Dear Author,

Please check your proof carefully and mark all corrections at the appropriate place in the proof (e.g., by using on-screen annotation in the PDF file) or compile them in a separate list. Note: if you opt to annotate the file with software other than Adobe Reader then please also highlight the appropriate place in the PDF file. To ensure fast publication of your paper please return your corrections within 48 hours.

For correction or revision of any artwork, please consult http://www.elsevier.com/artworkinstructions.

Any queries or remarks that have arisen during the processing of your manuscript are listed below and highlighted by flags in the proof. Click on the ‘Q’ link to go to the location in the proof.

<table>
<thead>
<tr>
<th>Location in article</th>
<th>Query / Remark: click on the Q link to go please insert your reply or correction at the corresponding line in the proof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Please confirm that given names and surnames have been identified correctly.</td>
</tr>
<tr>
<td>Q2</td>
<td>Keywords are required. Please provide.</td>
</tr>
<tr>
<td>Q3</td>
<td>The country name “United States” has been inserted for the first affiliation and the correspondence address. Please check, and correct if necessary.</td>
</tr>
<tr>
<td>Q4</td>
<td>The country name “Russian Federation” has been inserted for the second affiliation. Please check, and correct if necessary.</td>
</tr>
<tr>
<td>Q5</td>
<td>The country name “Sweden” has been inserted for the third affiliation. Please check, and correct if necessary.</td>
</tr>
<tr>
<td>Q6</td>
<td>The country name “Finland” has been inserted for the fourth affiliation. Please check, and correct if necessary.</td>
</tr>
<tr>
<td>Q7</td>
<td>Citation “Posen, Lee, and Yi (2013)” has not been found in the reference list. Please supply full details for this reference.</td>
</tr>
<tr>
<td>Q8</td>
<td>Citation “Audretsch, Kielbach, &amp; Lehman, 2006” has not been found in the reference list. Please supply full details for this reference.</td>
</tr>
<tr>
<td>Q9</td>
<td>Citation “Audretsch, Kielbach, &amp; Lehmann, 2006” has not been found in the reference list. Please supply full details for this reference.</td>
</tr>
<tr>
<td>Q10</td>
<td>Citation “Cohen, Nelson, &amp; Walsh (2000)” has not been found in the reference list. Please supply full details for this reference.</td>
</tr>
<tr>
<td>Q11</td>
<td>Citation “Chang, Chrisman, &amp; Kellermanns, 2011” has not been found in the reference list. Please supply full details for this reference.</td>
</tr>
<tr>
<td>Q12</td>
<td>Citation “Jacobs, Lee, Richard and Bates (2001) ” has not been found in the reference list. Please supply full details for this reference.</td>
</tr>
<tr>
<td>Q13</td>
<td>Uncited reference: This section comprises references that occur in the reference list but not in the body of the text. Please position each reference in the text or, alternatively, delete it. Thank you.</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Q14</td>
<td>Please check the telephone/fax number of the corresponding author, and correct if necessary.</td>
</tr>
</tbody>
</table>

Please check this box if you have no corrections to make to the PDF file. □

Thank you for your assistance.
Highlights

Technological arbitrage opportunities and interindustry differences in entry rates

Sergey Anokhin a,b,⁎, Joakim Wincent c,d

⁎ Kent State University, United States
a Voronezh State University, Russian Federation
b Luleå University of Technology, Sweden
c University of Vaasa, Finland

d Kent State University, United States

• Technological arbitrage opportunities are positively related to entry rates across industries.
• Effectiveness of patents, secrecy, and lead time negatively moderates this relationship.
• Arbitrage opportunities explain entrepreneurial dynamics above and beyond innovative opportunities.
• Arbitrage opportunities are very effective in explaining entry rates.
Technological arbitrage opportunities and interindustry differences in entry rates

Sergey Anokhin a,b,⁎, Joakim Wincent c,d

Article info

Article history:
Received 22 November 2011
Received in revised form 9 July 2013
Accepted 10 July 2013
Available online xxxx

Field Editor: Dino Dimov

A B S T R A C T

In this study we investigate the relationship between technological arbitrage opportunities and entry rates in twenty-six industries over the course of five years. Arbitrage opportunities are shown to be a positive and significant predictor of business entry rates. Such positive effect is weakened in industries with strong appropriability regime including effective patents, secrecy, and lead time. Adding arbitrage opportunities to the typical determinants of entrepreneurship such as innovative opportunities significantly increases predictive power of the regression models.

© 2013 Elsevier Inc. All rights reserved.

1. Executive summary

Entrepreneurs are believed to act in response to opportunities that come in two basic forms: innovative and arbitrage. Accordingly, the variance in business entry rates across industries may be explained by the relative availability of opportunities of these two kinds. While innovative opportunities, and the relationship between entrepreneurship and innovation, have been studied in some detail in the past, there is a dearth of empirical studies on entrepreneurship and arbitrage opportunities. Our research suggests that this is a major shortcoming as entrepreneurs often act on more trivial forms of opportunities than those aiming at grand innovation.

We take several steps in filling this research gap and uncovering the prominent role of arbitrage for entrepreneurship. First, we estimate the amount of arbitrage opportunities available to a typical firm in a wide set of industries. Specifically, we focus on technological arbitrage opportunity and discuss why it should be considered in entrepreneurship research. Effectively, the availability of technological arbitrage opportunities represents the extent to which a new entrant may expect to earn above-average returns by imitating industry leaders. We demonstrate that indeed the availability of arbitrage opportunities varies widely across industries with the lowest level of opportunity in industries such as automobile and truck manufacturing, air transportation, and publishing industry and the highest in industries such as software publishing, information services and pharmaceutical industry.

Second, we suggest that this variance in the availability of arbitrage opportunities may explain significant differences in the rates of new entry across industries. Indeed, we demonstrate that inclusion of arbitrage opportunities into regression models that predict new entry rates increases predictive power of statistical models by over 20% above that which could be attributed to innovative opportunities. That is, in addition to unexploited opportunities that have been suggested by the proponents of the knowledge spillover theory of entrepreneurship to explain the rates of entrepreneurship, underexploited opportunities apparently motivate new entry to a substantial degree.

Third, we demonstrate that the effectiveness of arbitrage opportunities in explaining rates of entrepreneurship is affected by the appropriability regime in the respective industries. Industries that enjoy effective patent protection or secrecy or lead time
advantages do not invite new entries to the same extent as industries where the effectiveness of those appropriability regime mechanisms is low. This has non-trivial implications for entrepreneurship and entrepreneurship policy recommendations since what works in some industries may prove ineffective in others.

Several implications emerge from our results. First, theoretically, we broaden the prevailing views of the origins of entrepreneurial opportunities by suggesting to look at underexploited and not just unexploited opportunities. Such an extension is fully in line with the entrepreneurship research classics and thus should complement extant literature naturally. Second, we show that the classic notions that play an important role in entrepreneurship research—such as that of risk—matter greatly in explaining the conversion of arbitrage opportunities into new entries. Third, we demonstrate that technological arbitrage opportunities explain new entries over and above the effects attributable to innovative opportunities and as such future research would be wise to consider inclusion of entrepreneurial arbitrage into the normological network. Our results suggest that at a minimum future entrepreneurship research should incorporate arbitrage opportunities as an important control since it is a powerful predictor of new business entry. In all likelihood, including arbitrage opportunities in the empirical investigation of entrepreneurial phenomena will generate major insights of theoretical and practical importance. For practice, our results help provide guidance to managers of existing firms and would-be entrants by uncovering the relative availability of arbitrage opportunities across industries and suggesting whether and how those opportunities may be exploited. Our research also informs policy makers with respect to designing effective regulatory frameworks.

2. Introduction

Despite the visible preoccupation of the empirical entrepreneurship literature with innovation and innovative opportunities (e.g., Eckhardt and Shane, 2003; Eddleston et al., 2008; Katila and Mang, 2003; Shane, 2001; Zahra, 1993; 1996), opportunities to which enterprising individuals respond are not limited to grand innovation. Indeed, given the fact that the vast majority of new firms are small in size and have little economic impact (Bhide, 2000; Shane, 2009), it appears that the opportunities to which many startups respond are of a different, more trivial nature than is often assumed in the empirical entrepreneurship research. As is argued by the entrepreneurship research classics, a lion’s share of new entries may be attributable to the so-called arbitrage opportunities (e.g., Kirzner, 1973). In their most basic form, such opportunities imply profiteering from ‘buying low and selling high’ (Kirzner, 1997). That is, market inefficiencies that make possible differential pricing of certain resources or their combinations are seen as a possible source of entrepreneurial rents.

