

## RESEARCH STATEMENT

ÁLVARO PARRA

I am an applied microeconomic theorist in the field of industrial organization; my research has often focused on the economics of innovation and competition policy. For example, my research has provided a better understanding of the relationship between competition and innovation, analyzed how patent policy affects market structure and innovation dynamics, and offered technical tools to facilitate prospective analysis of economic policies involving entry.

My research has appeared (or is scheduled to appear) in leading journals in the field of Industrial Organization, such as *RAND Journal of Economics*, *Journal of Industrial Economics*, *International Journal of Industrial Organization*, and *Management Science*. For most of my work, my collaborators were assistant professors or graduate students when completing our papers. In what follows, I summarize my main research contributions in two established areas (Dynamic Models of Innovation and Market Entry) and describe a new and exiting new research agenda (Insurance of Endogenous Health Outcomes).

**A. Dynamic Models of Innovation**

Innovation has been regarded by many as the engine of a growing economy. My work in this area has been devoted to understanding different aspects of innovation from a dynamic perspective. For instance, I have studied how changes in patent policy (or the number of competitors) can affect leader-follower dynamics, the pace of innovation, and the type and number of firms participating.

Arrow (1962) observed that a technology leader has less incentive to innovate than a follower, as, with the development of an innovation, a leader would cannibalize existing rents, gaining less from an innovation than a follower.<sup>1</sup> Behind *Arrow's replacement effect* is the fundamental idea that firms invest according to the incremental rents they derive from an innovation. My work seeks to better understand firms' R&D investment decisions. In particular, how different forms of strategic interaction affect firms' replacement effects. For example, I have studied how competition, through strategic pricing or different vertical arrangements, influence competitors' replacement effect, deterring them to invest in R&D.

In "Sequential innovation, patent policy, and the dynamics of the replacement effect" (*RAND Journal of Economics*, 2019), I study how patent policy—characterized by patent length and forward protection—affects R&D dynamics, leadership persistence, and market structure. The motivating observation for this paper is that when patents have an expiration date, firms' innovation incentives increase (are *nonstationary*) over time.

Consider the incentives a technology leader faces when deciding whether to improve upon its current patented technology. Because the residual value of a patent decreases

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<sup>1</sup>Arrow, K. (1962). Economic welfare and the allocation of resources for invention. In *The Rate and Direction of Inventive Activity: Economic and Social Factors*, NBER Chapters, National Bureau of Economic Research, Inc, pp. 609–626.

when the patent’s expiration date approaches, the leader’s replacement effect is mitigated over time. Incentives to invest in R&D increase as the patent term runs out.

A novel observation of this paper is that the leader’s replacement effect also affects firms that are behind in the technology race (the followers). Stronger patent protection against future innovations increases the followers’ probability of infringing on existing patents. In case of an infringement, an innovating follower pays damages proportional to the leader’s profit-loss (the residual value of a patent), inducing followers to internalize the leader’s replacement effect. Thus, when the patent’s expiration date approaches, the expected license fees paid by an infringing follower decrease, and the followers’ incentives to improve upon existing technologies are also increasing over time. Both followers and leaders have a greater incentive to invest in R&D toward the end of a patent’s life.

Under sufficiently high patent protection against future innovations, Arrow’s traditional result reverses: followers have less incentive to invest than leaders at every moment of the patent’s life. Given the nonstationarity of R&D investments and Arrow’s reversal result, I study the policy that maximizes innovative activity. I find that overly protective policies decrease innovation through two mechanisms: delaying firms’ investments toward the end of the patent’s life and reducing the number of firms performing R&D.

In terms of impact, this paper is well cited. According to the journal’s website, it is the paper with the largest number of published citations in its issue. In “Innovation and Competition: The Role of the Product Market” (with Guillermo Marshall; *International Journal of Industrial Organization*, 2019), we revisit one of the oldest questions in economics: what is the relation between competition and innovation? We study a dynamic oligopoly model where firms compete in the product market and through the development of a sequence of innovations. One of the framework’s main advantages is working with general product-market profit functions. This abstraction allows us to accommodate any form of product-market competition.

The main insight of the paper is that product-market competition determines pre- and post-innovation profits, affecting the firms’ replacement effect in complex ways. In this context, we show that (for example) different shapes of demand function can lead to various relations between competition and innovation (increasing, decreasing, or even tilde-shaped). Given this range of possibilities, we offer necessary and sufficient conditions for the aggregate R&D effort (and conditions for welfare) to increase or decrease with the degree of competition. These conditions are easy to verify with data—i.e., they depend only on the shape of the product market payoffs, not requiring solving for the equilibrium of the dynamic game—making them informative for competition policy practitioners.

