Discussion Paper Series

IZA DP No. 19044

October 2026

The Emperor Has No Clothes: A Critique of the Knowledge Spillover "Theory" of Entrepreneurship

Wim Naudé
RWTH Aachen University,
University of Coimbra
and IZA@LISER

The IZA Discussion Paper Series (ISSN: 2365-9793) ("Series") is the primary platform for disseminating research produced within the framework of the IZA@LISER Network, an unincorporated international network of labour economists coordinated by the Luxembourg Institute of Socio-Economic Research (LISER). The Series is operated by LISER, a Luxembourg public establishment (établissement public) registered with the Luxembourg Business Registers under number J57, with its registered office at 11, Porte des Sciences, 4366 Esch-sur-Alzette, Grand Duchy of Luxembourg.

Any opinions expressed in this Series are solely those of the author(s). LISER accepts no responsibility or liability for the content of the contributions published herein. LISER adheres to the European Code of Conduct for Research Integrity. Contributions published in this Series present preliminary work intended to foster academic debate. They may be revised, are not definitive, and should be cited accordingly. Copyright remains with the author(s) unless otherwise indicated.

IZA DP No. 19044 October 2026

The Emperor Has No Clothes: A Critique of the Knowledge Spillover "Theory" of Entrepreneurship

Abstract

The knowledge spillover theory of entrepreneurship (KSTE) claims that new ventures commercialize knowledge that incumbent firms leave unexploited, thereby linking entrepreneurship to economic growth. This paper studies the mathematical basis and empirical tests for the KSTE as provided in Acs et al. (2009). It is shown that the knowledge filter is absent; that entrepreneurial labour is idle; that the aggregation of individual start-up hazards is invalid; that the knowledge-filter interaction required by H2 is not established, while H3's negative entry response is conditional on an inconsistently stated interpretation of the institutional parameter; and that the valuation condition is dimensionally inconsistent. Its empirical design further relies on a pooled correlation between R&D intensity and the knowledge stock that does not establish their within-country relationship, and on inference that does not account adequately for country-level dependence. The subsequent model of Acs and Sanders (2013) does not solve the central problem: by assuming that all ideas spill over, it removes the knowledge filter altogether. It is concluded that the KSTE is a promising narrative, not a theory.

JEL classification

L26, O30, O40, D21, E24

Keywords

entrepreneurship, economic growth, knowledge, start-ups

Corresponding author

Wim Naudé
naude@time.rwth-aachen.de

1 Introduction

The intellectual origins of the knowledge spillover theory of entrepreneurship (KSTE) trace to Audretsch (1995), as acknowledged by Audretsch and Lehmann (2005). Acs et al. (2009) developed a formal and empirical formulation intended to advance the microeconomic foundations of endogenous growth theory. It assumes that incumbent firms and research institutions invest in new knowledge but, because of uncertainty, organizational inertia and asymmetric information, fail to commercialize all of it. The gap between the knowledge created and the knowledge commercialized is the knowledge filter (Acs et al., 2004). Individuals who see commercial value in knowledge that passes through the filter start new firms; thus "*entrepreneurship contributes to economic growth by acting as a conduit through which knowledge created by incumbent firms spills over to agents who endogenously create new firms*" (Acs et al., 2009, p. 17).

This paper critically examines the formulation of the KSTE by Acs et al. (2009), and its subsequent extension by Acs and Sanders (2013).

The influence of the KSTE, within entrepreneurship scholarship, has been substantial. The 2009 article, together with its restatement by Acs et al. (2013), has become a default theoretical frame in entrepreneurship scholarship and has informed initiatives to promote university spin-offs, regional entrepreneurial ecosystems and, more broadly, entrepreneurship policies aimed at economic growth (see e.g. Acs and Sanders, 2013; Audretsch and Keilbach, 2007; Braunerhjelm et al., 2010; Plummer and Acs, 2014; Qian and Acs, 2013; and, for a bibliometric review, Ghio et al., 2015). It is invoked to justify higher R&D spending in the expectation that more start-ups, and hence more growth, will follow, and sits at the center of entrepreneurial scholars' obsession with growth (Naudé, 2024).

Unfortunately, the KSTE suffers from fatal shortcomings so that it neither provides a microeconomic foundation for economic growth theory nor explain why certain people choose

entrepreneurship. In this paper I show this through eight formal propositions and proofs. These illustrate that the formal KSTE model does not contain the actual mechanism – the knowledge filter that it asserts; that several of its equations, including the central valuation condition, are internally inconsistent; that its hypotheses are problematic; and that its empirical test is mismatched to both its dependent and its explanatory variables.

The conclusion from exposing these shortcomings is that the claim by Acs et al. (2013, p. 758) that "*this approach advances the microeconomic foundation of the endogenous growth theory by providing a new framework explaining the unobserved heterogeneity of growth rates between regions and nations*" is not accurate: the 2009 model is not an economics growth model, even the empirical test provided by the authors has self-employment on the left-hand side, not economic growth.

I also show that the subsequent attempt by Acs and Sanders (2013) to place the KSTE in an endogenous growth model does not fix these shortcomings: it actually formalizes the knowledge filter away.

This paper is not the first critical analysis of the KSTE. The existing critiques, surveyed in section 3, take the basic KSTE model as given. To the best of my knowledge, this paper is the first to examine the formal structure of the original model, asking whether the defining mechanism is represented in the equations that the authors provide and whether their derivations hold, and none of the errors reported here seems to have been identified before.

The paper is organized as follows. In section 2 I provide a brief description of the KSTE. In section 3 I summarize the relevant critical literature and outline how this paper contributes to this literature. In Section 4 I critically analyses the formal model of Acs et al. (2009) as well as the empirical test that the authors provided. In section 5 I examines the subsequent growth model of Acs and Sanders (2013) which is based on the KSTE. Section 6 concludes.

2 The KSTE in Brief

The reader is referred to Acs et al. (2009) for the formal statement of the theory; here I summarize only what the critique requires. Notation follows the original as far as possible.

Knowledge, K, is of course central in the KSTE. Following Arrow (1962), only part of K is "economic knowledge", K^c, which holds commercial opportunity, and institutions impose a gap between the two, $0 < K^c/K < 1$ (Acs et al., 2009, p. 17). This gap, together with the failure of incumbents to commercialize all of the knowledge they create, constitutes the knowledge filter. Knowledge that incumbents do not exploit is a source of opportunities that an individual may pursue by leaving the organization and founding a firm. Entrepreneurial opportunities are thus endogenous, created by knowledge investment, rather than awaiting Kirznerian discovery or being monopolized by corporate laboratories as per Schumpeter (1934).

Acs et al. (2009) build on the quality-ladder models of Grossman and Helpman (1991) and Aghion and Howitt (1992). Consumers have logarithmic utility over successive qualities of a good that are perfect substitutes (their Eqs. 1 and 2), and a successful innovator becomes a temporary monopolist who earns the flow profit $\pi = (v-1)Y/v$ (Eq. 4), where $v > 1$ is the quality improvement and Y is total consumption expenditure. Labour is the only factor of production. The total supply, $\overline{L}$, is allocated to incumbent R&D (L_R), entrepreneurship (L_E) and final-goods production (L_F), and free mobility equalizes wages, resulting in their equation (3) (Acs et al., 2009, p. 19), which is here equation (1):

$$L_R + L_E + L_F = \overline{L}. \tag{1}$$

New qualities arrive through two independent Poisson processes. For incumbents the arrival rate is:

$$\mu = \frac{1}{\sigma} L_R^{\gamma}, \quad 0 < \gamma < 1, \tag{2}$$

where σ is an efficiency parameter that captures the institutional and organizational frictions in introducing new products. For start-ups, the individual hazard depends on individual entrepreneurial ability, $\overline{e}_j$, and on the knowledge stock, $\overline{K}$, and the aggregate is set equal to a concave function of $\overline{K}$:

$$\xi \sum_{j=1}^{\overline{L}} \overline{e}_j \overline{K} \equiv \frac{1}{\sigma} \overline{K}^{\gamma}. \tag{3}$$

Acs et al. (2009, pp. 20–21) write $\eta(\cdot)$ both for the individual hazard function and for the resulting start-up arrival rate. I thus use η for the aggregate start-up arrival rate, so that $\eta = \overline{K}^{\gamma}/\sigma$, and write ξ for the constant coefficient of the individual hazard, which I read as implicit in their $\eta(\cdot)$. The total arrival rate of innovations is

$$\kappa = \mu + \eta = \frac{1}{\sigma} \left(\overline{K}^{\gamma} + L_R^{\gamma} \right). \tag{4}$$

When differentiating I follow the authors' Appendix A (see Acs et al., 2009, pp. 28–29) and write K for $\overline{K}$. Equations (8) to (10) in Acs et al. (2009, p. 21) concern the valuation of firms and are critically examined in Section 4.4 below.

From (4) the authors derive comparative statics in their Appendix A ($\kappa_K > 0$, $\kappa_{KK} < 0$, $\kappa_{L_R} > 0$, $\kappa_{L_R L_R} < 0$, $\kappa_\sigma < 0$, $\kappa_{\sigma\sigma} > 0$) and state three hypotheses (p. 22). *H1*: an increase in the stock of knowledge is expected to have a positive effect on entrepreneurship. *H2*: the more efficiently incumbents exploit R&D, the smaller the effect of a given knowledge stock on entrepreneurship. *H3*: entrepreneurial activity decreases under higher regulation, administrative burdens and government intervention in the market.