These arbitrage opportunities range from inefficiencies caused by random events (such as drinking water or gasoline shortage after major natural disasters) to trivial and short-lived financial market inefficiencies to disturbances in consumer preferences that have to do with fashion evolution and changing public tastes to systematic differences in how resources are combined (i.e., the means–ends frameworks). While the ‘random’ arbitrage opportunities may be ignored since they have no discernable effect on long-term entrepreneurial dynamics, other types of arbitrage may (and should) be accounted for. Financial arbitrage has been studied extensively to date (e.g., Bradley et al., 2010; Gagnon and Karolyi, 2010; Mitchell et al., 2002; Shleifer and Vishny, 1997).

Arbitrage opportunities due to temporal shifts in public preferences, as the current research suggests (Anokhin et al., 2011a), may simply be controlled for with year dummies. Yet systematic differences in resource allocation efficiency within industries should be studied very closely for it is these opportunities—however ‘trivial’ (Alvarez and Barney, 2004) in the grand sense they may be—that motivate a major share of entrepreneurial activity (Kirzner, 1973; Minniti and Levesque, 2010) and may be the reason for the widely unequal startup rates across industries. (Evans and Siegfried, 1994; Fritsch and Falck, 2007; Geroski, 1995). This is particularly important because entrepreneurship, often proxied with the creation of new organizations (e.g., Gartner, 1989), is often viewed as the pursuit of opportunities regardless of the resources one controls (Stevenson and Jarillo, 1990)—and we suggest that much like innovative opportunities, arbitrage opportunities of this systematic nature vary widely across industries.

We refer to these as technological arbitrage opportunities (in the sense of Lipschitz et al., 2002 and Anokhin et al., 2011a), which in the industry context represents the extent to which a typical firm may improve its efficiency if it alertly recognizes and adopts the best way to combine resources that has to do with fashion evolution and changing public tastes to systematic differences in how resources are combined (i.e., the means–ends frameworks), as proffered by Eckhardt and Shane, 2003) and as such is not limited to traditional technology-intensive industries. Where such opportunities are especially pronounced or sustained, one may expect to see a major inflow of new firms that hope to extract and appropriate above-average returns (compared to a typical industry firm). In this sense, the entrepreneurial activity encouraged by the presence of technological arbitrage opportunities is akin to strategic catching-up imitation.1 In our empirical analysis we show that the intuition of the early entrepreneurship field theorists with respect to the major role played by arbitrage opportunities in explaining the startup

---

1 See Davidson (2003) for the analysis of ‘new organizations’ vs ‘opportunities’ views of entrepreneurship.
2 Throughout the rest of the paper, we use “technological arbitrage opportunities” and “arbitrage opportunities” interchangeably, unless specially noted.
3 Yet, we acknowledge that not all imitative efforts would be directed at the pursuit of arbitrage opportunities much like not all replication is necessarily imitative (Rivkin, 2001). Posen, Lee, and Yi (2013) in their convincing analysis demonstrate how imperfect imitation by industry leaders of the inferior technologies utilized by those lagging behind may result in significant innovative spurts. We exclude such cases from our consideration because in our view arbitrage opportunities represent the ‘low-hanging fruit’ (Anokhin, 2013) that firms may pick rather easily and without much uncertainty by imitating the best. That is, purposeful recombining with the view to innovate is not in the domain of entrepreneurial arbitrage. Thus, there is no one-to-one correspondence between technological arbitrage opportunities and imitation although the overlap may be substantial.

Please cite this article as: Anokhin, S., Wincent, J., Technological arbitrage opportunities and interindus try differences in entry rates, Journal of Business Venturing (2013), http://dx.doi.org/10.1016/j.jbusvent.2013.07.002
dynamics was correct, and that indeed new entry into industries may be motivated by the presence of the easy-to-grab, low-hanging “arbitrage opportunity fruit” and not exclusively by the innovative opportunities as is sometimes assumed by the entrepreneurship research.4

In terms of our conceptual development, we begin by relaxing some implicit assumptions of the knowledge spillover theory of entrepreneurship (Audretsch, Kielbach, & Lehmann, 2006; Acs et al., 2009) and incorporating the insights from the classic literature on risk (Knight, 1921) to derive a series of hypotheses that link the availability of arbitrage opportunities and key industry conditions (dimensions of the appropriability regime) to entrepreneurial dynamics. Our results clearly indicate that arbitrage opportunities are a strong, reliable predictor of entry rates in the industries. By so doing, we contribute to the entrepreneurship literature and complement earlier studies of Levin, Kleverick and their colleagues who provided insights into and estimates of interindustry differences in appropriability regimes and innovative (technological) opportunities (Kleverick et al., 1995; Levin et al., 1987).

The paper proceeds as follows. First, we discuss technological arbitrage opportunities in the industry context. Next, we set up a formal hypothesis that links arbitrage opportunities to entrepreneurial dynamics in the industry. We then develop the links between the notion and different manifestations of the appropriability regime and the concept of risk that is central to entrepreneurship research and formulate a set of hypotheses that qualify the relationship between arbitrage opportunities and industry entry rates. We follow by presenting our data, method, and results. The paper concludes with a discussion of our results and limitations of our research and elaborates at length on the possible avenues for future studies.

3. Conceptual framework and hypotheses development

3.1. Technological arbitrage opportunities: extending the knowledge spillover theory

The origin of opportunities to which enterprising individuals and entrepreneurially-oriented firms respond is of significant interest to the entrepreneurship literature. To explicate and theoretically ground our view of technological arbitrage opportunities we refer to the knowledge spillover theory (KST) of entrepreneurship (Audretsch, Kielbach, & Lehmann, 2006) that has recently gained much traction in the field but relax some of its assumptions. Our conceptual development, while building on the KST, expands its boundaries and offers novel yet straightforward and easily testable insights regarding the nature of the relationships between industry entry rates and entrepreneurial opportunities.

Under the KST, most opportunities are created through the purposeful investment into R&D by established corporations and specialized entities such as R&D labs and universities. Although the funding for such activity is provided by exogenous parties, the new knowledge created is embodied in individuals such as scientists, engineers, or knowledge workers. Because of the knowledge filter (Acs et al., 2004), the decision-making hierarchies within which such individuals are embedded may decide not to pursue the respective opportunities as the value of those opportunities may not seem worthy of expending exploitation efforts to the hierarchies. This is due to uncertainty accompanying the profit-generation potential of the opportunity. If and when the individuals who were part to the creation of new knowledge disagree in their assessment of the opportunity promise with the hierarchy, they may choose to pursue the opportunity on their own via a startup as “an endogenous response to opportunities” created by investments in new knowledge that are not commercialized because of the knowledge filter (Audretsch et al., 2006, p. 43). In some cases, entrepreneurially minded companies may venture into the new opportunity by setting up a new entity to pursue it via the process sometimes referred to as corporate venturing.

There are three implicit assumptions in this view of the origin of entrepreneurial opportunities that we suggest to relax to develop our notion of technological arbitrage opportunities: (1) the individuals (“knowledge workers”) have to be the party to the creation/discovery of the new means–ends relationships; (2) the opportunity has to be dismissed (left unexploited) by the decision-making hierarchy within which the discovery was made; and (3) the individuals who go after the opportunity that the hierarchy deemed unworthy of exploitation should have a remarkable tolerance for uncertainty. We, instead, suggest that (1) individuals do not have to be a party to the opportunity creation. They are simply more likely to discover opportunities that correspond to their background, and hence are more likely to recognize opportunities created within their firms (which is largely consistent with the KST) or within their industries due to intra–industry similarities (which is consistent with Shane, 2000).5 Further, (2) the opportunity does not have to be unexploited to draw attention of enterprising individuals and motivate them for action. Rather, it should be underexploited such that the market failure condition, referred to in the introduction, applies. We

4. To be fair, entrepreneurship literature has questioned the link between entrepreneurship and innovation in the recent and not-so-recent past (e.g., Schumpeter, 1942; Ferguson, 1988; Shane, 2009; Minniti and Levesque, 2010; Anokhin and Wincent, 2012).