This paper received IJIO’s 2019 best theory paper award. It is the journal’s most cited paper in the last three years and has been in the top-3 most downloaded papers since its publication (see the Appendix for reference). The paper is also cited by several books, such

as the latest Handbook of Industrial Organization.<sup>2</sup>

In “Announcing High Prices to Deter Innovation” (with Guillermo Marshall; *Management Science*, 2021), we explore how pricing decisions may affect competitors’ replacement effect and consequently their incentives to invest in R&D. The project started with the observation that many firms in innovative industries make price announcements at media events when unveiling new products. These price announcements are meaningful in that a firm usually does not revise the prices it announces until it makes a new product launch. We show that a firm can use price announcements to manipulate the rival rents and, ultimately, the rival’s incentives to invest in R&D. The fundamental insight is that announcing a higher price softens competition in the product market, reducing the business stealing (replacement effect) that the new product generates. If rival firms’ profits remain high despite introducing the new product, rivals will be less driven to innovate. Formally, we show that price announcements cause equilibrium prices to be higher and innovation rates to be lower relative to the equilibrium in which firms do not make price announcements.

In “Monopsony Power and Supplier Innovation” (with Guillermo Marshall; forthcoming at *Journal of Industrial Economics*), we observe that many innovative firms outsource manufacturing and developing parts for their products. These outsourcing firms are usually the primary or sole purchasers of the component, giving them market power. We asked, how a firm with monopsonistic power incentivize can the R&D that occurs outside the boundaries of their firm? Consistent with anecdotal evidence, we find that monopsonists can incentivize R&D by squeezing their suppliers until the innovation arrives—that is, paying them less and purchasing fewer units. Squeezing decreases the supplier’s current profits, reducing the supplier’s replacement effect, raising the incremental rent of innovation and the incentives to innovate.

We also explore how the squeezing incentives affect the boundaries of the firms. We show that when the component innovated upon is ‘small,’ firms prefer to remain disintegrated, leading to faster innovation. When the product component becomes substantial in the profit generation, firms prefer to vertical integrate, resolving the rent appropriation problem induced by operating separately.

In “On the Interaction of Patent Screening and its Enforcement” (with Gerard Llobet and Javier Suarez; Revision requested by *Journal of Industrial Economics*), we observe that the patent system is composed of (at least) two institutions: The patent office, which screens innovators looking for novelty and non-obviousness, and courts, which enforce patent rights. Better ex-ante screening leads to a lower ex-post probability of infringement. We explore the interplay between patent screening and patent enforcement in a dynamic economy with a continuum of markets and oligopolistic competition in each market. Enforcement involves type I and type II errors: rejecting novel innovators or allowing obvious entrants.

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<sup>2</sup>Bryan, K. A., & Williams, H. L. (2021). Innovation: market failures and public policies. In Handbook of Industrial Organization (Vol. 5, No. 1, pp. 281-388). Elsevier; Gilbert, R. J. (2022). Innovation matters: competition policy for the high-technology economy. MIT Press

We find that when the patent office takes the rates at which such errors occur as given (i.e., ignoring the strategic interaction between screening and enforcement), granting some invalid patents is socially optimal even in the absence of screening costs because it encourages innovation. When the influence of screening on courts' enforcement efforts is considered, these forces imply that screening and enforcement are complementary. Contrary to common wisdom, better screening induces better enforcement. Also, an increase in enforcement costs should be optimally accommodated with less rather than more ex-ante screening.

Finally, in “Vertical structure, downstream innovation, and pricing” (with Guillermo Marshall, *selected work in progress*), we consider an upstream supplier and two downstream firms competing in the product market and through the development of innovations that improve their products. Suppose the upstream supplier vertically integrates with one of the downstream competitors. In this case, the integrated firm will face the following trade-off: On the one hand, it has the traditional incentive to raise the rival's cost, forcing the competitor to price higher, decreasing the downstream competition for the vertically integrated firm. On the other hand, increasing the rival's costs reduces its replacement effect, pushing the competitor to innovate faster and increasing expected future competition.

## B. Market Entry

In this line of research, I try to better understand firms entry decisions. Although my research in this area is theoretical, the research questions have a strong empirical motivation.

In “Equilibrium Uniqueness in Entry Games with Private Information” (with J. Espin-Sanchez and Y. Wang; *RAND Journal of Economics*, 2023), we study the following questions: When does an entry game have a unique equilibrium? Can we provide testable conditions for an entry game to have a unique equilibrium? Establishing equilibrium uniqueness is particularly important when performing counterfactual analysis. It ensures that a model provides a single counterfactual prediction. To this end, we study equilibria in static entry games with single-dimensional private information. Our framework is quite general, embedding many models commonly used in applied work, such as auctions, competition in price, and quantities. The proposed framework allows for firm heterogeneity and selection at entry.

We introduce the notion of strength, which summarizes a firm's ability to endure competition. We show that an equilibrium in which entry strategies are ordered according to the firms' strengths always exists. We call this equilibrium herculean. From this equilibrium, we derived simple and testable sufficient conditions guaranteeing equilibrium uniqueness and consequently a unique counterfactual prediction. To show the usefulness of the proposed conditions, we use the model estimates to evaluate our sufficient condition in a set of papers in the literature that use numerical methods to argue for equilibrium uniqueness. We demonstrate theoretically (rather than by using numerical methods) that the equilibria in the models used in this set of paper are indeed unique.