To test these hypotheses, Acs et al. (2009, p. 22) estimate a fixed-effect panel for 19 OECD countries over 1981–2002:

$$\mathrm{ENT}_{jt} = \lambda_j + \alpha\,\mathrm{KSTOCK}_{jt} + \mathrm{BARR}'_{jt}\beta + \mathrm{INC}'_{jt}\iota + Z'_{jt}\zeta + \epsilon_{jt}. \tag{5}$$

Here j indexes countries and t years; ENT is the share of non-agricultural self-employment; KSTOCK is R&D expenditure relative to GDP, used as a proxy for the knowledge stock; BARR contains public expenditure and tax revenue shares of GDP (barriers); INC contains patents per capita and the output gap (incumbent exploitation); Z contains urbanization, age structure, growth and time effects; λ_j are country effects and ϵ_{jt} is an error term. I write ι and ζ for the coefficient vectors that Acs et al. (2009) denote as γ and $\alpha_4\delta$.

Following the regression of (5) (their equation 11), Acs et al. (2009) reports finding a positive and "strikingly robust" (p. 28) coefficient α and interpret it as support for the KSTE concluding that "*entrepreneurial activity responds positively to economic knowledge, regardless of time and variable specification*" (Acs et al., 2009, p. 28).

In what follows I show where, and why, the theory and its test fail, and ask why almost two decades of entrepreneurship scholarship has failed to recognize this.

3 Relevant Literature

Four strands of literature dealing critically with the KSTE can be distinguished, all strands accepting the formal model of Acs et al. (2009) as a starting point.

The first strand questions the assumption that knowledge becomes opportunity automatically. Qian and Acs (2013) and Qian et al. (2013) argue that general knowledge is not the same as commercially useful knowledge, and that human capital matters through an

entrepreneurial absorptive capacity to recognize and commercialize opportunities. Kirschning and Mrożewski (2022) find that the relationship between regional knowledge and entrepreneurship is positive only where such capacity is high.

The second strand is the growth-theoretic extension by Acs and Sanders (2013). It recognizes that the original lacked dynamic microeconomic foundations and attempts to embed entrepreneurship in a general-equilibrium model in which knowledge creation and commercialization compete for societal resources, so that market allocations need not maximize welfare. It is the only serious attempt to supply the formal content that the original lacks – but with, as will be shown in section 5, critical shortcomings. The more restatement by Acs et al. (2013) of the KSTE consolidates the theory however largely in verbal terms, and reasserts, rather than critically examine or add to the foundational mathematics.

The third strand of literature critical of the KSTE addresses gaps: localized competition (Plummer and Acs, 2014), and intrapreneurship, alliances and firm dynamics (Audretsch et al., 2021, 2026; Fotopoulos, 2022). Malerba and McKelvey (2020) argue that knowledge-intensive innovative entrepreneurship requires a combination of Schumpeterian, evolutionary and innovation-systems perspectives, and Ghio et al. (2015) trace how the theory has diffused.

Audretsch and Lehmann (2025) go furthest in this direction by proposing an explicitly narrative theory. They aim to complement the KSTE by "*introducing the spillover process of stories and narratives to attract people from outside, best described by a matching function of agents involved in all kinds of entrepreneurial activities -the knowledge spillover narrative theory of entrepreneurship (KSNTE)*" (Audretsch and Lehmann, 2025, p. 226). The appendix of Audretsch and Lehmann (2025) adds two bolt-on pieces of mathematics (surprising for a "narrative theory") namely a Cobb–Douglas "narrative matching function" and a Kermack-McKendrick (SIR) epidemic model. However, the matching function alone does not establish their paper's claim that narratives explain "*sustainable agglomeration effects*" (Audretsch and Lehmann, 2025, p. 226). The SIR component and its possible connection to

matching are not assessed here.

The authors claim that the "*narrative increases the matching probability of people in a particular place, thus enhancing agglomeration and can show long-lasting, since path-depending and self-enforcing effects*" (Audretsch and Lehmann, 2025, p. 237). The equation that they patch on in their appendix (p.238) to support this is $mt = nu_t^a v_t^b$ with u the entrepreneurs in the place, v the investors, scientists and other agents, and n, a and b "positive constants" (p. 238) with "a + b ˜ 1", (p. 239).

If $a + b = 1$ exactly, proportional expansion of both inputs leaves matches per entrepreneur unchanged. However, $a + b \approx 1$ does not establish exact constant returns: expansion by a factor c changes match per entrepreneur by c^{a+b-1}. Even under exact constant returns, $m/u = n(v/u)^b$ rises with the relative supply of complementary agents. These scale and composition effects do not, by themselves, explain persistent, self-reinforcing agglomeration. Nor does a constant n exclude dynamics through u_t or v_t; rather, the displayed matching equation supplies no law of motion or feedback mechanism for these inputs. Moreover, this matching function counts "matches," not new ventures, and not probabilities. It has no link from matches to firm creation or growth.

The fourth strand of literature critical of the KSTE is empirical. The predicted effect is found to be weak or insignificant in high-tech sectors (Qian et al., 2013; Tsvetkova and Partridge, 2021), geographically asymmetric and scale-dependent (Barboza, 2024; Barboza and Pede, 2024), absent in knowledge-rich but poorly connected college towns (Qian, 2018) and, in non-metropolitan areas, dependent on "ecosystem architects" who import non-local knowledge (Dutta and Forbes, 2024).

What none of the four strands provides a critical analysis of the mathematical foundations of the theory. To my knowledge, the entry equation has not been examined to see whether it actual contains the distinction between commercialized and uncommercialized knowledge

on which the theory rests. Formal models of entrepreneurial choice (mostly in the economics literature) specify who becomes an entrepreneur and why (Lucas, 1978; Lazear, 2005; Hellmann, 2007; Gries and Naudé, 2010), whereas the KSTE contains no decision problem. The hypotheses that Acs et al. (2009, p. 22) propose are treated as if derived from the model, although I know of no contribution that actually checks whether H2 and H3 follow from the stated equations. The valuation block, borrowed from the creative-destruction literature (e.g. Aghion and Howitt, 1992), has not been re-derived, nor has the empirical design been checked against the stock–flow structure of its variables.

The implication is that the mixed empirical findings cannot be read as boundary conditions of the filter if the base model does not contain it, since a mechanism that is absent cannot be conditioned. Nor can the findings of the empirical estimation be seen as confirmation of the "theory."

A contribution of this paper is therefore showing that the KSTE does not provide a foundation for integrating entrepreneurship into economic growth theory.

4 Critical Analysis of the Formal KSTE Model

In this section I analyze the model of Acs et al. (2009) under six headings: the knowledge filter (4.1); entrepreneurial labour and aggregation (4.2); the hypotheses (4.3); the financial block (4.4); conceptual limitations (4.5); and the empirical test (4.6).

4.1 The knowledge filter is absent from the formal model

The core claim of the KSTE is that the uncommercialized part of knowledge generates start-ups: "*entrepreneurial activity does not involve simply the arbitrage of opportunities, but also*

the exploitation of intra-temporal knowledge spillovers not appropriated by incumbent firms. (Acs et al., 2009, p. 28).

The fundamental shortcoming is, however, that the formal model makes the start-up arrival rate in Eq. (3) above a function of the stock K alone. To make this precise, let $\theta \in [0,1]$ be the share of K that incumbents commercialize, so that the knowledge filter is $1-\theta$ and the uncommercialized stock is $(1-\theta)K$.[1] Thus, proposition 1 follows:

Proposition 1 *In the KSTE model $\eta = K^{\gamma}/\sigma$ and therefore $(\partial\eta/\partial\theta)_K = 0$: holding the stock of knowledge constant, the start-up arrival rate is the same whether incumbents commercialize none or all of it. (Proof: Appendix A.)*

Equation (3) therefore cannot distinguish a world in which incumbents capture all of their knowledge from one in which they capture none, and the first world is, in the theory's own narrative, one without spillover entrepreneurship. The reduced form is a model of *knowledge-driven entry*, not of *spillover-driven entry*.

A defender of the KSTE might reply that $\overline{K}$ is not total knowledge but the knowledge effectively available to potential entrants. If one assumes this, then $\chi \in [0,1]$ is the accessible share of K (in the narrative, $\chi = 1-\theta$), so that $\eta = (\chi K)^{\gamma}/\sigma$ and

$$\left(\frac{\partial \eta}{\partial \theta}\right)_K = \frac{\gamma \chi^{\gamma-1} K^{\gamma}}{\sigma}\, \chi'(\theta). \tag{6}$$

This is non-zero if and only if the accessible share of knowledge depends on commercialization. The model supplies no such function: $\overline{K}$ enters as an exogenous stock, and the model does not say how incumbent R&D changes the share available to outsiders. The filter is then

[1] The ratio K^c/K measures the commercially useful share of knowledge, whereas $1-\theta$ measures the share not commercialized by incumbents. These are distinct margins: uncommercialized knowledge need not have commercial potential, and commercially useful knowledge may already be commercialized. Eq. (3) contains neither share explicitly.

not absent but unmodelled, and H2 requires an assumption that is nowhere stated, namely $\chi'(L_R) < 0$ when the accessible share is written as a function of incumbent R&D (Appendix A).

The simplest way in which Acs et al. could have introduced the filter is $\eta = [(1-\theta)K]^{\gamma}/\sigma$; Appendix A shows that this generates H2. My conclusion is thus that the model contains no relation between the knowledge variable in the entry equation and the share that incumbents commercialize.

Acs et al. (2013, p. 761) is therefore premature to declare that "*The knowledge filter prevents or at least impedes knowledge from automatically spilling over for innovation and commercialization.*" The filter does not appear in the start-up equation. It can be neither a barrier nor a conduit, because the model cannot tell full incumbent commercialization from none.