5. According to Shane (2000), an entrepreneur’s proclivity to spot opportunities is generally limited to a specific industry (Hayek, 1945) and also the ability to exploit them is subject to the same constraint. To exploit the technological arbitrage opportunity and appropriate the resulting rents the entrepreneur needs to assemble the resources in a specific way indicated by the innovator who introduced the novel technology to the industry. Because the extent to which the resources of the would-be imitator are similar to the resources of the innovator is higher for the firm or an entrepreneur contemplating an entry into a particular industry may want to study how others in the chosen industry combine their resources to not reinvent the wheel unnecessarily but to adopt the best known technology. In other words, for any underperforming firm (or a new entrant that has decided on the industry) it makes sense to study in depth its fellow industry inhabitants to identify the best ways to combine the resources because such ways could likely be imitated. At this point, the tasks faced by such less efficient or newly created firms become “trivial” (Alvarez and Barney, 2004).

Please cite this article as: Anokhin, S., Wincent, J., Technological arbitrage opportunities and interindustry differences in entry rates, Journal of Business Venturing (2013), http://dx.doi.org/10.1016/j.jbusvent.2013.07.002
believe that if the opportunity is completely unAPPED, it falls squarely within the realm of KST—and only those who had firsthand encounter with it (the ‘knowledge workers’) will be likely candidates for exploitation. If, on the other hand, the opportunity is completely exploited by the decision-making hierarchy, it has no potential for generating economic profits (i.e., above-average returns) and would be unable to motivate new entries. It is only when it has been shown to exist via the initial attempts at exploitation by the decision-making hierarchy that it becomes visible to individuals with fitting backgrounds still offering the chance to earn above-average returns. This is precisely when Kirznerian entrepreneur may choose to ‘snuff out’ given profit opportunities (Kirzner, 2009) thus correcting the mistakes embodied in the imperfections of prior entrepreneurial effort and bring the market closer to equilibrium. Finally, (3) because individuals are largely rather intolerant of uncertainty, which is abundant in the case of ‘untried’ resource combinations (indeed, Arrow (1962) talked about uncertainty with respect to whether the new product could be produced, how it should be produced, and whether there indeed was a future market for the product to justify the effort); potential entrants would be wise to go after lower risk opportunities that have been market-tested by others and still remained attractive due to the market’s failure to adjust prices accordingly.

In short, we agree with the KST (Acs et al., 2009) that new knowledge created in the innovative organizations generates opportunities for third parties through both "arbitrage of opportunities (Kirzner, 1973) and exploitation of new opportunities created but not appropriated by incumbent firms (Schumpeter, 1934)" but explicitly add to the framework that the opportunity in question may well be underexploited rather than unexploited. In a sense, in contrast to the KST, we are dealing with the opportunities that have successfully passed through the knowledge filter and have been acknowledged by the decision-making hierarchies. We extend the KST in that to us not only do people start new ventures because they are not able to commercialize their ideas within the context of an incumbent firm or an organization (Audretsch and Keilbach, 2008) but also new entries occur when there are opportunities to benefit from market failure virtually risk-free (inasmuch as there are no appropriability mechanisms in place that make such profiteering less likely)—that is, opportunities to snuff out the profits without much downside (Kirzner, 2009). Thus, we suggest that would-be entrepreneurs and current industry members may recognize opportunities that stem from differing levels of efficiency observed in the industry, and try to seize those by imitating the best resource combination. To us, Bhide’s (2000, p. 54) finding that full 75% of Inc. 500 startups used business ideas that were a replication or modification of the ideas they encountered through previous employment or that came to them as they were reading about the industry is a strong testament to the face validity of our claims.

There are remarkable differences in the effectiveness of the ‘best’ and ‘typical’ industry firms. Some industries are rather homogenous in terms of the technologies that their firms employ and force the lesser efficient ‘deviants’ out while others sustain a wide variety of more and less efficient firms. New entrants are expected to ‘hit the ground running’ in the industries of the first kind, which makes business entry much harder and thus less likely, whereas the industries of the second kind are more tolerant of less-than-perfect firms and provide multiple opportunities for new entrants and resident firms alike to gain by imitating the next best technology. The goal of the entrepreneur who undertakes to profit from exploiting technological arbitrage opportunities is thus to identify the most effective way to combine the resources in the respective industry and imitate it so as to extract entrepreneurial rents. Obviously, inasmuch as these better ways could be imitated, competitive advantages they confer on firms or individuals that exploit them are temporary and finite (see, e.g., Barney, 1991).

**3.2. Arbitrage opportunities and entrepreneurial dynamics**

It is generally believed in the entrepreneurship literature that the pursuit of opportunities by the entrepreneurs requires significant effort (Choi et al., 2008; Dimov, 2007) and is fraught with uncertainty and risks (Knight, 1921). This is especially true for innovative opportunities as is exemplified by the famous quote attributed to Thomas Edison who was describing his unsuccessful attempts to improve the inferior incandescent light bulb technology to create a commercially successful product: ‘I have not failed 700 times. I have not failed once. I have succeeded in proving that those 700 ways will not work. When I have eliminated the ways that will not work, I will find the way that will work’. Apart from the effort required to envision and try different resource combinations, and the technological uncertainty that enshrouds such attempts—namely, whether or not a particular combination will work as expected—there is a tremendous market uncertainty that awaits potential innovator. That is, even if the effort has been expended and the technology works as expected, the market may not accept the new product thus...

---

6 At the foundation of the ‘systematic’ arbitrage opportunities lies a particular type of market failure (Kirzner, 1973). In the most general sense, market failure implies “the failure of a ... system of price-market institutions to susta in ‘desirable’ activities or to es tоп ‘undesirable’ activities. The desirability of an activity, in turn, is evaluated relative to the solution values of some ... maximum-welfare problem” (Bator, 1958, p. 351). Activities, in Bator’s definition, include production. As can be inferred from this definition, the fact that a market system sustains less efficient producers when more efficient modes of production are available constitutes market failure. It is precisely this kind of failure that gives rise to (technological) arbitrage opportunities pursuit. Market failure may be attributed to imperfect information (Stiglitz, 1989). In case of multiple firms competing in the same industry, effective information exchange may even be purposefully sabotaged by innovator firms that try to exploit the better resource combinations by pursuing a “monopolistic ex cess of price over cost” (Williamson, 1971, p. 114) without letting rivals partake of the better ways of organizing. Thus, due to market failure of this kind inefficient methods of production in an industry coexist with more efficient ones, and firms that discover ways to improve their efficiency by imitating their more advanced peers are naturally inclined to go after the respective opportunities since no rational decision maker would choose to pursue areas of lower return when areas of higher return are available (Williamson, 1971).

7 It has to be acknowledged, however, that occasionally technological search uncovers opportunities not envisioned by the entrepreneur who has initiated the search for new combinations. Such is, for instance, the well-known story of sugar substitute aspartame (tradename Nutrasweet) that was discovered accidentally by the scientists looking for ulcer treatments (Anokhin, Wincent, & Frishammar, 2011).

---

Please cite this article as: Anokhin, S., Wincent, J. Technological arbitrage opportunities and interindustry differences in entry rates, Journal of Business Venturing (2013), http://dx.doi.org/10.1016/j.jbusvent.2013.07.002
eliminating the entrepreneur’s chance of success (Gaglió, 2004). Yet, despite the enormity of the effort required, and all the uncertainty and risks accompanying the pursuit of innovative endeavors, entrepreneurs routinely invest themselves into going after such elusive opportunities to the point where the very notions of entrepreneurship and innovation are often used interchangeably (Amit et al., 1995; Baron, 2008).

In contrast, the exploitation of technological arbitrage opportunities generally requires less effort on the part of the entrepreneur. Indeed, all one needs to take advantage of technological arbitrage opportunities is to spot relevant technological changes and recombine one’s resources so as to align them with the changed (more efficient) means–ends framework. That is, one needs to effectuate the process of purposeful knowledge spillover to appropriate some portion of the rents that the technology owner is unable (or unwilling) to claim. For instance, Lovefilm, a U.K.-based DVD rental startup, has had a remarkable success of reaching over 1.5 million subscribers paying over £12 million per month in subscription fees after replicating the novel business model pioneered in 1997 and perfected by 1999 by Netflix. Similar patterns can be seen in the case of Ryanair adopting the ‘technology’ (i.e., the way to combine resources) utilized by Southwest; the U.K.’s Asda building itself after Wal-Mart; and countless other examples (Moules, 2012). Similarly, the diet soda drinks revolution introduced by RC Cola gave rise to the industry incumbents’ imitative activity that quickly redressed the balance in their favor and rode the health consciousness wave (Schnaars, 1994). Not all industry participants choose to pursue such strategy. Some prefer to buy the components from the most innovative third parties thus walking away from the possibility to gain without having to deal with much uncertainty (Kao, 2009).

