RELISE

OPEN SCIENCE, REPRODUCIBILITY AND REPLICABILITY IN ENTREPRENEURIAL ECOSYSTEMS: A CONTEMPORARY EXAMPLE[1]

CIÊNCIA ABERTA, REPRODUTIBILIDADE E REPLICABILIDADE EM ECOSSISTEMA EMPREENDEDORES: UM EXEMPLO CONTEMPORÂNEO

Arturo Toscanine Soares Batista[2]
João Paulo Moreira Silva[3]
Rafael Povedano[4]
Eduardo Avancci Dionisio[5]
Edmundo Inácio Júnior[6]

INTRODUCTION

Research on entrepreneurial ecosystems (EEs) has gained significant prominence in recent decades, driven by the advancement and deepening of conceptual and empirical contributions. However, the field still lacks greater clarity regarding the causal relationships between inputs – that is, the fostering variables – and outputs, with high-growth firms (HGFs) being identified as one of the most important and recurring outcomes that EEs should generate, according to a substantial part of this literature.

In this context, debates emerge about the robustness of empirical evidence and the need to replicate studies in different regional settings, especially given the diversity of institutional configurations around the world.

This editorial aims to encourage the academic community to reflect on the relevance of reproduction and replication studies, the importance of open science principles, and the challenges of contributing to the advancement of

[1] DOI: doi.org/10.5281/zenodo.16960541
[2] Universidade Estadual de Alagoas/Universidade Estadual de Campinas. arturo.batista@uneal.edu.br
[3] Centro Universitário Unihorizontes. joao.silva@unihorizontes.br
[4] Fundação Herminio Ometto/Universidade Estadual de Campinas. rafael.fho@gmail.com
[5] Universidade Estadual de Campinas. eavancci@unicamp.br
[6] Universidade Estadual de Campinas. inaciojr@unicamp.br

scientific knowledge. It is a call to the collective responsibility of adding new knowledge to the field by testing, validating (or refuting) previous findings, with the goal of building stronger consensus on what EEs should, ultimately, be expected to produce.

REPLICATION RESEARCH AND OPEN SCIENCE

What do the discovery of pulsars and the relationship between cholera and the water supply have in common? Both were achieved after researchers observed data in innovative ways or, simply, from different perspectives (Munafò et al., 2017). By revisiting previous studies and datasets and adding new interpretations, researchers can extend the boundaries of knowledge in their fields of expertise and, eventually, broaden the understanding of the phenomena under study, influencing public policies and, ultimately, contributing to the overall well-being of society. This central property of scientific knowledge is known as reproducibility and replicability.

In objective terms, the difference between these two concepts lies in the nature of the data used. As clarified by Aguinis et al. (2017, p. 653):

> Reproducibility means that someone other than a published study's authors is able to obtain the same results using the authors' own data, whereas replicability means that someone other than a published study's authors is able to obtain substantially similar results by applying the same steps in a different context and with different data.

In short, scientific reproducibility contributes to greater confidence in study results, allowing for a better delimitation and demonstration of what their findings mean and, equally important, what they do not mean (Open Science Collaboration, 2015).

The importance of both initiatives becomes even more evident in the contemporary scenario, marked by various crises affecting scientific practice, including the so-called reproducibility crisis (Munafò et al., 2017), which also

impacts the fields of Management and Business Administration (Aguinis et al., 2017; Martins, 2020). In the face of this context of uncertainty and questions about the reliability of studies, a growing number of researchers have embraced the principles of Open Science (OS), which include, among other aspects, promoting public access to data and the replication of previously published studies (UNESCO, 2022).

OS can be understood as an “inclusive construct” (UNESCO, 2022) that encompasses both the openness and availability of knowledge and its effective accessibility by society. Thus, scientific knowledge would advance through scientific collaboration and the sharing of research data, particularly through the use of digital repositories (Academia Brasileira de Ciências, 2023).