4.2 Entrepreneurial labour is idle, and the start-up aggregation is invalid

Equation (1) removes L_E from production, so that output falls when more labour becomes entrepreneurial. But L_E does not appear in Eq. (3): the sum runs over all $\overline{L}$ individuals, so the start-up rate is independent of the number of people doing the starting up. This leads me to state proposition 2:

Proposition 2 *(a) In the KSTE model $\partial\eta/\partial L_E = 0$. (b) If wages are equalized across uses and entrepreneurs are paid their marginal product, no positive L_E is consistent with equilibrium. (c) If entrepreneurs instead share the expected value of start-ups equally, the allocation is determinate but unrelated to any productive contribution of L_E to η. (Proof: Appendix B.)*

Equation (3) gives entrepreneurial labour no productive role in start-up arrivals. An allocation relationship can be obtained by adding the equal-sharing condition considered in Proposition 2(c), but this auxiliary closure is not established in the original model. Nor does it provide an ability-based occupational-choice mechanism explaining who becomes an entrepreneur or a measurement relationship connecting innovative entry to observed self-employment.

It offers indeed no theory of entrepreneurial choice. Hence, it light, it is somewhat inaccurate for Acs et al. (2013, p. 760) to claim that "*The knowledge spillover theory of entrepreneurship explains the entrepreneurial act -why certain people become entrepreneurs while others abstain from entrepreneurship- as a response to knowledge spillovers.*" The model clearly has no choice problem. The KSTE says nothing about who starts firms or how many.

The aggregation in Eq. (3) is also invalid. Individual j's hazard is $\xi \overline{e}_j \overline{K}$, as the left-hand side states, so the aggregate hazard is $\mathcal{H} = \xi \overline{K} \sum_j \overline{e}_j = \xi \overline{K} \overline{L} \widehat{e}$, where $\widehat{e}$ is mean ability. Setting $\mathcal{H} = \overline{K}^{\gamma}/\sigma$ requires

$$\xi \, \overline{L} \, \widehat{e} = \frac{\overline{K}^{\gamma-1}}{\sigma}. \tag{7}$$

Hence "$\equiv$" can hold only as a restriction under which ξ varies with $\overline{K}$, $\overline{L}$, $\widehat{e}$ and σ; it cannot be an identity in a constant coefficient. If "$\equiv$" is instead read as defining the aggregate rate, the right-hand side is an assumed reduced form, and the individual-level structure plays no role. This leads me to forward proposition 3:

Proposition 3 *(a) For constant ξ, the left-hand side of (3) is linear in $\overline{K}$ and proportional to $\overline{L}\widehat{e}$, whereas the right-hand side is concave in $\overline{K}$ and independent of both; the two are not identical for any $\gamma < 1$. (b) If the individual hazard is concave in ability, the aggregate depends on the distribution of ability and not only its mean, and replacing the sum by a*

function of the mean overstates the rate (a Jensen gap); under the linear hazard in (3) there is no gap. (c) Under any normalization of the population, the right-hand side is independent of ability, so a population with higher mean ability has no higher start-up rate. (Proof: Appendix C.)

Part (c) of this proposition contradicts the motivation of Acs et al. (2009), who cite Lucas (1978) for the unequal distribution of talent. There is also no occupational-choice margin: a Lucas-type threshold ability e^* above which agents become entrepreneurs is never specified, so the model cannot say whether a rise in knowledge draws in high-ability founders or marginal, low-productivity self-employed.

4.3 The hypotheses and their interpretation

H2 distinguishes the spillover theory from a general "more knowledge, more entrepreneurs" statement. It requires that the marginal effect of knowledge on entry falls as incumbent exploitation rises, that is, a negative cross-derivative. This can be stated in proposition 4.

Proposition 4 *In the KSTE model* $\partial\eta/\partial L_R = 0$ *and* $\partial^2\kappa/\partial K\,\partial L_R = 0$. *Incumbent R&D neither reduces start-up entry nor attenuates the marginal effect of knowledge. (Proof: Appendix D.)*

Because equation (4) is additively separable in K and L_R, nothing in the model can generate an interaction. Appendix A of Acs et al. (2009, p. 29) differentiates the total arrival rate $\kappa = \mu+\eta$ rather than η, so its comparative statics concern innovation arrivals, not entrepreneurial entry ($\partial\kappa/\partial L_R > 0$). The statement that patents and the output gap "*are assumed to influence entrepreneurship negatively*" (p. 23) is not shown mathematically. The financial block does contain a competition channel (a higher κ lowers firm value), but no occupational or financing condition translates it into fewer start-ups.

Equation (5) (Acs et al's equation 11) does not test H2 either: it enters the incumbent proxies additively, whereas H2 predicts a negative interaction between KSTOCK and INC.

Moreover, the hypotheses are derived holding L_R fixed, although a model in which incumbents choose R&D labour contains a condition that determines L_R as a function of K. Let w denote the wage (set to one by Acs et al.) and suppose that R&D labour is hired until the expected value of the marginal success equals the wage. This leads to proposition 5:

Proposition 5 *Suppose $V\,\partial\mu/\partial L_R = w$, with $V = \pi/(r+\kappa)$ and π, r and w given. Then $dL_R/dK < 0$ and $d\kappa/dK = \frac{\partial\kappa}{\partial K} \cdot \frac{\pi(1-\gamma)}{\pi(1-\gamma)+L_R} < \frac{\partial\kappa}{\partial K}$, whereas $d\eta/dK = \partial\eta/\partial K$ is unchanged. (Proof: Appendix D.)*

Knowledge thus crowds out incumbent R&D, and the equilibrium effect of knowledge on total innovation is only a fraction of the partial effect that the authors report; the size of the attenuation is specific to the closure, but $\partial\eta/\partial L_R = 0$ holds under any closure. The only route through which incumbent R&D could depress the *number* of entrepreneurs is the valuation channel $V = \pi/(r+\kappa)$, if entrepreneurs share the value of start-ups (Appendix B). That is a wholly different mechanism from the knowledge filter.

As for H3, it has a conditional sign implication. Holding K fixed, $\partial\eta/\partial\sigma = -K^\gamma/\sigma^2 < 0$, so entrepreneurial entry falls if greater institutional barriers correspond to higher σ. However, Acs et al. (2009) associate barriers with low σ in the main text (p. 22), while their Appendix A treats values near zero as implying fewer obstacles. This inconsistent interpretation leaves the mapping from institutions to entry ambiguous. Moreover, σ directly scales both entrepreneurial and incumbent innovation: it represents a common innovation friction, not a disadvantage specific to entrepreneurs. H3 therefore follows under a particular parameter interpretation, but the equations alone neither resolve that interpretation nor establish that the empirical barrier proxies measure the relevant friction. This leads me to suggest proposition 6:

Proposition 6 *Suppose $K > 0$, $L_R > 0$, $\sigma > 0$, and $0 < \gamma < 1$. Holding K and L_R fixed, the following results hold. (a) Increasing σ reduces entrepreneurial and incumbent innovation at the same proportional rate: $\frac{\partial \eta}{\partial \sigma} = -\frac{K^\gamma}{\sigma^2} = -\frac{\eta}{\sigma} < 0$, $\frac{\partial \mu}{\partial \sigma} = -\frac{L_R^\gamma}{\sigma^2} = -\frac{\mu}{\sigma} < 0$. The entrepreneurial share is therefore invariant to σ at fixed inputs: $s \equiv \frac{\eta}{\kappa} = \frac{K^\gamma}{K^\gamma + L_R^\gamma}$, $\frac{\partial s}{\partial \sigma}\big|_{K,L_R} = 0$. Thus, H3's negative prediction for entrepreneurial entry follows if greater institutional barriers correspond to higher σ. Common scaling does not contradict this level prediction, but it supplies no entrepreneur-specific direct disadvantage. (b) Total innovation is decreasing and convex in σ: $\frac{\partial \kappa}{\partial \sigma} = -\frac{K^\gamma + L_R^\gamma}{\sigma^2} < 0$, $\frac{\partial^2 \kappa}{\partial \sigma^2} = \frac{2(K^\gamma + L_R^\gamma)}{\sigma^3} = \frac{2\kappa}{\sigma^2} > 0$. Defining efficiency as $e = 1/\sigma$, total innovation is linear in efficiency, $\kappa = e(K^\gamma + L_R^\gamma)$, rather than exhibiting diminishing returns. (Proof: Appendix E.)*

The fixed-input qualification here is important. Under Proposition 5's closure, holding K, π and r fixed, higher σ reduces incumbent R&D labour and raises the entrepreneurial share when $r > 0$. Share invariance is therefore a direct-effect result, not an unconditional equilibrium prediction. The difficulty with H3 is not the absence of a negative level response, but the inconsistent interpretation of σ in the original presentation and the unestablished mapping from that parameter to the institutional proxies used in Eq. (5).

Part (a) limits the model's institutional interpretation rather than refuting H3. Holding K and L_R fixed, a higher σ reduces both innovation channels proportionately and leaves the entrepreneurial share unchanged. This does not contradict H3's prediction about entrepreneurial activity in levels. Nor is share invariance an unconditional equilibrium result: under Proposition 5's closure, holding K, π and r fixed, higher σ reduces L_R and raises the entrepreneurial share when $r > 0$. These responses, however, operate through a common friction and research reallocation, not through a knowledge-filter mechanism.

I can also mention here a small error: their equation (A.1b) (p. 29) prints the second derivative as $-(1/\sigma)(\gamma - 1)\gamma L_R^{\gamma-2} < 0$, which is positive for $0 < \gamma < 1$; the correct sign is

negative (Appendix D).

