now suppose instead that[58]

$$z_0 \geq 1 - \int_{\underline{\theta}}^{\widehat{\theta}} p_L(\theta)\mathrm{d}F(\theta) - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta) = z_L(\widehat{\theta}). \tag{25}$$

In these cases, $w_H(\cdot)\big|_{z_0\geq z_L(\cdot)} = \frac{1+z_H(\cdot)}{2}$ as before, $w_0(\cdot)\big|_{z_0\geq z_L(\cdot)} = 0$, and

$$w_L(\cdot)\big|_{z_0\geq z_L(\cdot)} = \frac{z_H^2(\cdot)-z_0^2}{2(z_H(\cdot)-z_L(\cdot))}.$$

is decreasing in z_0. Since the RHS of (13) is increasing in $w_L(\cdot)$, it follows that it decreases in z_0. Hence, in this case $\frac{\partial\widehat{\theta}^{NTU}}{\partial z_0} < 0$.

To conclude the proof, note that

$$\left.\frac{w_L(\cdot)-w_0(\cdot)}{w_H(\cdot)-w_0(\cdot)}\right|_{z_0<z_L(\cdot)} < \left.\frac{w_L(\cdot)-w_0(\cdot)}{w_H(\cdot)-w_0(\cdot)}\right|_{z_0\geq z_L(\cdot)} \iff z_0 < z_L(\cdot).$$

This implies that there exists a unique pair $(\hat{z}_0, \widehat{\theta}^{\mathrm{NTU}})$, with $\hat{z}_0 \in (1-\mathbb{E}[p_L(\theta)], 1-\mathbb{E}[p_H(\theta)])$, such that, for $z_0 = \hat{z}_0$:

$$\hat{z}_0 = z_L(\widehat{\theta}^{\mathrm{NTU}}) \text{ and } \frac{p_H(\widehat{\theta}^{\mathrm{NTU}})}{p_L(\widehat{\theta}^{\mathrm{NTU}})} = \left.\frac{w_L(\widehat{\theta}^{\mathrm{NTU}})-w_0(\widehat{\theta}^{\mathrm{NTU}})}{w_H(\widehat{\theta}^{\mathrm{NTU}})-w_0(\widehat{\theta}^{\mathrm{NTU}})}\right|_{z_0<z_L(\widehat{\theta}^{\mathrm{NTU}})} = \left.\frac{w_L(\widehat{\theta}^{\mathrm{NTU}})-w_0(\widehat{\theta}^{\mathrm{NTU}})}{w_H(\widehat{\theta}^{\mathrm{NTU}})-w_0(\widehat{\theta}^{\mathrm{NTU}})}\right|_{z_0\geq z_L(\widehat{\theta}^{\mathrm{NTU}})}.$$

Then, for all $z_0 < \hat{z}_0$, there is a unique equilibrium $\widehat{\theta}^{\mathrm{NTU}}$ and it satisfies (24), hence it is increasing in z_0, and for all $z_0 \geq \hat{z}_0$, there is again a unique equilibrium $\widehat{\theta}^{\mathrm{NTU}}$ and it satisfies instead (25), hence it is decreasing in z_0. Overall, $\widehat{\theta}^{\mathrm{NTU}}$ is thus inverted U-shaped in z_0. □

[58]To make things interesting, hereafter I still suppose

$$z_0 < 1 - \int_{\widehat{\theta}}^{\overline{\theta}} p_H(\theta)\mathrm{d}F(\theta) = z_H(\widehat{\theta}),$$

as otherwise choosing L-projects always gives zero payoff, and hence there are no interior equilibria: $\widehat{\theta}^{\mathrm{NTU}} = \underline{\theta}$.