Nevertheless, despite the benefits derived from OS initiatives – such as greater access, including in terms of download numbers, to studies identified as aligned with these principles (Munafò et al., 2017) – OS practices remain incipient, especially in the field of Business Administration. In general, journals in this area still provide scarce recommendations regarding data openness and availability (Silva & Inácio Júnior, 2024, 2025).

Initiatives such as that of the *Scientific Electronic Library Online Brazil* (SciELO Brasil) have sought to promote OS through the *TOP Guidelines (Transparency and Openness Promotion Guidelines)*. These guidelines are subdivided into eight dimensions: (i) citations; (ii) data transparency; (iii) analytical methods transparency (codes); (iv) research materials transparency; (v) design and analysis transparency; (vi) study preregistration; (vii) analysis plan preregistration; and (viii) replication. Each of these dimensions can be classified into four levels, from 0 to 3, with the latter being the most demanding for editors, reviewers, and authors alike (SciELO, 2018).

With regard specifically to replication, for example, a scientific journal operating at level 0 (zero) does not provide specific guidelines or even

encourage the submission of studies of this nature. At the other end of the spectrum, a journal operating at level 3 not only actively encourages such submissions but also integrates replication tests and the use of open data into the peer review process itself.

It is understood that, through these initiatives, scientific reproducibility – including in the field of Business Administration – contributes to expanding knowledge about complex phenomena, such as EEs.

A CONTEMPORARY EXAMPLE IN RESEARCH ON EES

Preamble (The beginning)

The starting point of this discussion is the seminal study by Friesenbichler & Hölzl (2020), in which the authors investigated the determinants of the incidence and persistence of HGFs in regions of Austria. Although it was not originally designed to directly assess Stam's (2015, 2018) EE model, the article provided a relevant empirical basis and a methodological framework that influenced subsequent studies more closely aligned with this approach.

The authors argued that, in order to understand the dynamics of HGFs, regional-level analyses would provide more insights than firm-level analyses, as they capture interactions between contextual and systemic variables of ecosystems. They further proposed that the persistence of high growth should be understood as its recurrence in consecutive years, which would indicate the presence of more robust EE conditions.

In the study, they tested three main hypotheses. The first (H1) examined whether regional sectoral structures influenced the incidence of HGFs, using variables such as the share of high-tech sectors, industrial participation, and sectoral diversity in fixed-effects models. The second (H2)

analyzed whether barriers to labor force mobility affected the persistence of HGFs, operationalized through the percentage of graduates, occupational mobility, and the age composition of the workforce.

Finally, the third hypothesis (H3) assessed whether structural and institutional conditions would explain the persistence of HGFs across regions, with variables such as business density, specialization, sectoral productivity, and human capital. In seven Ordinary Least Squares (OLS) regression models with regional microdata, the authors investigated whether these variables would explain both the prevalence and continuity of HGFs in different regions of Austria.

For H1, the results showed a positive and statistically significant association between technological intensity, labor mobility, and the HGF rate. H2, however, revealed weaker evidence: factors related to human capital proved relevant but not as decisive as structural variables. H3 indicated that the same structures that favor the incidence of HGFs also contribute to their continuity, especially in contexts with greater diversification and innovative dynamism.

With respect to OS, although the authors mention the existence of supplementary material on the journal's website, this is limited to additional statistical analyses and does not include the data or codes used. Nor is there any mention of availability upon request. This absence hinders the reproducibility of the study, although replication may be partially feasible based on the methodological description provided in the article.

Thesis (The deepening)

The article by Coad and Srhoj (2023) marks the starting point of the debate by questioning a central assumption of the EE model: the positive relationship between EE quality and the prevalence and persistence of HGFs.

In particular, the authors seek to assess whether there is, in fact, empirical support for the causal relationships between the so-called inputs of EEs and the outcomes represented by the regional HGF rate. The empirical context chosen involves two small economies of the European Union, Croatia and Slovenia, analyzed through time series covering the period from 2008 to 2019, based on subnational units equivalent to the NUTS3 level[7].