4.4 The financial block is incoherent

Investors hold diversified portfolios and require the return r. Let V be the value of a firm and κ the arrival rate of innovations that displace it. Acs et al. (2009, p. 21) write the no-arbitrage condition as

$$\frac{\pi}{V}\,dt + \frac{\dot{V}}{V}[1-\kappa]dt + \frac{\dot{V}-V}{V}\,\kappa\,dt = r\,dt, \tag{8}$$

describing $1-\kappa$ as "*the probability that the firm survives and* κ *represents the probability that the firm will be forced out of business*". Acs et al. (2009, p. 21).

This derivation contains two mistakes.

The first mistake is that a rate is treated as a probability. κ is the hazard rate of a Poisson process, with the dimension of 1/time, and it is $\kappa\,dt$ that is a dimensionless probability. The survival weight $1-\kappa$ therefore adds a pure number to a quantity measured in 1/time, and since a hazard can exceed one, $1-\kappa$ can be negative. Choosing units such that $dt = 1$ contradicts the continuous-time setting, and even then the exact survival probability is $e^{-\kappa}$, not $1-\kappa$. Over a short interval, the displacement probability is $1 - e^{-\kappa\,dt} = \kappa\,dt + o(dt)$.

The second mistake is that a level is subtracted from a rate. Equation (8) contains $\dot{V} - V$, but $\dot{V}$ is a change in value per unit of time and V is a value level. A surviving shareholder gains approximately $\dot{V}\,dt$; a shareholder whose firm is displaced loses the stake V, a return of -1 per unit of value held.

The correct derivation should have been as follows. Over dt, a shareholder earns the dividend $(\pi/V)\,dt$; with probability $1-\kappa\,dt$ the firm survives and the holder earns the capital gain

$\left(\dot{V}/V\right) dt$; with probability $\kappa\, dt$ the holder loses the whole stake. Setting the expected return equal to $r\, dt$,

$$\frac{\pi}{V}\, dt + \frac{\dot{V}}{V}[1 - \kappa\, dt]dt - \kappa\, dt + o(dt) = r\, dt. \tag{9}$$

The survival capital gain is already of order dt, so its product with the displacement probability is of order dt^2. Dividing by dt and letting $dt \to 0$ gives $\dot{V}/V + \pi/V = r + \kappa$, which is Eq. (9) of Acs et al., and in a steady state $V = \pi/(r+\kappa)$, their Eq. (10). Hence, proposition 7 can be stated:

Proposition 7 *(a) Equation (8) is dimensionally inconsistent in two respects: "*$1 - \kappa$*" and "*κ*" cannot be probabilities, since the survival and displacement probabilities over dt are* $e^{-\kappa\, dt} \approx 1 - \kappa\, dt$ *and* $1 - e^{-\kappa\, dt} \approx \kappa\, dt$*; and the displacement term subtracts the level* V *from the rate* $\dot{V}$*. The printed terms nonetheless collapse to Acs et al's Eq. (9), so the final formula is right but its stated derivation is invalid. (b) With logarithmic utility the Euler equation is* $\dot{Y}/Y = r - \rho$*, with* r *the net return on assets; constant expenditure* Y *therefore requires* $\rho = r$*, not* $\rho = \widetilde{r} = r + \kappa$ *(Acs et al's Eq. 10). (Proof: Appendix F.)*

Stated simply, proposition 7 states that Acs et al.'s (2009) equation for what a firm is worth is built on two arithmetic mistakes but that the mistakes happen to cancel out, so their final formula is correct. However, there is a separate problem in how they close the model. The authors state that "*the consumer rate of time-preferences (*ρ*) must equal the rate of return (*$\widetilde{r}$*) of investments over time*" (p. 21), but $\pi/V = r + \kappa$ is a *gross* payout yield from which expected destruction losses have not yet been subtracted; equating time preference to it counts the destruction hazard twice. The authors acknowledge that a full growth closure is omitted; my point here is an inconsistency in the closure that *is* proposed.

There is also a conceptual problem. Acs et al. (2009) open with a quotation on uncertainty

(Shackle, 1982), yet their model contains only objective, memory-less Poisson hazards and fully diversified investors who bear no idiosyncratic risk. There is no uncertainty to be resolved by entrepreneurial judgement and no modelled residual claimant whose decision determines entry. Entrepreneurial labour carries an opportunity cost because it withdraws resources from production, yet it makes no marginal contribution to the start-up arrival rate (Section 4.2 and Appendix B). The problem is the absence of a productive entrepreneurial role and a specified decision problem.

4.5 Conceptual limitations

The KSTE also rests on assumptions that sit uneasily with the economics of knowledge and of the firm. I discuss three.

First, knowledge is a free input in the KSTE. It enters the start-up hazard at no private cost, whereas absorbing, decoding and commercializing specialized knowledge requires investment in absorptive capacity, human capital and finance (see e.g. Arrow, 1962; Cohen and Levinthal, 1990). A model in which entrants exploit corporate R&D at zero private cost overstates entry and ignores the financing constraint that most early-stage ventures face; the extension by Qian and Acs (2013) tried to repair this fundamental omission. As they put it "knowledge spillover entrepreneurship depends not only on new knowledge but more importantly on entrepreneurial absorptive capacity that allows entrepreneurs to understand new knowledge, recognize its value, and commercialize it by creating a firm" (Qian and Acs, 2013, p. 185). Entrepreneurial absorptive capacity (EAC) is defined by Qian and Acs (2013, p. 1919) as the "*ability of an entrepreneur to understand new knowledge, recognize its value, and subsequently commercialize it by creating a firm.*" They then present this as a "dual-conduit model" in which human capital works through new knowledge and through EAC (p. 193). The mathematics is however absent. There is no model, no derivation, no proposition

and no comparative statics. Nothing links EAC to an entry decision, an occupational choice, a hazard or an equilibrium. Somewhat similar to the KSTE overall, in Qian and Acs (2013) a verbal concept is declared to solve a formal gap, and the narrative story of a model stands in for an actual rigorous, consistent mathematical model.

It suggests that Romer's (2015) "mathiness" critique[2] may be especially relevant for some entrepreneurship scholarship: notation and diagrams that look like theory but cannot be falsified or derived from stated assumptions.

Second, the filter is an exogenous wedge. Incumbents spend on R&D, fail to use some of the results and let these spill over. This is difficult to reconcile with the contract-theoretic literature on employee start-ups, in which the employee and the employer bargain over the exploitation of an idea, and the employer can develop it, license it, spin it out with equity or acquire the entrant (Anton and Yao, 1995; Hellmann, 2007; Lazear, 2005). The claim that "*if an innovation makes the incumbent firm a true monopolist, it will not be profitable for the agent to pursue a start-up, since the sum of rents in a duopolistic market will be less than monopoly rent*" (Acs et al., 2009, p. 19) is a statement about *joint* rents. It does not establish that a start-up is unprofitable for the individual: entry depends on the entrant's own appropriable return net of entry costs and the employment alternative, and lower joint rents merely allow an entry-deterring transfer if one is feasible and enforceable. No such transfer or contract is modelled.

Third, the policy discussion conflates the appropriation of rents with the restriction of access to knowledge. Acs et al. (2009, p. 28) conclude that strong intellectual property protection reduces innovation and growth because complete appropriation by incumbents eliminates spillovers. But capturing the rents from an innovation is not the same as preventing diffusion

[2]In terms of Romer's (2015) mathiness critique, the KSTE can perhaps be seen as fitting the textbook description, as the maths does not contain the theory, the hypotheses do not follow easily from the math, the microfoundations are fictional and the mathematical notation seems layered over an intuitive verbal story, giving the illusion of rigor.

of the knowledge it embodies; as the authors themselves note (on p. 17), patented knowledge can inform other applications.

4.6 Empirical shortcomings

In this section I identify five problems with the empirical work of Acs et al. (2009).

First, the dependent variable is a stock, whereas the theory concerns a flow. The KSTE is about the arrival rate of successful innovative start-ups, yet the dependent variable ENT is the stock, S, of non-agricultural self-employment. Let J be gross entry into self-employment and δ_S the exit rate, so that $\dot{S} = J - \delta_S S$, and let $J = J_0 + \eta$, where J_0 is routine and necessity entry and η is innovative entry. In a steady state

$$S = \frac{J_0 + \eta}{\delta_S}, \qquad \frac{\partial S}{\partial \eta} = \frac{1}{\delta_S}. \tag{10}$$

The comparative static $\partial S/\partial K = (\partial \eta/\partial K)/\delta_S$ therefore holds only if J_0 and δ_S are unaffected by K and by the variables that move with it (income per capita, the business cycle, sectoral composition). Self-employment is mostly low-technology services, trade and manual work with low growth expectations, its share falls as countries develop (Gollin, 2008), and it declined across the OECD until the 1970s and then rose for reasons unrelated to R&D (Blau, 1987). These conditions are unlikely to hold.

Proposition 2 establishes that entrepreneurial labour has no marginal effect on innovative entry. Although an additional remuneration rule can relate η to L_E, the original model does not establish that rule or connect entrepreneurial labour to measured self-employment. A proxy dominated by non-innovative activity can still be weakly related to innovative entry; the regression cannot separate the two. The original footnote concedes only a weak

correlation with start-up data from the World Bank (p. 22), and the denominator of ENT is the labour force in the text but non-agricultural employment in the data table (p. 29).

Second, the stock of knowledge is replaced by a flow. Acs et al. (2009) replace the accumulated stock by annual R&D relative to GDP, justified by a full-sample correlation of 0.95 to 0.98 between stock and flow (5-year averages, p. 23). But fixed-effect estimation is identified from *within-country* variation, and a high pooled correlation is dominated by cross-country differences in R&D levels. Let R_t denote R&D intensity in a country, δ_K the depreciation rate (10 per cent in Acs et al.), and $a = 1 - \delta_K$.