For ‘pure’ arbitrage opportunities that imply simply benefitting from differential pricing of the same resource in different markets, even such minor efforts at recombining resources are not necessary (Bradley et al., 2010; Gagnon and Karolyi, 2010; Mitchell et al., 2002; Shleifer and Vishny, 1997).

For a potential entrant into the industry the existence of substantial differences between the leading and the average industry members’ efficiency is particularly attractive because it indicates the presence of sizeable opportunities that could be exploited without the need to expend the overwhelming effort (Edison’s hundreds of repetitions) or have to deal with the technological uncertainty (since the ways to combine resources have been already shown to work). It is in this sense that by aggregating the inefficiencies of the individual firms to the industry level one can make a judgment as to whether or not the industry is prone to technological arbitrage. Much like aggregating the opinions of the industry participants with respect to innovative opportunities can give a prospective entrepreneur a good sense of the technological development to happen, such collective assessment of arbitrage opportunities is a key to formulating an accurate view of technological arbitrage opportunities. This, in turn, improves the entrepreneur’s “judgment of possibilities” (as opposed to “calculation of certainties”) (Shackle, 1982, p. vii, as quoted in Acs et al., 2009) required for purposeful action. Thus, although a new entrant going after arbitrage as opposed to innovative opportunities is less likely to create the next Microsoft, Google, or Facebook, such an entrepreneur (individual or corporate) should be naturally drawn to the industries that sustain substantial arbitrage opportunities. Such industries high in arbitrage opportunities should attract prospective entrepreneurs. In other words:

Hypothesis 1. There is a positive relationship between arbitrage opportunities and startup rates in the industry.

3.3. Appropriability regime, risks, and the pursuit of arbitrage opportunities

While the uncertainty implied by the pursuit of arbitrage opportunities is substantially reduced compared to innovative opportunities, and the effort required to attain superior resource combinations is minimal since they already have been shown to work, another key concept associated with entrepreneurship—that of risk—still manifests profoundly in the quest for arbitrage opportunities. The nature of the risks, however, is distinct. Unlike ‘pure’ Kirznerian arbitrage that is about buying low and selling high, technological arbitrage opportunities pursue involves replicating someone else’s know how, and such replication may be accompanied by unique challenges of its own. Specifically, the factors associated with the strength of the industry appropriability regime—such as effectiveness of patent protection, product secrecy, and lead time in warding off imitators (Cohen et al., 2000)—may lower the attractiveness of arbitrage opportunities for prospective entrepreneurs and thus decrease entry rates into industries otherwise rich in arbitrage opportunities.

Patents as a means of protection from imitation are unique in that they require the innovator of a particular resource combination to disclose the vital information about the newly found innovative opportunity in exchange for protection awarded to the innovator by the intellectual property rights system (Griliches, 1984). Effectiveness of such system varies from industry to industry. In some industries it is relatively easy to ‘invent around’ someone’s patent (Teece, 1998) whereas other industries like the pharmaceuticals may be effectively shielded from such replication due to the laborious process of obtaining the FDA clearances. When patents are effective, imitation becomes risky since any perceived violation is likely to be countered by a lawsuit from the patent holder. As long as the strength of the patent protection regime is a known quantity—which is generally believed to be the case (Cohen et al., 2000)—the prospective entrepreneur may assign probabilities to the likelihood of a counterattack by the patent holder and/or estimate the chance of the endeavor success and take those probabilities into account when considering whether or not to pursue the respective opportunity.

*a Partly, this may be attributed to the overwhelming success and the media coverage that a small fraction of such technologically-oriented entrepreneurs achieve from Bill Gates to Sergey Brin and Larry Page to Mark Zuckerberg.

Please cite this article as: Anokhin, S., Wincent, J., Technological arbitrage opportunities and interindustry differences in entry rates, Journal of Business Venturing (2013), http://dx.doi.org/10.1016/j.jbusvent.2013.07.002
As the effectiveness of patents as a means to ward off imitators increases, the likelihood of blatant imitation by new entrants or fellow industry members declines. Prospective entrepreneurs may either decide against such imitation altogether, or consider alternative means of getting access to the desired technology such as obtaining a license (e.g., Markman et al., 2005). This, in turn, makes the entire endeavor subject to the whims of the technology owner who may deny granting a license to the entrepreneur or demand substantial payments thus reducing the effectiveness of the resource combination available to the arbitrageur while at the same time increasing own returns (Teece, 1986). This, all else equal, will put the imitator in the inferior position compared to the technology owner and may discourage the entry. In short, greater risks of a counteraction by the technology owner and lower returns available to imitators in the industries with the tight appropriability regime should weaken the positive relationship between arbitrage opportunities and business entry rates in the industry. To state formally:

Hypothesis 2. Effectiveness of patents as a means to ward off imitation negatively moderates the relationship between arbitrage opportunities and startup rates in the industry.

Similarly, the effectiveness of secrecy as a means to keep imitators at bay is likely to negatively affect the rate at which arbitrage opportunities are converted into new business entry in the industry. Exploitation of technological arbitrage opportunities is contingent on the ability of the arbitrageur to decipher the more effective resource combinations and replicate them at will (Acs et al., 2009; Shane, 2000). Absent such deciphering, no knowledge transfer to a third party could take place. If the industry is such that its technologies are unlikely to be deciphered by the would-be imitators, the presence of substantial arbitrage opportunities does not guarantee the entry of the imitatively inclined entrepreneurs. Here, the risks that the arbitrageur faces have to do with the inability to replicate the effective resource combination. That is, despite the fact that the better resource combination is being exploited by some industry members, new entrants or fellow industry inhabitants risk not being able to replicate the exact recipe for success. As such, new entry into the industry is unlikely to reach the same level of profitability that the technology holder possesses. For instance, the unique advantage enjoyed by Coke due to its tight control over the ‘secret ingredient’ of its syrup has successfully resisted multiple attempts at imitation. Accordingly, prospective arbitrageurs realize that their returns would be lower vis-à-vis those of the secret holder, which may prevent excessive entry into the industry. This is, perhaps, one of the reasons why KFC’s franchise (with secret seasoning ingredients of its own) remains unchallenged while McDonald’s has a number of very close me-too competitors.

In other words, where secrets are a potent way to keep the imitators at bay, prospective entrepreneurs are less likely to pursue arbitrage opportunities even if the differences in the industry firms’ efficiencies are evident. Effectively, new entrants would be reduced to utilizing the generic (i.e., average) resource combinations, which hardly justifies the entrepreneurial endeavor (Hitt et al., 2001; Mueller, 1977), or will have to engage in high-effort, uncertain innovative activities trying to create their own ‘secret’ way to combine resources. This, in essence, implies that they would be pursuing innovative and not arbitrage opportunities. To state formally:

Hypothesis 3. Effectiveness of secrets as a means to ward off imitation negatively moderates the relationship between arbitrage opportunities and startup rates in the industry.

Finally, some industries are known to rely on lead time as a way to keep rivals at bay. If lead time is effective in protecting the innovators from imitation, this can also have a negative impact on the relationship between arbitrage opportunities and new business entry into the industry. That is, because imitation is lengthy in some industries, those who control the resources may realize the changed means–ends framework before alert arbitrageurs are able to imitate the more effective way to combine resources (Utterback, 1974) and reprice the resources before knowledge spillover (Acs et al., 2009; Audretsch and Keilbach, 2007, 2008) has completed. As such, by the time imitation is possible, the market failure to price the resources correctly under the changed means–ends framework is likely to be corrected by the resource owners, which makes the exploitation of arbitrage opportunities improbable. In this sense, differences in efficiencies of the industry firms may still reflect failure of the resource owners to adjust the resource pricing in a timely fashion but this does not imply that would-be arbitrageurs can exploit the respective opportunity before the resource owners correct their mistake.

What this means in practice is that for industries where lead time is known to be effective, would-be arbitrageurs are less likely to seriously consider entering the competitive race because the competitive advantage that is accorded by the more effective way to combine resources does not last long enough to justify such entry. In Acs’ and his colleagues terms, to succeed in such industries one needs to rely on the flows of knowledge and not on the stock of knowledge (Acs et al., 2009). This favors incumbents and not prospective entrepreneurs. In other words, the relationship between arbitrage opportunities and rates of business entry in such industries will likely be somewhat less pronounced compared to industries where lead time is of less importance. Stated formally:

Hypothesis 4. Effectiveness of lead time as a means to ward off imitation negatively moderates the relationship between arbitrage opportunities and startup rates in the industry.