Two hypotheses guide the investigation. The first (H1) assumes that regions with higher EE quality would, on average, exhibit a higher HGF rate. The second (H2) assumes that, if ecosystem quality is maintained over time, the HGF rate should also remain stable – in other words, persistence in results would reflect persistence in inputs. To test these propositions, the authors use panel data econometric models with fixed effects.

The empirical results directly challenge both hypotheses. In the case of H1, the association between EE quality and the HGF rate proved statistically insignificant in most models, and even negative in some specifications. In the case of H2, no robust evidence was found that HGF persistence over time is associated with the stability of regional EEs. The authors' critique is forceful: they argue that, at least in the way it has been operationalized, Stam's model does not measure what it claims to measure:

> At present, the persistence of inputs is statistically incongruent with a lack of persistence of outputs, which casts doubt on the causal influence of EE inputs on outputs. (Coad & Srhoj, 2023, p. 15)

To illustrate the analytical and prescriptive limitation of the model, the authors coin the metaphor of the "broken clock": "[...] just as a broken clock is correct twice a day[...]" (Coad & Srhoj, 2023, p. 16), suggesting that even if

[7] The analysis was conducted at the NUTS3 level, covering 21 Croatian regions and 12 Slovenian regions, totaling 33 units of analysis. This level of regional disaggregation allows for greater statistical sensitivity in assessing spatial and temporal variations in ecosystem quality and in firm growth patterns.

there are occasional findings consistent with the theory, these would be incidental and unreliable for guiding policy decisions.

The authors also stand out for their commitment to OS. In the *Data availability* section, the data files and the codes used in the econometric analyses conducted in the study can be found online in *Appendix 3. Supplementary Data*. This methodological transparency not only strengthens the robustness of the conclusions presented but also fosters replicability and scrutiny by the scientific community – particularly relevant given the controversial and potentially paradigmatic nature of their findings.

Antithesis

The counterpoint to the criticism formulated by Coad and Srhoj (2023) was articulated by Stam and his team in two stages: a technical report (van Dijk et al., 2024) and then in a scientific article (van Dijk et al., 2025). Both directly respond to the thesis that EEs, as conceived by Stam (2015, 2018), do not consistently explain the persistence of HGFs.

While Friesenbichler and Hölzl (2020) found only a moderate relationship in Austria, Coad and Srhoj (2023) found no statistically significant association in Croatia and Slovenia. Based on these findings, they concluded that the EE model is a "broken clock": although it occasionally produces explanations consistent with the data, this would occur by chance rather than by underlying causality, making it inadequate as a prescriptive tool for public policy. Prompted by this criticism, van Dijk et al. (2025) sought to replicate and expand the study. Their article is divided into two parts. In Part 1, the authors test the hypotheses in a new national context – the Netherlands – characterized by a more developed ecosystem. The results showed a strong, positive association between the quality of EEs and the persistence of HGFs in the

Dutch regions, suggesting that the model would have greater explanatory validity in advanced contexts.

In Part 2, they conducted a joint analysis including the four countries evaluated in previous studies (Austria, Croatia, Slovenia, and the Netherlands). The findings reinforced regional heterogeneity: the association between the quality of EEs and the persistence of HGFs was weak in Croatia and Slovenia, in line with Coad and Srhoj (2023), moderate in Austria, as in Friesenbichler and Hölzl (2020), and strong in the Netherlands. The conclusion, therefore, does not invalidate previous studies, but rather relativizes their generalizations. The lack of consistent effects should not be interpreted as theoretical failure, but rather as a reflection of the contextual sensitivity of the model.