Proposition 8 *Let $K_t = aK_{t-1} + R_t$ and let the within-country deviation of R_t from its country mean be AR(1) with persistence ω. Then the within-country correlation between K_t and R_t is $\sqrt{(1-a^2)\,/\,(1-a^2\omega^2)}$. With $\delta_K = 0.10$ this is 0.44 when $\omega = 0$, 0.49 when $\omega = 0.5$ and 0.74 when $\omega = 0.9$, however high the pooled correlation. (Proof: Appendix G.)*

The result concerns a stock in its stationary state; a stock built from 1981 onwards also contains an initial build-up, which Acs et al. cite as the reason for the substitution.

To check that the gap arises in a sample of the original's size, I simulated 19 countries over 25 years with $\delta_K = 0.10$, country mean R&D intensities drawn uniformly between 0.6 and 3.2 per cent of GDP, a within-country standard deviation of 0.15 percentage points, and 2,000 replications.

Country knowledge stocks were initialized at the country-specific steady-state mean, $K_{i0} = \bar{R}_i/\delta_K$, with the first-year deviation of R&D intensity drawn from its stationary AR(1) distribution. Each simulated series included $B = 200$ preliminary years, which were discarded before retaining the 25-year estimation window. Initialization and the preliminary period were chosen to approximate the stationary process assumed in Proposition 8: since $a^{200} < 10^{-9}$, the initial condition has no influence on the retained window. Setting K_{i0} at

its steady-state mean does not by itself achieve this, because it fixes the mean of the stock but not its deviations, and with $a = 0.9$ these carry the initial condition into the sample. Varying B from 50 to 500 changes no reported within-country correlation by more than 0.002. Without a burn-in the choice does matter: starting at the steady-state mean gives within-country correlations of 0.51, 0.47 and 0.45 for $\omega = 0$, 0.5 and 0.9, and starting from $K_{i0} = 0$ gives a pooled correlation of 0.69 and a within-country correlation of about 0.03. The Python code for the simulation is in Appendix H.

The pooled correlation between stock and flow is 0.98 to 0.99 for all three values of ω, whereas the mean within-country correlation is 0.49, 0.45 and 0.51 for $\omega = 0$, 0.5 and 0.9 (5th to 95th percentile of the 19-country mean across replications: 0.45 to 0.52, 0.40 to 0.49 and 0.41 to 0.60). These differ from the population values in Proposition 8 because demeaning within a 25-year window removes low-frequency variation, which raises the correlation when $\omega = 0$ and lowers it when $\omega = 0.9$; with $T = 2,000$ the simulation reproduces Proposition 8 to within 0.004. A pooled correlation of 0.95 or more is therefore compatible with a within-country correlation of about one half.

Third, the proxies do not isolate the theory's concepts. KSTOCK measures total R&D expenditure, not knowledge left uncommercialized by incumbents. Patents per capita reflect inventive output and the propensity to patent as much as incumbent appropriation, the data are not split by incumbents and entrants, and the definition mixes applications and grants (p. 29). The output gap measures general resource utilization and labour-market slack, which could produce the same sign through wage-employment alternatives. The tax variables are revenue shares of GDP rather than tax rates, and a higher corporate tax revenue share can reflect a larger profit base. Public expenditure over GDP is justified as a proxy for regulation by reference to Nicoletti et al. (2000), who construct the OECD product market regulation indicators from detailed survey data precisely because aggregates of this kind do not capture regulation.

Fourth, the inference is unreliable. The standard errors assume i.i.d. errors in a panel with persistent regressors, spline-interpolated age, overlapping moving-average growth rates and only 19 clusters. The rise in t-statistics when moving from five-year averages to annual data partly reflects the larger number of observations, but it is also what neglected serial correlation would produce (Bertrand et al., 2004). Country-clustered errors with small-sample corrections (Cameron et al., 2008) and checks for residual dependence after year effects and country trends are standard and absent.

Fifth, the causal language is not supported. The claim that opportunities "*do not appear to be exogenous but rather systematically created by a high presence of knowledge spillovers*" (Acs et al., 2009, p. 23) requires causal identification. Country and time effects do not remove time-varying country-specific confounders or reverse causation (self-employment may feed back on R&D intensity through investment or GDP), and lags do not by themselves resolve this. The positive KSTOCK coefficient is consistent with the theory but equally with alternatives, such as a general R&D-intensity effect on self-employment through the demand for specialized services. The empirical specification therefore neither isolates nor causally identifies the knowledge-filter mechanism.

5 Embedding the KSTE in a growth model

In section 3 I pointed out that the growth-theoretic extension by Acs and Sanders (2013) recognizes that the original KSTE formulation lacked dynamic microeconomic foundations and attempted to provide this. They did so by embedding knowledge spillover entrepreneurship in a dynamic general-equilibrium model with a representative household with logarithmic utility, m final-goods firms undertaking R&D, intermediate-goods entrants, and homogeneous educated labour allocated between corporate R&D and entrepreneurial venturing by wage arbitrage.

In Acs et al. (2009) the filter is missing because the entry equation omits it (Proposition 1). In Acs and Sanders (2013) it is removed by assumption: in their footnote 7 they note that, rather than entering through a wedge of uncommercialized knowledge, all ideas spill over. Entry of intermediate-goods firms is a Cobb–Douglas function of total corporate knowledge and the number of varieties[3],

$$\dot{n} = \varphi A^{\delta} n^{1-\delta} \Lambda_n \tag{11}$$

(Acs and Sander's Eq. 13, p.781). There is no commercialized and uncommercialized stock, and nothing for incumbents' own commercialization to leave unused, so $\partial \dot{n}/\partial \theta = 0$ by construction. What the growth model formalises is knowledge-driven entry under the label of knowledge spillover entrepreneurship. Absorption is free, there is no occupational choice or entrepreneurial heterogeneity, and educated labour enters linearly. The welfare results of the extension, concerning whether spillovers are upstream or downstream and how market allocations diverge from the optimum, are informative about a model with free-access knowledge and homogeneous labour. They are not microfoundations for the filter, because the filter is not in the model.

6 Concluding Remarks

"Men han har jo ikke Noget paa!" (Andersen, 1837)[4]

The KSTE of Acs et al. (2009) has been very influential within entrepreneurship scholarship, having being cited more than 3,000 times at the time of writing (as per Google Scholar) and inspiring a myriad of further papers. The authors have variously claimed that the

[3]Note that the notation of Acs and Sanders (2013) clashes with the notation I have already used, so in this section only I use their symbols and refer to their equation numbers.

[4]Translated as "But he has nothing on!" (Andersen, 1837, *The Emperor's New Clothes*).

KSTE provides a microeconomic foundation to economic growth theory and that it "*explains the entrepreneurial act*" (Acs et al., 2013, p.760). D'Alessandro et al. (2024, p.3) even claimed that the KSTE "*represents a significant advancement in economic thought.*" Block et al. (2013, p.696) lauded the KSTE, claiming that "*The knowledge spillover theory of entrepreneurship [...] is an important step in understanding the microeconomic foundations of how entrepreneurship leads to economic growth.*"

In this paper I have shown that these claims are premature. This is because the KSTE contains serious shortcomings. These were explained in this paper, in the form of propositions with mathematical proofs.

The first shortcoming that was illustrated was that the knowledge filter is not in the model (Proposition 1). The second shortcoming concerns the hypotheses: the model does not establish the knowledge-filter interaction required by H2, while H3 follows only under a consistent barrier-to-parameter mapping that the original presentation does not maintain. (Propositions 4 to 6). The third is a set of derivation errors (Propositions 2, 3 and 7). The fourth shortcoming is that the empirical test is mismatched (Section 4.6 and Proposition 8).

That a heavily cited paper can contain such errors without their being noticed or published for almost two decades brings Andersen's tale to mind. The clothes of the KSTE are the knowledge filter, but the theory does not wear them (Proposition 1), and Acs and Sanders (2013) did not supply the missing garment: they assume that all ideas spill over. As in the tale, the admiration from the entrepreneurship scholarly community was collective: the literature reviewed in Section 3 embroidered the cloth or measured how it fits different wearers, but none asked whether the entry equation represents the filter. There was even an entire special issue of the *Journal of Technology Transfer* devoted in 2026 to the KSTE. None of the papers nor the editors' introduction (see Audretsch et al., 2026) for a moment suggested that the Emperor in fact, has no clothes. Does this perhaps provide a further indication, as Naudé (2025) has argued, that entrepreneurship has become a degenerative

field?

In conclusion, these findings set out in this paper do not imply that knowledge spillovers are irrelevant to entrepreneurship. They imply that the existence and magnitude of the relationship between knowledge, entrepreneurship and growth cannot be inferred from the formal KSTE models as they stand. The KSTE offers a potentially useful idea, but it remains to be turned into a theory.

Appendices

Appendices A to G contain the proofs of Propositions 1 to 8 in order (Appendix D proves Propositions 4 and 5). Appendix H contains the simulation code.