9 Again, as argued by Posen et al. (2013), imperfect imitation may actually lead to superior innovative outcomes.

Please cite this article as: Anokhin, S., Wincent, J., Technological arbitrage opportunities and interindustry differences in entry rates, Journal of Business Venturing (2013), http://dx.doi.org/10.1016/j.jbusvent.2013.07.002
4. Method

4.1. Data

The data for this study came from several secondary sources. Information required to compile startup rates by industry was collected from the U.S. Census Bureau that made available its analytics on the number of firms for the United States in all industries for a number of years. Specifically, we gathered this information from 1998 to 2005. Arbitrage opportunities were estimated based on the data from Compustat, where we utilized the information on 10,650 firm-year observations with no missing values for inputs and outputs for the years from 1999 through 2003. Compustat also was a source of other firm-level variables that were aggregated to the industry level. Meaningful aggregation was possible for 26 industries as defined by the system of NAICS codes. Finally, various aspects of the appropriability regime were borrowed directly from Cohen, Nelson, & Walsh (2000). Overall, our sample size equals 130 industry-year observations over the five-year period. We lost year 1998 due to the way arbitrage opportunities are estimated (as explained below); we chose not to use business entry estimates for 2005 because one-year, and not two-year lag between predictor and criterion variables has provided the most adequate and consistent results. Thus effectively our data coverage ends in 2004 for the criterion variable and 2003 for predictor variables.

4.2. Variables

4.2.1. Dependent variable

We followed recent entrepreneurship literature (Chang, Chrisman, & Kellermanns, 2011; Anyadike-Danes et al., 2005; Bosma et al., 2011) to operationalize entrepreneurial dynamics as net business entry rates by industry. Specifically, net startup rate in year \( t \) was defined as the ratio of the difference in the stock of active businesses in year \( t \) and \( t - 1 \) to the stock of active firms in year \( t - 1 \). Thus, to estimate the startup rate in 1999 we divided the difference in the number of active firms between years 1999 and 1998 by the number of active firms in year 1998. This measure is typically used when the information on new entrants as such is not available (Chang et al., 2011) and is advantageous in the context of this study in that it demonstrates net increase/decrease in the number of active firms that we seek to attribute to arbitrage opportunities. Using new establishments statistics without accounting for business failure would have been problematic because we are interested in the increase in industry occupancy that could be sustained due to the presence of arbitrage opportunities. We tried different time lags and report the set of estimates with a one-year lag between the predictor variables and the observed startup rates. That is, we explicitly allow the entrepreneurs to respond to the changes in the level of arbitrage opportunities in the respective industries.

4.2.2. Independent variable

To estimate arbitrage opportunities in each of the 26 industries over the course of 1999 to 2003 we followed the procedure described in Anokhin et al. (2010a). Specifically, we used Compustat to collect information on 10,650 firm-year observations for which there were no missing values for inputs and outputs. Following existing literature (see, e.g., Färe et al. (1998)), we utilized labor and capital as inputs while sales were used as the output. The numbers were adjusted for inflation based on annual CPI indices as reported by the Bureau of Labor Statistics. Although the calculations behind arbitrage opportunities evaluation are rather involved, the intuition is rather simple. By looking at inputs utilized by the industry firms and their respective outputs, we constructed a production frontier such that efficient firms found themselves on the frontier and the less efficient firms— at a distance from the frontier. In some industries such distances were rather small indicating that arbitrage opportunities were not sustained there. For others there was a significant variance in the firms’ efficiency and the distances were rather large on average.

We aggregate firm-level distances from the frontier to the industry level by averaging them. Such an average estimate indicates the amount of arbitrage opportunity—i.e., room for optimizing under a given means–ends framework—available to a typical firm in the industry. They are the opportunities that a prospective newcomer may expect to go after and that the typical firm knows it has in its disposal. To ensure that frontiers established for industries in subsequent years did not intersect (the requirement similar to indifference curves not allowed to intersect in mainstream economics), we introduced an additional constraint to the model described in Anokhin et al. (2010a) thus avoiding the unreasonable situation where an observation could be declared efficient using year \( t \)'s frontier after being deemed inefficient under the frontier established for the year \( t - 1 \).

The mathematical programming models were solved using Frontline Systems’ Premium Solver for Microsoft Excel as is explained in Anokhin et al. (2010a). The distribution of arbitrage opportunities across industries and the average value of opportunities per industry are reported in Fig. 1. An illustrative two-by-two matrix that classifies industries according to their level of arbitrage opportunities and entry rates can be found in Fig. 2 (it should be noted that the companies identified in the figure do not necessarily pursue technological arbitrage). Our analysis indicates that arbitrage opportunities are rather consistent.  

---

10 Although the use of production (possibility) frontier-based techniques remains rather rare in the entrepreneurship research, there are a number of recent studies that employ various versions of this approach or at least employ this concept in their conceptual development (e.g., Anokhin and Schulze, 2009; Anokhin et al., 2011a; Minniti and Levesque, 2010; Zahra and Bogner, 2000). There are also uses of this technique in strategy research (e.g., Delmas and Tokat, 2005; Durand and Vargas, 2003) and innovation literature (e.g., Thursby and Thursby, 2002).

11 Generally, the choice of inputs and outputs should be dictated by the theory one attempts to test. For illustrative purposes our choice of variables is limited to what has previously been used in the efficiency estimation literature. The technique itself allows for multiple inputs and outputs.

12 Specifically, our approach is a combination of intertemporal and sequential approaches to the frontier formulations (see Tulkens and Eeckaut, 1995). For the specific details on how the estimates of arbitrage opportunities were derived, see Anokhin et al. (2010b).
Fig. 1. Arbitrage opportunities across industries.

- High entry rates
  - Accommodation and food services
  - Air transportation
  - Courier services
  - Electromedical equipment manufacturing
  - Food and drinks manufacturing
  - Hospitals and healthcare services
  - HR and staffing services
  - Retail trade
  - Utilities

- Low entry rates
  - Automobile and truck manufacturing
  - Communication equipment manufacturing
  - Industrial machinery manufacturing
  - Publishing industry
  - Pulp, paper, and paperboard
  - Special equipment manufacturing
  - Telecommunications carriers
  - TV, radio, cable services
  - Wholesale trade

- Chemical manufacturing
- Computer related services
- Consulting and advertising
- Information services
- Pharmaceutical industry

Fig. 2. Four groups of industries.
across industries throughout the years although there is a fair amount of variance within industries. As such, it should be possible to use them as relatively stable for industries in subsequent studies, much like current research still utilizes the estimates of the appropriability regime (Cohen et al., 2000; Levin et al., 1987) and technological opportunities (Klevorick et al., 1995) reported in the previous decades. Importantly, our estimates of arbitrage opportunities for the publishing industry are very close to the one reported in Anokhin et al. (2010a) (the only industry that paper has analyzed) thus suggesting consistent application of the method utilized for the assessment of arbitrage opportunities.

4.2.3. Moderator and control variables

The measures of the three aspects of the appropriability regime—the effectiveness of patents, secrecy, and lead time as means to ward off imitators—were borrowed directly from the work of Cohen et al. (2000) which was based on a large-scale survey where industry concordance was impossible to establish beyond reasonable doubt, industry average scores were used. Despite some differences between Cohen et al.’s estimates and those reported earlier by Levin et al. (1987), all in all appropriability conditions are sufficiently stable, enduring drivers of technical advance (Cohen and Levin, 1989). Yet, we readily admit that the estimates of the strength of the appropriability regimes used in this paper may not be perfect. We use them in good faith that they portray the appropriability conditions adequately (especially given the temporal closeness of our data to Cohen et al.’s) but cannot guarantee that our results will remain unchanged when new data concerning appropriability becomes available. The estimates reported in Cohen et al. (2000) are based on the percentage of innovations for which the respective mechanisms (patents, secrecy, and lead time) were deemed effective by the firm R&D and intellectual property specialists.