The central contribution of van Dijk et al. (2025) lies in the identification of two structural factors that condition the persistence of HGFs: the size and quality of ecosystems. Size refers to regional population density, which broadens the entrepreneurial base and favors knowledge diffusion. Quality, on the other hand, refers to the institutional allocation of resources and support services. Both factors were positively associated with entrepreneurial outcomes, although with diminishing marginal returns as the ecosystem matures.

Thus, van Dijk et al. reassess the original critique and argue that the EE model should not be discarded, but rather calibrated. Rather than denying its usefulness, they propose that its explanatory capacity depends on the interaction between scale, institutional endowment, and ecosystem maturity. Coad and Srhoj's (2023) critique, while valid in its context, does not justify abandoning the approach, but rather its empirical reformulation. As suggested in the article's title, *the entrepreneurial ecosystem clock keeps on ticking*.

The “Rejoinder”: The debate continues

The debate surrounding the relationship between HGFs and EEs continues with the publication of Coad et al. (2023, 2025), the technical report preceding the final publication in a journal. Although these new works do not explicitly reference the response formulated by van Dijk et al. (2024, 2025), their analytical framework and conclusions function, in practice, as a critical rejoinder, even more direct, as the authors adopt the EE index based on the approach of Stam (2015, 2018), testing it empirically with data from 20 European Union countries, from 2008 to 2020.

The first hypothesis (H1) suggested that more developed regions would have a higher prevalence of HGFs. To this end, the authors used GDP per capita, number of patents per capita, R&D investment per capita, and the Entrepreneurial Ecosystem Index (EE Index), based on Stam's model, as indicators. The second hypothesis (H2) assessed whether there was regional persistence in HGF rates – that is, whether regions that already had a high incidence of HGFs in previous years tended to maintain this characteristic over time. Finally, the third hypothesis (H3) tested whether this persistence would be stronger in more developed regions, assuming that stronger structural and systemic conditions for EEs would favor a continued growth trajectory.

The study's results challenged H1 by showing that the highest incidence of HGFs occurred in regions considered less developed according to the indicators used (such as GDP per capita and patents per capita), in addition to being in geographically peripheral areas, such as the Canary Islands (Spain), Sicily (Italy), and the Algarve (Portugal). This finding contradicts the widely accepted premise in the literature on HGFs, according to which more developed regions would have higher levels of dynamic entrepreneurial activity. In the case of H2, which investigated the regional persistence of HGF rates over time, the

data showed that the proportions of HGFs tend to vary considerably from year to year, not supporting the idea of a consistent and lasting trajectory.

Finally, in H3, the authors tested whether the persistence of HGFs was stronger in more developed regions, under the premise that stronger structural and systemic conditions for HGFs would favor a continuous growth trajectory. However, no robust evidence was found to support this hypothesis. Instead, the results suggest that even less developed regions may exhibit significant levels of HGFs, albeit sporadically and not systematically.

These findings reinforce the questions previously raised by Coad and Srhoj (2023), suggesting that the quality of EE, as measured by its indicators, may not be causally related to expected outcomes. The authors then consider two possibilities: either the HGF rate does not adequately represent EE performance, or the EE model itself, as formulated and operationalized, lacks robust explanatory power. In this sense, the authors advocate a more cautious stance on the part of public policymakers:

> A prudent approach would be for policymakers to avoid investing in applying EE principles, at least until a stronger evidence base emerges regarding how the EE framework can generate the expected EE outputs in European regions. At present, there is insufficient evidence that the EE framework can effectively achieve its stated goals. (Coad et al., 2023, p. 30; Coad et al., 2025, p. 19).

Regarding OS, Coad et al. (2025) adopt a more restrictive stance compared to the previous study by Coad and Srhoj (2023). Although the article includes an extensive set of supplementary materials, organized in appendices A to I, its content is limited to providing conceptual justifications and additional robustness results. However, there is no mention of the availability of microdata or codes, nor is there any indication of on-demand access. This gap limits the transparency of the results and weakens the study's adherence to OS principles, especially in a potentially paradigmatic investigation.