In “Early-Stage Venture Financing” (with Ralph Winter; *Journal of Corporate Finance*, 2022), we are motivated by the emergence of a new financing instrument, a “SAFE,” which is exclusively used by new ventures and is becoming dominant in early financing rounds. This instrument gives investors the right to a pre-specified value of shares at a price determined when equity is issued in the future. This right over shares is triggered only when new equity is issued. We develop a theory of venture financing at the earliest stages to better understand why we only observe SAFE with new ventures and the role they fulfill. Ventures choose between issuing equity or a SAFE. Our key assumption is that the market learns information that is initially private to the entrepreneur between the two financing rounds. This information asymmetry is maximal at the early stages of a venture and explains why we do not observe SAFEs for more mature organizations.

We find that higher-quality ventures prefer to issue a SAFE over equity for the first round of financing because, under the SAFE, they know that their types will be revealed to the market before determining the number of shares they must provide. Offsetting this attraction to SAFEs is a moral hazard (debt-overhang) cost of SAFEs. We find initial support for the theory in a data set of 500 financing rounds.

I conclude by briefly summarizing two (selected) ongoing projects in the area of market entry. In “Herculean Equilibrium and Risk Dominance” (with J. Espin-Sanchez), we show that the notions of strength and herculean equilibrium—introduced in “Equilibrium Uniqueness in Entry Games with Private Information”—are incomplete-information analogs of the notions of risk factor and risk-dominant equilibrium.

In “Efficiency in Second Price Auctions with Entry Costs” (with J. Espin-Sanchez), we show that an auction in which participation is costly has three sources of potential inefficiencies: i) excessive entry; ii) no entry when entry is desirable; and, iii) inefficient allocations of the product being auctioned. Despite these inefficiencies, a second-price auction always has an ex-ante efficient equilibrium. Thus, when the equilibrium is unique, it is efficient.

### **C. Insuring Endogenous Health Outcomes**

This project is joint with Vitor Luz Farinha at UBC’s VSE. It focuses on a dynamic dimension of health insurance overlooked by current economic analysis—but certainly not by health sciences. The main observation is the following: Health shocks (e.g., an accident or illness) arrive as a function of the underlying health status of an individual (say, a healthy or unhealthy person) and the preventive care she undertakes (e.g., getting a flu shot, exercising, eating healthy). On the other hand, the future health status of an individual depends on how complete and thorough the treatment is after a negative health shock occurs. The thoroughness of care that an individual undertakes, however, strongly depends on the terms of the insurance contract she has. A high deductible contract, for instance, induces undertreatment at the benefit of more preventive care. Thus, healthcare decisions affect the individual’s future health status and distribution of health shocks.

A concrete example may help to illustrate the point. Treating a broken leg may con-

sist of surgery, immobilization, and physiotherapy. How thorough the treatment will be, depends on the health insurance coverage. Not completing physiotherapy, say for lack of coverage, leads the individual to have reduced mobility and an increased likelihood of future injuries. In other words, when designing the terms of an insurance contract, we account for an individual's financial well-being and their distribution of health outcomes over time. This new dynamic effect is independent of traditional moral hazard and adverse selection problems. However, it interacts with them in complex ways.

Our observation leads to several research questions (papers). Our current focus is on how competition affects the terms of insurance and the health outcomes of an individual in a world without moral hazard and adverse selection. We intend to show that even in an idealized world—where healthcare decisions are contractible—incorporating the dynamic impact that today's health decisions have on future outcomes lead to non-trivial effects.

We have preliminary and interesting results comparing competitive vs. monopolized health markets. In the standard model—where today's health decisions do not affect the distribution of future health outcomes—competition is always good, as competitive insurers give all their rent to consumers. In contrast, we found that competition might damage health markets when incomplete treatment is possible. Since competitive insurers perceive no rents (present or future), they have no incentives to invest in an individual's health status. Competitive insurers, thus, only provide minimal mandatory treatment after a health shock. In turn, monopolistic insurers extract rents from consumers, harming them. At the same time, they have incentives to invest in improving the health status of their population if a healthier individual leads to higher future rents. This dynamic incentive leads to better health outcomes and a lower financial burden for consumers and insurers. The trade-off described above is non-trivial and depends on the magnitude of the health shocks, their persistence, and the individual and insurer's (through the contract they provide) ability to affect future health outcomes.

The previous idea is just the starting point for the project. We foresee many possible future paths. Adding moral hazard (i.e., healthcare decisions are not contractible) is a natural extension to understanding how preventive vs. reactive care incentives interact and evolve throughout an individual's lifetime. Another interesting extension is assuming that health status is not observable (adverse selection) and how pre-existing conditions will interact with the dynamic incentives of investing in people's health. Another research avenue recognizes that designing insurance for a population (not just an individual's) conveys additional constraints (e.g., no age discrimination). We can then study the population's endogenous health outcomes throughout different health systems system

This project is well-motivated, important, of general interest, and exciting from an applied and theoretical perspective. We believe that its development can affect the design of public and private health systems and, at the same time, develop new useful tools to study dynamic contracting in general.