We also controlled for a number of variables. First, because entrepreneurship has been argued in the past to be related to the pursuit of innovative opportunities (as opposed to arbitrage), we accounted for those by looking at the average R&D intensity of the industry firms (the ratio of R&D expenses to sales). Although several approaches to measuring innovative opportunities exist including survey-based estimates (e.g., Zahra, 1996), we side with those industry research experts who see such opportunities through the prism of sectoral R&D intensity (Malerba and Orsenigo, 1997) and suggest that they may be generated by the research efforts undertaken by incumbent firms (Dosi et al., 2006). Beside, we felt it was beneficial to use secondary data sources to ensure easy replication whenever possible. It may be expected that in industries where reliance on innovative opportunities is high such ratio will be high as well whereas for industries where innovative opportunities are not seen as the driver of the entrepreneurial dynamics R&D intensity will be lower.

Because some industries are naturally more fragmented, entrepreneurial in nature while others tend to be more concentrated, we partialed out the effect of industry concentration ratio measured as the share of the market controlled by the four largest firms. This measure has been used in the literature before (Chuang and Lin, 1999; Dean and Meyer, 1996). Finally, we also included year dummies to account for the temporal effects that may bear on industry entrepreneurial dynamics as well as to account for the effects of pure arbitrage opportunities caused by processes such as fashion trends. The variables exhibited reasonable correlations as could be seen in Table 1 and thus could be employed in the regression analysis. We, however, would like to note a high level of correlation between innovative and arbitrage opportunities (.67). Although it is below the .7 level that may raise the multicollinearity concerns, it clearly suggests that there is a fundamental relationship between these kinds of entrepreneurial opportunities.

4.3. Models and estimation

Given the multi-year, multi-industry nature of our data we needed to utilize panel data techniques to test our hypotheses with industry-year being our unit of analysis. Specifically, we utilized random effects estimation procedure with corrections being made for the first-order autoregression in the disturbance term using the methods derived in Baltagi and Wu (1999). In all, we report three nested models. Model 1 includes control variables. Model 2 adds arbitrage opportunities to the set of predictors to

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 1</strong> Descriptive statistics and correlations.</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>t.1.1</td>
</tr>
<tr>
<td>t.1.2</td>
</tr>
<tr>
<td>t.1.3</td>
</tr>
<tr>
<td>t.1.4</td>
</tr>
<tr>
<td>t.1.5</td>
</tr>
<tr>
<td>t.1.6</td>
</tr>
<tr>
<td>t.1.7</td>
</tr>
<tr>
<td>t.1.8</td>
</tr>
<tr>
<td>t.1.9</td>
</tr>
<tr>
<td>t.1.10</td>
</tr>
<tr>
<td>t.1.11</td>
</tr>
<tr>
<td>t.1.12</td>
</tr>
<tr>
<td>t.1.13</td>
</tr>
<tr>
<td>t.1.14</td>
</tr>
<tr>
<td>t.1.15</td>
</tr>
<tr>
<td>t.1.16</td>
</tr>
<tr>
<td>t.1.17</td>
</tr>
<tr>
<td>t.1.18</td>
</tr>
</tbody>
</table>

Please cite this article as: Anokhin, S., Wincent, J., Technological arbitrage opportunities and interindustry differences in entry rates, Journal of Business Venturing (2013), http://dx.doi.org/10.1016/j.jbusvent.2013.07.002
test **Hypothesis 1.** Finally, Model 3 includes the three dimensions of the appropriability regime—effectiveness of patents, secrecy, and lead time—and the required interaction terms to test **Hypotheses 2–4.** To minimize the multicollinearity concerns, all predictor variables are standardized (Marquardt, 1980). Additional investigation suggested that multicollinearity is not likely to affect statistical inference in that all variance inflation factors were substantially lower than the recommended cut-off value of 10, and the condition indices were well below both stringent and lax cut-off values of 15 and 30, respectively.

5. Results

5.1. Regression analyses results

As Table 2 documents, Model 1 that only includes control variables fits the data adequately as is suggested by the test statistic (Wald $\chi^2(7) = 21.95, p < .01$) and explains about 16% of the variance in the interindustry entrepreneurial dynamics. Two of the control variables were significant at the conventional levels. As expected, innovative opportunities were a very strong, significant, positive predictor of startup rates in the industry ($β = .04, p < .001$). Similarly, concentration ratio was shown a significant determinant of the entrepreneurial dynamics in the industry ($β = .04, p < .01$). Interestingly, the effect of industry concentration on net startup rates is positive, meaning that new entrants select industries where competition from the smaller counterparts will be lower, which may indicate that new entrants consider pursuing the niche strategy.

Model 2 that added arbitrage opportunities to the set of predictors demonstrates a remarkable improvement in the model fit ($Δ\chi^2(1) = 64.25, p < .001$) and explains 38% of variance in the interindustry startup rates thus increasing the predictive power of Model 1 by 22%. Arbitrage opportunity emerges as a strong, positive predictor of the entrepreneurial dynamics in the industry ($β = .02, p < .001$). This provides support to Hypothesis 1. Concentration ratio retains its sign and significance ($β = .04, p < .001$) and explains 38% of variance in the interindustry startup rates thus increasing the predictive power of Model 1 by 22%. Arbitrage opportunity emerges as a strong, positive predictor of the entrepreneurial dynamics in the industry ($β = .02, p < .001$).

### Table 2

<table>
<thead>
<tr>
<th>Dependent variable: entry rates</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Innovative opportunities</strong></td>
<td>.04***</td>
<td>− .02†</td>
<td>.01</td>
<td>.01</td>
<td>.01†</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)†</td>
</tr>
<tr>
<td><strong>Concentration ratio</strong></td>
<td>.01**</td>
<td>.02*</td>
<td>.02*</td>
<td>.02*</td>
<td>.02***</td>
</tr>
<tr>
<td></td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.00)</td>
</tr>
<tr>
<td><strong>Year 1 dummy</strong></td>
<td>.05†</td>
<td>.06*</td>
<td>.05*</td>
<td>.06**</td>
<td>.05*</td>
</tr>
<tr>
<td></td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
</tr>
<tr>
<td><strong>Year 2 dummy</strong></td>
<td>.05†</td>
<td>.05*</td>
<td>.05*</td>
<td>.05*</td>
<td>.05*</td>
</tr>
<tr>
<td></td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
</tr>
<tr>
<td><strong>Year 3 dummy</strong></td>
<td>.04</td>
<td>.04*</td>
<td>.04*</td>
<td>.04*</td>
<td>.04*</td>
</tr>
<tr>
<td></td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
</tr>
<tr>
<td><strong>Arbitrage opportunities</strong></td>
<td>.08***</td>
<td>.09***</td>
<td>.09***</td>
<td>.07**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.03)</td>
<td></td>
</tr>
<tr>
<td><strong>Patents</strong></td>
<td>− .04**</td>
<td>− .03**</td>
<td>− .03**</td>
<td>− .03**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td></td>
</tr>
<tr>
<td><strong>Secrecy</strong></td>
<td>− .04***</td>
<td>− .04*</td>
<td>− .04*</td>
<td>− .04*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td></td>
</tr>
<tr>
<td><strong>Lead time</strong></td>
<td>− .03†</td>
<td>− .02*</td>
<td>− .02*</td>
<td>− .02*</td>
<td>− .03***</td>
</tr>
<tr>
<td></td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td></td>
</tr>
<tr>
<td><strong>Arbitrage opportunities × Patents</strong></td>
<td>− .04***</td>
<td>− .04*</td>
<td>− .04*</td>
<td>− .04*</td>
<td>− .03†</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td></td>
</tr>
<tr>
<td><strong>Arbitrage opportunities × Secrecy</strong></td>
<td>− .07**</td>
<td>− .06**</td>
<td>− .06**</td>
<td>− .06**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td></td>
</tr>
<tr>
<td><strong>Arbitrage opportunities × Lead time</strong></td>
<td>− .05†</td>
<td>− .04*</td>
<td>− .04*</td>
<td>− .04*</td>
<td>− .04†</td>
</tr>
<tr>
<td></td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td></td>
</tr>
<tr>
<td><strong>Intercept</strong></td>
<td>− .03</td>
<td>− .04*</td>
<td>− .02</td>
<td>− .02***</td>
<td>− .02***</td>
</tr>
<tr>
<td></td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.00)</td>
<td></td>
</tr>
<tr>
<td><strong>Baltagi-Wu LBI statistic</strong></td>
<td>1.97</td>
<td>2.39</td>
<td>2.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall R^2</strong></td>
<td>.16</td>
<td>.38</td>
<td>.48</td>
<td>.51</td>
<td>.48</td>
</tr>
<tr>
<td><strong>ΔR^2</strong></td>
<td>−</td>
<td>− .22</td>
<td>.10</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td><strong>Wald χ^2</strong></td>
<td>$\chi^2(7) = 21.95$</td>
<td>$\chi^2(8) = 86.20$</td>
<td>$\chi^2(14) = 137.38$</td>
<td>$\chi^2(9) = 71.95$</td>
<td>−</td>
</tr>
<tr>
<td><strong>Δχ^2</strong></td>
<td>−</td>
<td>$\Delta\chi^2(1) = 64.25$</td>
<td>$\Delta\chi^2(6) = 51.18$</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td><strong>F-test</strong></td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>$F_{(13, 24)} = 19.26$</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>$p &lt; .01$</td>
<td>$p &lt; .001$</td>
<td>$p &lt; .001$</td>
<td>$p &lt; .001$</td>
<td>$p &lt; .001$</td>
</tr>
</tbody>
</table>

Standard errors are in parentheses.