SUMMARY: CONCLUSIONS AND FUTURE SUGGESTIONS

This editorial aims to foster critical reflection on recent studies of ecosystems that address the relationships between their inputs and outcomes. Based on a sequential analysis of three studies, which represent a movement of preamble, thesis, antithesis, and rejoinder, we propose four central reflections to guide the advancement of research on this topic.

The first concerns the largely unquestioned assumption that the rate of high-growth firms (HGFs) is the main expected outcome of ecosystems. This hypothesis that accelerated growth is central to ecosystem success is questionable. As the differences between the studies by Coad and Srhoj (2023) and van Dijk et al. (2025) demonstrate, outcomes can be measured in multiple ways: the proportion of HGFs in total firms, the volume of jobs and sales generated by these firms, or even the density of innovative startups. This plurality points to the need to expand the repertoire of metrics, to better reflect the diversity of dynamics that characterize EEs.

It is essential to broaden the scope of indicators used to assess the results of EEs. The centrality given to HGFs must be complemented by more comprehensive metrics that reflect the diversity of ecosystem objectives and contexts. We suggest focusing more on the forest typology than on a specific tree; we suggest focusing on the fauna of companies (Gazelles, Unicorns, HGFs, Traditional) rather than on just one of them. The diversification of the business community also deserves recognition and systematic investigation as potentially relevant outcomes. This expansion of metrics, aligned with different regional realities and types of enterprises, is essential for EEs to be analyzed and promoted more fairly, effectively, and usefully for public policy.

Secondly, we emphasize that the behavior of HGFs is strongly influenced by macroeconomic variables such as interest rates, exchange rates, inflation, and the level of economic activity (recession or expansion). Therefore,

we propose that future research consider the use of multilevel regression models that allow for the isolation and control of macroeconomic contextual effects on the outcomes attributed to EEs. This type of approach can help to more accurately distinguish the systemic effects inherent to EEs from those arising from the broader economic environment.

The third point concerns OS. Despite the growing appreciation for scientific transparency, none of the three studies analyzed made the data and codes used fully available through public repositories. Even in cases where supplementary appendices are available (e.g. Coad et al., 2025), the published material is limited to additional statistical analyses, without considering the raw database or complete econometric scripts. This limitation compromises the reproducibility of the analyses and the possibility of cumulative advances in the field.

Fourth, we emphasize the importance of methodological rigor in replication studies. The differences between Coad and Srhoj (2023) and van Dijk et al. (2025) illustrate this point well. Although both adopt similar approaches, they differ in the output variables used, the databases (official vs. private, such as Crunchbase), and the geographic level of analysis (NUTS-2 vs. NUTS-3). Such variations not only affect the comparability of findings but also reinforce the need for transparent explanation of any methodological adaptations, as well as their limitations and implications.

We therefore conclude that the field of entrepreneurial entrepreneurship still lacks greater theoretical maturity and empirical consistency. Progress in this direction will require not only the strengthening of open science, but also the pluralization of performance metrics, methodological improvements, and recognition of the multilevel complexity that permeates entrepreneurial phenomena. As the authors of one of the articles analyzed suggest, until a more robust empirical basis is established, it may be prudent to avoid hastily applying

the entrepreneurial ecosystem model as a normative tool. After all, the entrepreneurial ecosystem clock keeps ticking – but its functioning still requires calibration.