Appendix A. Proof of Proposition 1

By Eq. (3), $\eta = K^{\gamma}/\sigma$, which contains neither θ nor K^{c}. Hence, at constant K,

$$\left(\frac{\partial \eta}{\partial \theta}\right)_{K} = 0. \tag{A1}$$

Now let the accessible stock be $\chi(\theta)K$ with $\chi \in [0,1]$. Then $\eta = (\chi K)^{\gamma}/\sigma$ and

$$\left(\frac{\partial \eta}{\partial \theta}\right)_{K} = \frac{\gamma \chi^{\gamma-1} K^{\gamma}}{\sigma}\, \chi'(\theta), \tag{A2}$$

which is zero if $\chi'(\theta) = 0$ and is otherwise determined entirely by the function $\chi(\cdot)$, which the model does not supply. For the simple repair $\chi = 1 - \theta$, so that $\eta = [(1-\theta)K]^{\gamma}/\sigma$,

$$\frac{\partial \eta}{\partial K} = \frac{\gamma(1-\theta)^{\gamma} K^{\gamma-1}}{\sigma}, \qquad \frac{\partial^{2} \eta}{\partial K\, \partial \theta} = -\frac{\gamma^{2}(1-\theta)^{\gamma-1} K^{\gamma-1}}{\sigma} < 0. \tag{A3}$$

For the general condition for H2, let the accessible share depend on incumbent R&D, $\chi = \chi(L_R)$. Then $\partial \eta/\partial K = \gamma \chi^{\gamma} K^{\gamma-1}/\sigma$ and

$$\frac{\partial^{2} \eta}{\partial K\, \partial L_R} = \frac{\gamma^{2} \chi^{\gamma-1} K^{\gamma-1}}{\sigma}\, \chi'(L_R), \tag{A4}$$

which is negative if and only if $\chi'(L_R) < 0$. If $\chi = 1 - \theta(L_R)$ with $\theta' > 0$, (A4) equals $\theta'(L_R)\,\partial^2\eta/\partial K\,\partial\theta < 0$ by (A3). □

Appendix B. Proof of Proposition 2

(a) By Eq. (3), $\eta = K^\gamma/\sigma$, so $\partial\eta/\partial L_E = 0$. Let V be the value of a successful start-up and w the wage in other sectors.

(b) The expected marginal product of entrepreneurial labour is $V\,\partial\eta/\partial L_E = 0 < w$. Free mobility with marginal-product remuneration requires $V\,\partial\eta/\partial L_E = w$ whenever $L_E > 0$. This cannot hold, so $L_E^* = 0$: the model predicts no entrepreneurs yet generates start-ups at the rate $\eta > 0$.

(c) Suppose that entrepreneurs share the expected value of start-ups equally, so that expected income is $V\eta/L_E$. Mobility then gives, with $V = \pi/(r+\kappa)$ and $w = 1$,

$$L_E = \frac{V\eta}{w} = \frac{\pi K^\gamma}{\sigma(r+\kappa)}. \tag{B1}$$

This is determinate, but the marginal contribution of L_E to η is zero while its opportunity cost is w, so (B1) is not linked to any productive role of entrepreneurial labour. It also makes L_E depend on L_R through κ: $\partial L_E/\partial L_R = -\pi K^\gamma \sigma^{-1}(r+\kappa)^{-2}\,\partial\kappa/\partial L_R < 0$. This runs through the valuation channel, which is not the knowledge-filter mechanism. □

Appendix C. Proof of Proposition 3

Individual j's hazard is $\xi\overline{e}_j\overline{K}$, with ξ constant. The aggregate hazard is

$$\mathcal{H} = \sum_{j=1}^{\overline{L}} \xi \overline{e}_j \overline{K} = \xi \overline{K}\overline{L}\widehat{e}, \tag{C1}$$

where $\widehat{e} = \overline{L}^{-1} \sum_j \overline{e}_j$.

(a) $\mathcal{H} = \overline{K}^{\gamma}/\sigma$ requires (7), $\xi \overline{L}\widehat{e} = \overline{K}^{\gamma-1}/\sigma$. For $\gamma < 1$ this cannot hold for a constant ξ across values of $\overline{K}$, $\overline{L}$ or $\widehat{e}$: $\mathcal{H}$ is linear in $\overline{K}$ and in $\overline{L}\widehat{e}$, whereas the right-hand side is concave in $\overline{K}$ and independent of $\overline{L}\widehat{e}$.

(b) Suppose instead that the individual hazard is concave in ability, $h(\overline{e}, K) = (\overline{e}K)^{\gamma}/\sigma$. By Jensen's inequality, $\mathbb{E}[\overline{e}^{\gamma}] \leq (\mathbb{E}\overline{e})^{\gamma}$, strictly for non-degenerate $\overline{e}$. A second-order expansion gives $\mathbb{E}[\overline{e}^{\gamma}] \approx \widehat{e}^{\gamma}\left[1 - \frac{1}{2}\gamma(1-\gamma)\mathrm{CV}^2\right]$, where CV is the coefficient of variation of ability, so substituting the mean overstates the aggregate rate. Under the linear hazard of (C1), $\mathbb{E}[\overline{e}]$ enters exactly and there is no Jensen gap.

(c) Under (C1), $\partial\mathcal{H}/\partial\overline{L} = \xi\overline{K}\widehat{e} > 0$ and $\partial\mathcal{H}/\partial\widehat{e} = \xi\overline{K}\overline{L} > 0$. The right-hand side $\overline{K}^{\gamma}/\sigma$ is independent of both under any normalisation of $\overline{L}$ (for example $\overline{L} = 1$): its derivative with respect to mean ability is zero while that of the left-hand side is positive. □

Appendix D. Proofs of Propositions 4 and 5

Proposition 4. From (4), $\partial\kappa/\partial K = \gamma K^{\gamma-1}/\sigma$, and therefore

$$\frac{\partial^2 \kappa}{\partial K\, \partial L_R} = \frac{\partial}{\partial L_R}\left(\frac{\gamma K^{\gamma-1}}{\sigma}\right) = 0. \tag{D1}$$

Also $\partial\eta/\partial L_R = \partial\left(K^{\gamma}/\sigma\right)/\partial L_R = 0$. Finally $\kappa_{L_R L_R} = (1/\sigma)\gamma(\gamma-1)L_R^{\gamma-2} < 0$, the sign following from $\gamma < 1$; the version printed in Eq. (A.1b) of Acs et al. (2009), with an additional leading minus sign, is positive and contradicts the inequality printed beside it. □

Proposition 5. Let $\mu_{L_R} = \gamma L_R^{\gamma-1}/\sigma$ and $w = 1$. The condition $V\mu_{L_R} = w$ with $V = \pi/(r+\kappa)$, multiplied through by σ and using (4), is

$$F(L_R, K) \equiv \pi\gamma L_R^{\gamma-1} - r\sigma - K^\gamma - L_R^\gamma = 0. \tag{D2}$$

Here $F_K = -\gamma K^{\gamma-1}$ and $F_{L_R} = \gamma L_R^{\gamma-2}\left[\pi(\gamma-1) - L_R\right] < 0$.

By the implicit function theorem,

$$\frac{dL_R}{dK} = -\frac{F_K}{F_{L_R}} = -\frac{K^{\gamma-1}L_R^{2-\gamma}}{\pi(1-\gamma) + L_R} < 0. \tag{D3}$$

The total effect of knowledge on the arrival rate of innovations is then

$$\sigma\frac{d\kappa}{dK} = \gamma K^{\gamma-1} + \gamma L_R^{\gamma-1}\frac{dL_R}{dK} = \gamma K^{\gamma-1}\,\frac{\pi(1-\gamma)}{\pi(1-\gamma) + L_R}, \tag{D4}$$

which is positive but smaller than the partial effect $\gamma K^{\gamma-1}$ by the factor $\pi(1-\gamma)/\left[\pi(1-\gamma) + L_R\right] < 1$. The start-up rate $\eta = K^\gamma/\sigma$ does not depend on L_R, so $d\eta/dK = \partial\eta/\partial K$. If instead V is held fixed, $L_R = [V\gamma/(\sigma w)]^{1/(1-\gamma)}$ is independent of K and the equilibrium and partial responses coincide; the attenuation is therefore closure-specific, whereas $\partial\eta/\partial L_R = 0$ survives every closure. □

Appendix E. Proof of Proposition 6

(a) With $\eta = K^\gamma/\sigma$ and $\mu = L_R^\gamma/\sigma$,

$$\frac{\eta}{\kappa} = \frac{K^\gamma/\sigma}{\left(K^\gamma + L_R^\gamma\right)/\sigma} = \frac{K^\gamma}{K^\gamma + L_R^\gamma}, \tag{E1}$$

which is independent of σ: a change in σ scales both channels by the same factor. The result depends on the common scaling. This invariance holds with K and L_R fixed; under Appendix D's closure, holding K, π and r fixed with $r > 0$, $dL_R/d\sigma = r/F_{L_R} < 0$, so the entrepreneurial share increases with σ because incumbent R&D labour falls. With channel-specific frictions, $\eta = K^\gamma/\sigma_E$ and $\mu = L_R^\gamma/\sigma_R$,

$$\frac{\eta}{\kappa} = \frac{K^\gamma \sigma_R}{K^\gamma \sigma_R + L_R^\gamma \sigma_E}, \qquad \frac{\partial(\eta/\kappa)}{\partial \sigma_E} = -\frac{K^\gamma L_R^\gamma \sigma_R}{\left(K^\gamma \sigma_R + L_R^\gamma \sigma_E\right)^2} < 0, \tag{E2}$$

so a friction specific to entrepreneurs would reduce their share of innovation.