*** $p < .001$.

** $p < .01$.

* $p < .05$.

† $p < .10$.

Random effects estimates in Models 1–3; Prais–Winsten regression with panel-corrected standard errors in Model 4; non-parametric estimation with Driscoll–Kraay standard errors in Model 5.

Please cite this article as: Anokhin, S., Wincent, J., Technological arbitrage opportunities and interindustry differences in entry rates, Journal of Business Venturing (2013), http://dx.doi.org/10.1016/j.jbusvent.2013.07.002
Importantly, innovative opportunities no longer appear to be a positive predictor of startup rates; the sign of the relationship reverses (however, the significance level drops to .09). That is, although innovative opportunities are undoubtedly important for some new ventures, and are especially critical for the high-growth gazelles, by and large new entry into the industry could be attributed to arbitrage and not innovation. This is not meant to diminish the importance of innovation; in fact, the very existence of technological arbitrage opportunities has to do with innovative discoveries by some firms and individuals that push the frontier forward and open up room for imitation for others via the knowledge spillover (Acs et al., 2009). Yet, our results call for reassessment of the relative weights of the two types of opportunity.

Finally, Model 3 demonstrates another significant improvement in the model fit ($\Delta \chi^2 (3) = 41.60, p < .001$) and explains up to 48% of variance in the interindustry entrepreneurial dynamics and additional 10% improvement in $R^2$ compared to Model 2. Arbitrage opportunities remain a significant predictor of industry startup rates ($\beta = .09, p < .001$), concentration ratio's effect remains consistent although loses some of its effect ($\beta = .02, p < .05$), while innovative opportunities remain insignificant. All three indicators of the appropriability regime attain significance (although lead time does so only at the $p < .10$ level). Most importantly, all three interaction terms are significant and in the hypothesized direction. The interaction of patenting effectiveness with arbitrage opportunities is most significant ($\beta = -.04, p < .001$), followed by the interaction of secrecy and arbitrage opportunities ($\beta = -.07, p < .01$), followed by the interaction of arbitrage opportunities and the effectiveness of lead time ($\beta = -.05, p < .10$). This lends support to Hypotheses 2–4, although in case of Hypothesis 4 we can only claim weak or partial support. Importantly, according to the Baltagi-Wu LBI statistic that varies from 1.97 for Model 1 to 2.39 for Model 2 and 2.52 for Model 3, we are likely to underestimate the level of statistical significance in all our models. As such, this gives us extra confidence in the results we report. To ease the interpretation of the interactions, we plot them in Figs. 3–5 at one standard deviation above and below the mean value of the moderators to denote high and low conditions of the strength of the appropriability regime, respectively.

5.2. Robustness checks and sensitivity analysis

To ensure additional level of confidence in the results we report, we re-estimated our full Model 3 using alternative estimation techniques. In Model 4 we report the results obtained with the help of Prais–Winsten regression with panel-corrected standard errors (PCSE). PCSE accounts for the panel structure and allows for heteroskedasticity, within-panel AR(1) serial correlation, and cross-sectional dependence, while being more conservative than alternative techniques (Beck and Katz, 1995; Greene, 2000). In Model 5 we re-estimated the full model using a non-parametric approach with Driscoll and Kraay (1998) heteroscedasticity consistent standard errors that are robust to cross-sectional and temporal dependence as introduced in Hoechle (2007). The effects reported by these alternative estimations are remarkably close to those obtained in Model 3.13

We also tested sensitivity of our results to the exclusion of certain industries for which the appropriateness of the notion of technological arbitrage opportunities may be questioned (such as Consulting and Advertising), although, as explained earlier, we subscribe to the soft view of technology that is akin to the notion of resource combination. Indeed, the results remain stable: exclusion of those industries did not affect our results substantively. For instance, removing Consulting and Advertising industry

13 We have also re-estimated the key models using the fixed effects estimator. Due to our moderator variables being time-invariant, we only used this model to investigate whether the main effect of arbitrage opportunities remains consistent. Indeed, it remained to be a positive, statistically significant predictor of business entry. In fact, its magnitude is somewhat larger than in random effects estimates (.12 vs. .09 in the full model) with the same level of statistical significance ($p < .001$).
from the analysis left key parameters of the model virtually unchanged. The effect of arbitrage opportunities remains positive and significant ($\beta = .10, p < .001$ vs. $\beta = .09$ in the original Model 3). The interaction of patenting effectiveness with arbitrage opportunities is negative and significant and is exactly the same as in Model 3 ($\beta = -.04, p < .001$). The interaction of secrecy and arbitrage opportunities actually grows in strength while being consistent in sign and significance ($\beta = -.08, p < .01$ vs. $\beta = -.07, p < .01$ in Model 3). The interaction of arbitrage opportunities and the effectiveness of lead time exactly matches that reported in Model 3 ($\beta = -.05, p < .10$).

Given the novel nature of our results, we sought to make sure that they are not an artifact of the statistical measures or procedures we used and attempted to validate our findings by utilizing other sources of information on the levels of entrepreneurship in various industries as well as by employing different statistical techniques. Once again, if our expectations are correct, one should expect to see higher rates of entrepreneurship in industries where technological arbitrage opportunities are abundant. Although we were not able to collect large enough datasets to re-test our interaction hypotheses, we managed to conduct several robustness checks for the relationship between arbitrage opportunities and the rates of entrepreneurship in different industries.

First, we correlated the share of self-employed within the industry (arguably, those individuals would be more likely to imitate rather than engage in uncertain and costly innovation) as documented in Audretsch et al. (2009) to our estimates of arbitrage opportunities. We were only able to more or less accurately map eighteen out of twenty-six industries included in our dataset. Moreover, Audretsch et al.’s estimates of entrepreneurship did not exhibit temporal dynamics. Nevertheless, we observed a significant positive correlation ($r = .38$) between average arbitrage opportunities and industry entrepreneurship.

![Fig. 4. Secrecy effectiveness and the relationships between arbitrage opportunity and industry entry rates.](image1)

![Fig. 5. Lead time effectiveness and the relationships between arbitrage opportunity and industry entry rates.](image2)
Second, we studied the relationship between self-employment across industries as reported by the U.S. Census Bureau and arbitrage opportunities for all twenty-six industries. Following the expert advice on using efficiency estimation scores in the second-stage regression analysis (e.g., Daraio and Simar, 2007; Hoff, 2007; McDonald, 2009; Papke and Wooldridge, 1996), we chose to estimate the relationships between technological arbitrage opportunity and entrepreneurship with the help of fractional logit model (robust standard errors) that has been shown to perform effectively in the context such as ours (McDonald, 2009). The results indicate a strong positive relationship between entrepreneurship and arbitrage opportunities in the industry (p < .05).

Although by themselves these extra tests are insufficient to establish the pattern of relationship between arbitrage opportunities and entrepreneurship, and despite the fact that we are unable to similarly re-test the moderation of this relationship by patenting, secrecy, and lead time, the consistent picture they paint and the similarity of the results to those reported above provide an extra degree of confidence in the results we report.

6. Discussion and suggestions for future research

To the best of our knowledge, this paper is the first empirical test of the relationship between arbitrage opportunities and startup rates long postulated by the entrepreneurship literature classics (e.g., Kirzner, 1973) in the cross-industry context. We demonstrate that arbitrage opportunities are indeed a strong and reliable predictor of industry entry rates that by themselves explain over 20% of startup dynamics across industries. Moreover, accounting for the interaction effects of arbitrage opportunities and different facets of the industry appropriability regime further increases the predictive power of such models by 10% overall explaining about 50% of the interindustry variance in net entry rates.