REFERENCES

Academia Brasileira de Ciências. (2023). Open Science: overview and general recommendations (C. M. B. Medeiros & A. H. F. Laender, Eds.; 1st ed.). Academia Brasileira de Ciências. https://www.abc.org.br/wp-content/uploads/2023/11/Open-Science-Overview-and-General-Recommendations.pdf

Aguinis, H., Cascio, W. F., & Ramani, R. S. (2017). Science's reproducibility and replicability crisis: International business is not immune. Journal of International Business Studies, 48(6), 653–663. https://doi.org/10.1057/s41267-017-0081-0

Coad, A., Domnick, C., Santoleri, P., & Srhoj, S. (2023). Regional incidence and persistence of high-growth firms: Testing ideias from the Entreprenuerial Ecosystems literature (No. 02/2023; JRC Working Papers Series on Corporate R&D and Innovation). https://publications.jrc.ec.europa.eu/repository/handle/JRC134469

Coad, A., Domnick, C., Santoleri, P., & Srhoj, S. (2025). Regional incidence and persistence of high-growth firms: testing ideas from the entrepreneurial ecosystems literature. Regional Studies, 59(1). https://doi.org/10.1080/00343404.2024.2433498

Coad, A., & Srhoj, S. (2023). Entrepreneurial ecosystems and regional persistence of high growth firms: A 'broken clock' critique. Research Policy, 52(6), 104762. https://doi.org/10.1016/j.respol.2023.104762

Friesenbichler, K., & Hölzl, W. (2020). High-growth firm shares in Austrian regions: the role of economic structures. Regional Studies, 54(11), 1585–1595. https://doi.org/10.1080/00343404.2020.1742316

Martins, H. C. (2020). A importância da Ciência Aberta (Open Science) na pesquisa em Administração. Revista de Administração Contemporânea, 24(1), 1–2. https://doi.org/10.1590/1982-7849rac2020190380

Munafò, M. R., Nosek, B. A., Bishop, D. V. M., Button, K. S., Chambers, C. D., Percie du Sert, N., Simonsohn, U., Wagenmakers, E.-J., Ware, J. J., & Ioannidis, J. P. A. (2017). A manifesto for reproducible science. Nature Human Behaviour, 1(1), 0021. https://doi.org/10.1038/s41562-016-0021

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. Science, 349(6251). https://doi.org/10.1126/science.aac4716

SciELO. (2018). Guia de citação de dados de pesquisa [online]. https://wp.scielo.org/wp-content/uploads/Guia_TOP_pt.pdf

Silva, J. P. M., & Inácio Júnior, E. (2024). Mapeamento da Ciência Aberta em Revistas Brasileiras de Administração: Situação Atual e Perspectivas Futuras. Abec Meeting. https://doi.org/10.21452/abecmeeting2024.240

Silva, J. P. M., & Inácio Júnior, E. (2025). A Ciência Aberta ainda é tema incipiente nos periódicos de Administração. In SciELO em Perspectiva. https://doi.org/10.21452/abecmeeting2024.240

Stam, E. (2015). Entrepreneurial Ecosystems and Regional Policy: A Sympathetic Critique. European Planning Studies, 23(9), 1759–1769. https://doi.org/10.1080/09654313.2015.1061484

Stam, E. (2018). Measuring Entrepreneurial Ecosystems. In A. O'Connor, E. Stam, F. Sussan, & D. B. Audretsch (Eds.), Entrepreneurial Ecosystems. International Studies in Entrepreneurship (1st ed., Vol. 38, pp. 173–197). Springer. https://doi.org/10.1007/978-3-319-63531-6_9

UNESCO. (2022). Recomendação da UNESCO sobre Ciência Aberta. https://doi.org/10.54677/XFFX3334

van Dijk, J., Leendertse, J., Stam, E., & van Rijnsoever, F. (2024). The entrepreneurial ecosystem clock keeps on ticking – Regional persistence of highgrowth firms (24–02; U.S.E. Research Institute Working Paper Series). https://www.uu.nl/sites/default/files/LEG_USE_WP_24-01.pdf

van Dijk, J., Leendertse, J., Stam, E., & van Rijnsoever, F. (2025). The entrepreneurial ecosystem clock keeps on ticking – A replication and extension of Coad and Srhoj (2023). Research Policy, 54(2), 105154. https://doi.org/10.1016/j.respol.2024.105154