(b) $\partial\kappa/\partial\sigma = -\kappa/\sigma$ and $\partial^2\kappa/\partial\sigma^2 = 2\kappa/\sigma^2 > 0$, so κ is convex in σ. The marginal gain from a reduction in σ, $-\partial\kappa/\partial\sigma = \left(K^\gamma + L_R^\gamma\right)/\sigma^2$, rises as σ falls, and in terms of efficiency $1/\sigma$ the arrival rate $\kappa = (1/\sigma)\left(K^\gamma + L_R^\gamma\right)$ is linear. Neither representation gives diminishing returns to efficiency. □

Appendix F. Proof of Proposition 7

(a) Let $[t]$ denote the dimension of time and $[V]$ that of value. In Eq. (8), the terms π/V, $\dot{V}/V$, κ and r all have dimension $[t]^{-1}$, and $\kappa\, dt$ is dimensionless. The factor $1 - \kappa$ adds the pure number 1 to a quantity of dimension $[t]^{-1}$, and $\dot{V} - V$ subtracts a quantity of dimension $[V][t]^{-1}$ from one of dimension $[V]$. With a constant Poisson arrival rate κ, the probability of at least one displacement in $[t, t + dt]$ is $1 - e^{-\kappa\, dt} = \kappa\, dt + o(dt)$ and the survival probability is $e^{-\kappa\, dt} = 1 - \kappa\, dt + o(dt)$; κ itself is a rate, may exceed one and is not a probability. Setting the interval to one unit does not help (Section 4.4).

Dividing their Eq. (8) by dt gives

$$\frac{\pi}{V}+\frac{\dot{V}}{V}(1-\kappa)+\frac{\dot{V}-V}{V}\kappa=\frac{\pi}{V}+\frac{\dot{V}}{V}-\frac{\kappa\dot{V}}{V}+\frac{\kappa\dot{V}}{V}-\kappa=\frac{\pi}{V}+\frac{\dot{V}}{V}-\kappa=r. \tag{F1}$$

The two terms in $\kappa\dot{V}/V$ cancel, so the printed terms collapse to Eq. (9), which also follows from (9): the term $-\kappa\left(\dot{V}/V\right)\,dt^2$ in (9) is $O\left(dt^2\right)$ and is dropped, and division by dt gives the same condition.

Let W be household wealth, y non-asset income and Y consumption expenditure and let r be the *net* return on wealth, so that $\dot{W}=rW+y-Y$. Maximizing $\int_0^\infty e^{-\rho t}\ln Y_t\,dt$ gives the Euler equation

$$\frac{\dot{Y}}{Y}=r-\rho. \tag{F2}$$

By (F1), the gross payout yield is $\pi/V=r+\kappa-\dot{V}/V$, so that r is the return after expected destruction losses. Constant expenditure ($\dot{Y}=0$) therefore requires $\rho=r$. The closure $\rho=\widetilde{r}=r+\kappa$, substituted into (F2), gives

$$\frac{\dot{Y}}{Y}=r-(r+\kappa)=-\kappa\neq 0, \tag{F3}$$

So that expenditure shrinks at the destruction rate, contradicting the stationarity that the closure is meant to impose unless $\kappa=0$. The destruction hazard is thus clearly counted twice. □

Appendix G. Proof of Proposition 8

Let $K_t = \sum_{\tau \geq 0} a^\tau R_{t-\tau}$ and let the within-country deviation $u_t = R_t - \overline{R}_i$ have autocovariance $\Gamma_s = \Gamma_0 \omega^{|s|}$, where $\overline{R}_i$ is the mean of country i. The within-country covariance and variance are

$$\mathrm{Cov}\left(K_t, u_t\right) = \sum_{\tau \geq 0} a^\tau \Gamma_\tau = \frac{\Gamma_0}{1 - a\omega}, \tag{G1}$$

$$\mathrm{Var}\left(K_t\right) = \Gamma_0 \left[\frac{1}{1-a^2} + \frac{2}{1-a^2}\frac{a\omega}{1-a\omega}\right] = \Gamma_0 \frac{1+a\omega}{\left(1-a^2\right)\left(1-a\omega\right)}. \tag{G2}$$

The variance sums $a^{s+s'}\Gamma_{|s-s'|}$ over all pairs (s, s'): the diagonal terms give $\Gamma_0/\left(1-a^2\right)$ and the off-diagonal terms, counted twice, give the second term. Therefore

$$\mathrm{corr}_{\text{within}}\left(K_t, R_t\right) = \frac{1/(1-a\omega)}{\sqrt{\frac{1+a\omega}{(1-a^2)(1-a\omega)}}} = \sqrt{\frac{1-a^2}{1-a^2\omega^2}}. \tag{G3}$$

With $a = 0.9$, (G3) equals $\sqrt{0.19} = 0.436$ when $\omega = 0$, 0.488 when $\omega = 0.5$ and 0.743 when $\omega = 0.9$. The *pooled* correlation, in contrast, is dominated by between-country variance in the means $\overline{R}_i$ and in the steady-state stocks $\overline{R}_i/\delta_K$, and can be arbitrarily close to one irrespective of (G3). □

Appendix H. Simulation Code

```
#!/usr/bin/env python3
"""
Simulation for Section 4.6 / Proposition 8 (stock-flow correlation, pooled vs within).
Model per country i and year t
    R[i,t] = Rbar[i] + u[i,t],   u[i,t] = omega*u[i,t-1] + e[i,t],  sd(u) = SD_U (
    stationary)
    K[i,t] = a*K[i,t-1] + R[i,t],   a = 1 - delta_K
Design: N_COUNTRIES countries, T_KEEP retained years, REPS replications,
Rbar[i] ~ U(RBAR_LO, RBAR_HI) (per cent of GDP).
Initialisation / burn-in (explicit, because it matters when a = 0.9):
    init = "stationary": simulate B + T_KEEP years, starting from
             u_0 drawn from the stationary AR(1) distribution and
             K_0 = Rbar_i/delta_K (country steady-state mean of the stock),
           and discard the first B years. For B large (a**B ~ 0) the retained
           window is a draw from the stationary joint process of Proposition 8.
    init = "steady_mean", B = 0:  K_0 = Rbar_i/delta_K, no burn-in (deviations of K
           from its mean are set to zero, NOT stationary).
    init = "zero", B = 0:  K_0 = 0 (full build-up from scratch, as for a stock
           accumulated from the first sample year).
Usage:  python simulate_stock_flow.py            # full report incl. burn-in check
        python simulate_stock_flow.py --reps 200 # quick run
"""
import argparse
import numpy as np

N_COUNTRIES, T_KEEP, REPS = 19, 25, 2000
DELTA_K = 0.10
RBAR_LO, RBAR_HI = 0.6, 3.2
SD_U = 0.15
OMEGAS = (0.0, 0.5, 0.9)
SEED = 20261023

def theory(a, omega):
    return np.sqrt((1 - a**2) / (1 - a**2 * omega**2))

def simulate_panel(rng, omega, burn, init, delta=DELTA_K, n=N_COUNTRIES, t_keep=T_KEEP):
    """Return R, K arrays of shape (n, t_keep) after discarding `burn` years."""
    a = 1.0 - delta
    rbar = rng.uniform(RBAR_LO, RBAR_HI, size=n)
    total = burn + t_keep
    innov_sd = SD_U * np.sqrt(1 - omega**2)          # keeps sd(u) = SD_U for any omega
    e = rng.normal(0.0, innov_sd, size=(n, total))
    u = np.empty((n, total))
    u[:, 0] = rng.normal(0.0, SD_U, size=n)           # stationary start for the flow
    deviation
    for t in range(1, total):
        u[:, t] = omega * u[:, t - 1] + e[:, t]
    R = rbar[:, None] + u
    K = np.empty_like(R)
    K0 = {"zero": np.zeros(n), "steady_mean": rbar / delta, "stationary": rbar / delta}[
    init]
```

```
    K[:, 0] = a * K0 + R[:, 0]                          # K_1 = a*K_0 + R_1
    for t in range(1, total):
        K[:, t] = a * K[:, t - 1] + R[:, t]
    return R[:, burn:], K[:, burn:]

def within_corr(R, K):
    Rd = R - R.mean(axis=1, keepdims=True)
    Kd = K - K.mean(axis=1, keepdims=True)
    return (Rd * Kd).sum(1) / np.sqrt((Rd**2).sum(1) * (Kd**2).sum(1))

def run(omega, burn, init, reps=REPS, seed=SEED, delta=DELTA_K):
    rng = np.random.default_rng([seed, int(round(omega * 100))])   # same seed across
    burn-ins
    pooled, within_mean, within_all = [], [], []
    for _ in range(reps):
        R, K = simulate_panel(rng, omega, burn, init, delta)
        pooled.append(np.corrcoef(R.ravel(), K.ravel())[0, 1])
        w = within_corr(R, K)
        within_mean.append(w.mean())
        within_all.append(w)
    pooled, within_mean = np.array(pooled), np.array(within_mean)
    within_all = np.concatenate(within_all)
    return dict(pooled=pooled.mean(),
                pooled_p5_p95=np.percentile(pooled, [5, 95]),
                within=within_mean.mean(),
                within_rep_p5_p95=np.percentile(within_mean, [5, 95]),
                within_ctry_p5_p95=np.percentile(within_all, [5, 95]))

def fmt(r):
    return (f"pooled {r['pooled']:.3f}  within {r['within']:.3f}  "
            f"[5-95 over reps {r['within_rep_p5_p95'][0]:.3f},{r['within_rep_p5_p95
    '][1]:.3f}] "
            f"[5-95 over country draws {r['within_ctry_p5_p95'][0]:.3f},{r['
    within_ctry_p5_p95'][1]:.3f}]")


if __name__ == "__main__":
    ap = argparse.ArgumentParser()
    ap.add_argument("--reps", type=int, default=REPS)
    ap.add_argument("--burn", type=int, default=200, help="burn-in B for the headline run
    ")
    args = ap.parse_args()
    a = 1 - DELTA_K

    print("Proposition 8 (stationary, infinite sample):",
          {w: round(theory(a, w), 3) for w in OMEGAS})

    print(f"\n== Headline: stationary initialisation, burn-in B={args.burn}, reps={args.
    reps} ==")
    for w in OMEGAS:
        print(f"omega={w}: ", fmt(run(w, args.burn, 'stationary', args.reps)))

    print("\n== Burn-in check (same seeds; within-country mean correlation) ==")
    burns = [0, 10, 25, 50, 100, 200, 500]
```

```
print("B      " + "  ".join(f"w={w:<4}" for w in OMEGAS) + "   | pooled(w=0.9)")
for B in burns:
    row = [run(w, B, 'stationary', args.reps) for w in OMEGAS]
    print(f"{B:<6} " + "  ".join(f"{r['within']:.3f}" for r in row) + f"   | {row
[2]['pooled']:.3f}")

print("\n== Validation: long sample (T=2000) should approach Proposition 8 ==")
rng = np.random.default_rng(1)
for w in OMEGAS:
    v = []
    for _ in range(40):
        R, K = simulate_panel(rng, w, 300, 'stationary', t_keep=2000)
        v.append(within_corr(R, K).mean())
    print(f"omega={w}: simulated {np.mean(v):.3f}  theory {theory(a, w):.3f}")

print("\n== Monte Carlo error: headline run with a second seed ==")
for w in OMEGAS:
    r = run(w, args.burn, 'stationary', args.reps, seed=SEED + 1)
    print(f"omega={w}: ", fmt(r))

print("\n== Alternative initial conditions, no burn-in ==")
for init in ("zero", "steady_mean"):
    for w in OMEGAS:
        print(f"K0={init:<12} omega={w}: ", fmt(run(w, 0, init, args.reps)))
```