Furthermore, the inclusion of arbitrage opportunities into empirical models calls for renewed research attention to the unique role of innovative opportunities in explaining the entrepreneurial dynamics. Consistent with statistics reported in Bhidé (2000), we see that many enterprising individuals respond to arbitrage and not innovative opportunities per se. Importantly, we do not say that innovative opportunities are unimportant. In fact, it is precisely the actions of those who push the frontier through innovation that open up arbitrage opportunities for all, and the strong correlation between innovative and arbitrage opportunities should not be ignored. Besides, admittedly, the measure of innovative opportunities used herein is only one of the possible alternatives, and additional insights could be generated if the relationship between arbitrage and innovation is studied specifically in the business entry context.

The overall significance of arbitrage opportunities as a predictor of entrepreneurial dynamics in the industry suggests that excluding them from empirical investigations of entrepreneurship may lead to omitted variable bias. Given the percentage of the variance explained by arbitrage opportunities above and beyond that attributable to innovative opportunities (about 20%) and the overall predictive power of the fully specified model (almost 50%) it seem prudent to consider including such estimates (at least as controls) in subsequent industry studies of entrepreneurial dynamics.

Our paper relaxes some of the assumptions of the knowledge spillover theory of entrepreneurship (Acs et al., 2009) thus extending it and making it possible to apply it to the context of technological arbitrage that has previously been left underinvestigated empirically despite the works of the entrepreneurship research classics who saw arbitrage opportunities as a legitimate entrepreneurial endeavor (e.g., Kirzner, 1973). We believe that incorporation of the views of Arrow (1962) into the theory by Acs, Audretsch and colleagues opens new avenues for research both conceptually and empirically. We thus invite fellow-researchers to embrace the notion of technological arbitrage opportunities and study this fascinating phenomenon in a variety of contexts.

As our results demonstrate, not only is the level of arbitrage opportunities generally high, but there is also substantial interindustry variance, which calls for further attention to the optimal strategies available to firms in different industries depending on the relative abundance of profitable ways to imitate. Our estimates of five-year average arbitrage opportunities vary from a low of 1.50 for automobile and truck manufacturing to a high of 28.38 for the pharmaceutical industry. Although these are obviously extremes, our analyses suggest the immediate implication is that some industries encourage imitation while others leave few opportunities for their firms to profit from mimicry and make innovation the most promising way to generate above-average returns.

Our study also suggests that whether or not imitation is a viable option for new entrants or lesser effective industry occupants may depend on the strength of the appropriability regime in the industry as proxied by the effectiveness of patents, secrecy, and lead time. In other words, our study conceptually and empirically suggests that not all arbitrage opportunities may be immediately available for exploitation and outline why some parts of the technological arbitrage opportunities present may be never attainable. That is, in addition to factors suggested by Acs et al. (2009) as potentially affecting the entrepreneurs’ engagement in purposeful knowledge spillover, we demonstrate that the various aspects of the appropriability regime may also weigh in on the scale and effectiveness of such spillover.

Of course, this study leaves a number of issues to be addressed in the future research and at the same time opens up a number of avenues that promise advancement in the field of entrepreneurship. For instance, we did not truly analyze the economic implications of exploiting arbitrage opportunities. Doing so may generate novel insights both at the individual level of analysis (by studying the relationship between arbitrage orientation of a firm or individual and the venture success) and the higher levels of analysis such as regions or cross-country comparisons. It could be that by going after arbitrage opportunities entrepreneurs close the gap between lagging and leading regions and thus contribute to economic development in ways distinct from innovation that is so favored by the current entrepreneurship research.
We did not consider why technological arbitrage opportunities persist in some industries but get exhausted quickly in others. Perhaps, it may have to do with the nature of capital, which is an important component in our measure of arbitrage.14 We also did not investigate why some firms choose to go after arbitrage opportunities while others do not. The answer, we believe, may lie in marrying our conceptual development with firm-level theories such as the resource-based view of the firm that have been used extensively in the strategy research. Although we believe the line of argumentation blending the proposed extension of the knowledge spillover theory of entrepreneurship with the modified treatment of the notion of risk is valuable to maintain in future research, this framework could be further expanded to explicitly accommodate the views professed by Cohen and Levinthal (1990) who suggest that existing industry actors may vary in their capacity to adapt new technology. This will naturally suggest that the potential of startups and existing industry members to appropriate returns from new knowledge created by the third parties is likely dependent on the absorptive capacity of industry incumbents. In industries where such capacity is low, entrepreneurial dynamics may be more prominent. At this stage, we believe the speculations as to the underpinnings of these relationships to be premature and suggest this as a promising area for future research.

Moreover, it would be beneficial to shift attention from purely industry-level variables to firm-level and the level of individuals such as engineers and others who act as carriers of new knowledge. By looking at cross-level interactions of individual characteristics and entrepreneurial opportunities of different kind, one may gain unique insights into the nature of the individual-opportunity nexus that is believed to reflect the very essence of entrepreneurship (Shane and Venkataraman, 2000).

One may also study to what extent the transfer of knowledge carriers with a specific set of new knowledge can contribute to reducing or enhancing the level of technological arbitrage opportunity available to lagging industry companies. In this sense, studying cross-level interplays may prove particularly interesting and insightful. Audretsch (1995) suggested that shifting the unit of observation from aggregated units such as industries and companies to individuals could provide a more fine-grained picture of knowledge transfer and thus open up for a better understanding of how technological arbitrage could be initiated in existing companies and de novo startups. The loyalty and mobility of knowledge workers would likely be important ingredients in such studies.

We also believe the technological arbitrage opportunity measurement presented here to be useful at lower and higher levels of unit of analysis. Although we applied the technological arbitrage opportunity measure at the industry level, the method could be employed at the company, regional or national level. Moreover, one may actually start looking at whether and how technological arbitrage opportunities at the industry level in one region can be exploited by companies in other regions. Using the measure of arbitrage opportunities at different levels and testing cross-level interactions could reveal more specific insights into the origins and consequences of technological arbitrage opportunities. This may also open up for the study of knowledge transfer and knowledge spillovers at different levels. Drawing upon the study of the urbanists Jacobs, Lee, Richard and Bates (2001) who outlined the importance of social diversity and human capital for innovation and patenting, one may expect such measures to count for the reduction of available technological arbitrage opportunities. In the same way as regions and vibrant cities can be important for the exploitation of technological innovation opportunities, they may be important for filling technological arbitrage opportunities.

Finally, a fruitful extension of the current research is the exploration of within-industry distribution of arbitrage opportunities to examine if industry firms converge over time in terms of their efficiency thus moving closer to equilibrium (Kirzner, 1973) or if disparity increases thus providing a picture more consistent with the Schumpeterian (1934) view of entrepreneurship and innovation. The appropriability regime reasoning pursued here would enable integration and extension of the fundamental ideas in the entrepreneurship literature. The results obtained while working on this study (available from the authors upon request) suggest that there is a gradual move toward the equilibrium that is occasionally disturbed (perhaps, by breakthrough innovations that push the frontier further): despite the occasional ‘innovation outbreaks’, on average firm efficiency improves with time (i.e., inefficiency diminishes). Perhaps, such a gradual movement may be restricted by strong appropriability regimes but we believe a longer panel is needed for developing this idea further. Nevertheless, studying arbitrage opportunities within industries in addition to cross-industry research is likely to generate insights of substantial value for the scholarly community.

Our research has some limitations that need to be considered. For example, our measures of technological arbitrage opportunities are conceptually related to the notion of total factor productivity. Prior literature has raised certain doubts as to total factor productivity-based estimates (Klevorick et al., 1995). The same issue should be explored in more detail for our measures of arbitrage opportunities as well. To that end, we believe some caution should be taken before the estimates we report are adopted for a wider use. Our hope with this article is to demonstrate that entrepreneurship research may benefit from incorporating arbitrage opportunities into consideration when working with industry-level theories that explain entrepreneurial dynamics. We believe that employing frontier-based estimates of efficiency to measure arbitrage opportunities may be an important step in that direction. As such, we hope to stimulate and encourage more research about this specific topic.

7. Uncited reference

Anokhin et al., 2011b

14 We thank an anonymous reviewer for pointing this out.
References