Declaration on AI Use

The author disclose the use of Claude Sonnet 5.5 and Gemini 3.8 Flash in the drafting phase to assist with ideation, language polishing and grammatical corrections. All such outputs were critically reviewed and edited by the author to eliminate potential hallucinations or inaccuracies. The author take full responsibility for the content of the manuscript.

References

Acs, Z. J., Audretsch, D. B., Braunerhjelm, P., and Carlsson, B. (2004). The missing link: The knowledge filter and entrepreneurship in endogenous growth. CEPR Discussion Paper 4783, Centre for Economic Policy Research.

Acs, Z. J., Audretsch, D. B., and Lehmann, E. E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 41(4):757–774.

Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., and Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 32(1):15–30.

Acs, Z. J. and Sanders, M. (2013). Knowledge spillover entrepreneurship in an endogenous growth model. *Small Business Economics*, 41(4):775–795.

Aghion, P. and Howitt, P. (1992). A model of growth through creative destruction. *Econometrica*, 60(2):323–351.

Andersen, H. C. (1837). Keiserens nye Klæder [The emperor's new clothes]. In *Eventyr, fortalte for Børn*. C. A. Reitzel. Third booklet.

Anton, J. J. and Yao, D. A. (1995). Start-ups, spin-offs, and internal projects. *Journal of Law, Economics, & Organization*, 11(2):362–378.

Arrow, K. J. (1962). Economic welfare and the allocation of resources for invention. In Nelson, R. R., editor, *The Rate and Direction of Inventive Activity: Economic and Social Factors*, pages 609–626. Princeton University Press.

Audretsch, D. B. (1995). *Innovation and Industry Evolution*. The MIT Press, Cambridge, MA.

Audretsch, D. B., Belitski, M., and Caiazza, R. (2021). Start-ups, innovation and knowledge spillovers. *The Journal of Technology Transfer*, 46:1995–2016.

Audretsch, D. B., Belitski, M., and Fiedler, A. (2026). The knowledge spillover theory of entrepreneurship and innovation: Taking stock and new directions. *The Journal of Technology Transfer*, 51:2117–2140.

Audretsch, D. B. and Keilbach, M. (2007). The theory of knowledge spillover entrepreneurship. *Journal of Management Studies*, 44(7):1242–1254.

Audretsch, D. B. and Lehmann, E. E. (2005). Does the knowledge spillover theory of entrepreneurship hold for regions? *Research Policy*, 34(8):1191–1202.

Audretsch, D. B. and Lehmann, E. E. (2025). A knowledge spillover narrative theory of entrepreneurship. *The Journal of Technology Transfer*, 51:226–242.

Barboza, G. (2024). Missing links of knowledge spillover effects on firm intensity and regional development. *Small Business Economics*, 63:1721–1745.

Barboza, G. and Pede, V. (2024). Weak vs strong knowledge spillover effects: Evidence from geographic distribution of innovative startup in Italy. *Review of Regional Studies*.

Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How much should we trust differences-in-differences estimates? *The Quarterly Journal of Economics*, 119(1):249–275.

Blau, D. M. (1987). A time-series analysis of self-employment in the United States. *Journal of Political Economy*, 95(3):445–467.

Block, J., Thurik, R., and Zhou, H. (2013). What Turns Knowledge into Innovative Products? The Role of Entrepreneurship and Knowledge Spillovers. *Jornal of Evolutionary Economics*, 23.:693–718.

Braunerhjelm, P., Acs, Z. J., Audretsch, D. B., and Carlsson, B. (2010). The missing link: Knowledge diffusion and entrepreneurship in endogenous growth. *Small Business Economics*, 34(2):105–125.

Cameron, A. C., Gelbach, J. B., and Miller, D. L. (2008). Bootstrap-based improvements for inference with clustered errors. *The Review of Economics and Statistics*, 90(3):414–427.

Cohen, W. M. and Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1):128–152.

D'Alessandro, F., Santarelli, E., and Vivarelli, M. (2024). The Knowledge Spillover Theory of Entrepreneurship and Innovation (KSTE+I) Approach and the Advent of AI Technologies: Evidence from the European Regions. *IZA Discussion Papers, No. 17206, Institute of Labor Economics (IZA), Bonn*.

Dutta, S. and Forbes, D. P. (2024). Fostering entrepreneurship in nonmetro areas: Ecosystem architects as conduits of knowledge spillovers. *Academy of Management Journal*.

Fotopoulos, G. (2022). Knowledge spillovers, entrepreneurial ecosystems and the geography of high growth firms. *Entrepreneurship Theory and Practice*, 47(5):1877–1914.

Ghio, N., Guerini, M., Lehmann, E. E., and Rossi-Lamastra, C. (2015). The emergence of the knowledge spillover theory of entrepreneurship. *Small Business Economics*, 44(1):1–18.

Gollin, D. (2008). Nobody's business but my own: Self-employment and small enterprise in economic development. *Journal of Monetary Economics*, 55(2):219–233.

Gries, T. and Naudé, W. (2010). Entrepreneurship and structural economic transformation. *Small Business Economics*, 34(1):13–29.

Grossman, G. M. and Helpman, E. (1991). *Innovation and Growth in the Global Economy*. MIT Press, Cambridge, MA.

Hellmann, T. (2007). When do employees become entrepreneurs? *Management Science*, 53(6):919–933.

Kirschning, R. and Mrożewski, M. (2022). The role of entrepreneurial absorptive capacity for knowledge spillover entrepreneurship. *Small Business Economics*, 60:105–120.

Lazear, E. P. (2005). Entrepreneurship. *Journal of Labor Economics*, 23(4):649–680.

Lucas, R. E. (1978). On the size distribution of business firms. *The Bell Journal of Economics*, 9(2):508–523.

Malerba, F. and McKelvey, M. (2020). Knowledge-intensive innovative entrepreneurship integrating Schumpeter, evolutionary economics, and innovation systems. *Small Business Economics*, 54(2):503–522.

Naudé, W. (2024). Entrepreneurship is dangerously obsessed with growth and incompatible with current visions of a post-growth society. IZA Discussion Paper 17158, Institute of Labor Economics.

Naudé, W. (2025). Business and entrepreneurship is declining as scholarly field: Empirical evidence. *PLOS ONE*, 20(5):e0323297.

Nicoletti, G., Scarpetta, S., and Boylaud, O. (2000). Summary indicators of product market regulation with an extension to employment protection legislation. OECD Economics Department Working Papers 226, OECD Publishing.

Plummer, L. A. and Acs, Z. J. (2014). Localized competition in the knowledge spillover theory of entrepreneurship. *Journal of Business Venturing*, 29(1):121–136.

Qian, H. (2018). Knowledge-based regional economic development: A synthetic review of knowledge spillovers, entrepreneurship, and entrepreneurial ecosystems. *Economic Development Quarterly*, 32(2):163–176.

Qian, H. and Acs, Z. J. (2013). An absorptive capacity theory of knowledge spillover entrepreneurship. *Small Business Economics*, 40(2):185–197.

Qian, H., Acs, Z. J., and Stough, R. R. (2013). Regional systems of entrepreneurship: The nexus of human capital, knowledge and new firm formation. *Journal of Economic Geography*, 13(4):559–587.

Romer, P. M. (2015). Mathiness in the theory of economic growth. *American Economic Review*, 105(5):89–93.

Schumpeter, J. A. (1934). *The Theory of Economic Development*. Harvard University Press. Translated by R. Opie. Original work published 1911.

Shackle, G. L. S. (1982). Foreword. In Hébert, R. F. and Link, A. N., editors, *The Entrepreneur: Mainstream Views and Radical Critiques*. Praeger. Foreword to the volume by R. F. Hébert and A. N. Link.

Tsvetkova, A. and Partridge, M. (2021). Knowledge-based service economy and firm entry: An alternative to the knowledge spillover theory of entrepreneurship. *Small Business Economics*.