Essays on Entrepreneurial Strategy and Performance

by

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Abstract:

This dissertation examines the conditions under which entrepreneurial firms are most apt to succeed. Besides grappling with the multiple strategic choices that they face, these firms also have to address the institutional complexities in their environments. Together these three essays contribute to our understanding of how the challenges associated with addressing these multi-faceted environmental conditions impact firm outcomes.

The first study examines the process of entrepreneurial strategy making by analyzing the competitive history of the Internet video industry in China. Leveraging a new hand-collected dataset that records activity by all entrants into the Chinese Internet video industry from 2006-2011, this study documents how entrants who adapted to a disadvantageous shift in the environment outperform those firms that chose a strategy that did *not* require change; and how strategic commitments to user communities can serve as a complementary asset to enhance the resilience of a start-up against disadvantageous shifts in their environment.

The second essay considers how the endogenous nature of appropriability impacts entrepreneurial strategy and performance. This study focuses on the entrepreneur's choice between investing their time and scarce resources in ensuring appropriability versus investing in the execution and operation of their fledgling businesses. We investigate these ideas empirically in the context of a unique sample of academic entrepreneurs: within a sample of ventures that could have been developed by either faculty or students (or both), we find that faculty-led ventures are much more closely associated with intellectual property, but are less agile in terms of their start-up and commercialization activities.

The third essay examines the impact of local institutional arrangements on firm-level spillover effects from universities. This study provides early evidence suggesting that foreign invested firms collocated with universities in China are more innovative than their domestic counterparts. Furthermore, the performance discrepancy is most apparent among smaller firms. This finding raises some substantial policy implications about public investments in universities when the benefits of such investments are juxtaposed against localized institutional arrangements.

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"It's been a hard day's night."
~ The Beatles, 1963

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Chapter One

Essays on Entrepreneurial Strategy and Performance: Introduction and Overview

1.1 BACKGROUND

This dissertation examines the conditions under which entrepreneurial firms are most apt to succeed. Put simply, the dissertation seeks to understand how entrants formulate commercialization strategies, and the impact of these choices on performance. It explores the multiple strategic choices that entrepreneurs face, the consequences of these choices, and the institutional complexities these firms have to address in their environments..

In three distinct essays, it investigates the consequences of choices made by entrepreneurs, the endogenous nature of appropriability, and the impact of local institutional arrangements on firm-level spillover effects from universities. It therefore examines the behavior and performance of entrepreneurial firms from a variety of perspectives, at the level of firm choices up to the environment itself. This dissertation proposes "clone" companies – companies leveraging original ideas spawned in different geographical markets – as a new research tool for entrepreneurial strategy research. It also provides insights about the endogenous nature of appropriability, and how entrepreneurs exercise choice in their commercialization strategies. Finally, it expands our understanding of the institutional environment ans its interaction with firm-level innovative efforts. The ambition of this dissertation is to help scholars, entrepreneurs and policy-makers better navigate the decidedly uncertain process that is entrepreneurship.

Existing empirical analysis of entrepreneurial strategy has traditionally relied on surveys of convenience samples. While these datasets have been extremely helpful in uncovering general patterns and trends in entrepreneurial behavior and strategy, the limitations of these datasets are apparent. For example, the underlying entrepreneurial opportunity is typically unobserved. As a result, the results may have bias resulting from the conflation of the underlying entrepreneurial opportunity with the marginal effect of the strategic choice. This dissertation uses various approaches to overcome methodological difficulties such as this. For instance, the first essay proposes using clones of YouTube in China – highly similar video-sharing websites exploiting a common entrepreneurial opportunity – as an innovative setting to study entrepreneurial strategy. The second essay leverages academic entrepreneurship as a useful setting to potentially endogenous appropriability regimes, creating and studying a sample of firms which can be

developed by either faculty or students (or both). The third essay uses a unique dataset which records information of all manufacturing firms in China to study the effects of university spillovers.

1.2 OVERVIEW OF THE DISSERTATION ESSAYS

1.2.1 The Clone Wars: Competitive Dynamics in the Internet Video Industry

The early stages of an emergent industry are often uncertain as entrants explore different commercialization paths. As a consequence, firms that adopt the eventual winning business model often reach there following different paths. However the few empirical studies that examine startup performance and strategic choice either ignores the dynamic nature of strategy-making or only examine the initial strategic choices made by the startups. Although building blocks are available from prior work on industry renewal or disruption (see for example Anderson & Tushman 1990; Henderson & Clark 1990; Klepper & Simons 2005; Suarez & Utterback 1995), we know relatively little about the long-term implications of strategic choices made as firms navigate the decidedly uncertain startup environment.

This paper undertakes a novel approach in developing a fresh study on entrepreneurial strategy. I leverage a unique entrepreneurial development in China's emerging Internet video industry to identify a set of ventures that are exploiting the same underlying entrepreneurial opportunity. The enforced exclusion of YouTube and other foreign Internet video websites from the Chinese Internet market inspired a rush of domestic entrepreneurs who surged in to create the dominant Chinese Internet video websites. Between 2006 and 2008, more than 100 Internet video websites were spawned in China. These clones not only capitalized on the original technological idea of distributing videos over the Internet (which had spawned in the US), but also experimented in different business models to exploit the entrepreneurial opportunity (Liu et al. 2011). Aided as well by Chinese Internet users' desire for localized content (Fung 2008), these domestic entrants arose in an entirely separate and distinctive entrepreneurial context. These unique institutional features in the Chinese Internet space allowed for the simultaneous inception of multiple ventures with varied business models around the common entrepreneurial opportunity of becoming China's dominant Internet video platform – the ideal experimental petri dish to observe entrepreneurial strategy at play.

The paper documents how entrants that are able to adapt to a disadvantageous shift in the environment may end up outperforming those firms which chose a strategy that did not require change; and how strategic commitments to user communities can serve as a complementary asset to enhance the resilience of a start-up against disadvantageous shifts in their environment. Results are confirmed when the entrants were matched by entry and performance characteristics. The findings introduce a dynamic view to entrepreneurial strategy making by directly linking strategic choice to venture performance.

1.2.2 Control versus Execution: Endogenous Appropriability and Entrepreneurial Strategy

This essay, co-authored with Scott Stern, Fiona Murray and Joshua Gans, considers how the endogenous nature of appropriability impacts entrepreneurial strategy and performance. Most prior research (often implicitly) assumes that the appropriability regime surrounding an innovation is exogenous – that the potential to capture value from innovation is largely determined by the prevalence of institutions such as intellectual property or the effectiveness of trade secrecy. We focus on the choice that entrepreneurs face between investing their time and scarce resources in ensuring appropriability versus investing in the execution and operation of their fledgling businesses. When investment in execution allows entrepreneurs to advance more quickly than competitors, but control requires delays in commercialization, control and execution will be strategic substitutes. As a consequence, entrepreneurs might choose execution over control even when intellectual property rights are strong. In other words, appropriability is an endogenous outcome and is only one element of an overall entrepreneurial strategy.

We investigate these ideas empirically in the context of a unique sample of academic entrepreneurs: within a sample of ventures that could have been developed by either faculty or students (or both), we find that faculty-led ventures are much more closely associated with intellectual property, but are less agile in terms of their start-up and commercialization activities.

1.2.3 Institutions, University Spillovers and Firm Innovation

This essay, co-authored with Yasheng Huang, examines the impact of local institutional arrangements on firm level spillover effects from universities.

Using a unique dataset from the National Bureau of Statistics of China, we find evidence suggesting that relative to domestic firms, foreign-invested firms in university-influenced regions were more innovative. Furthermore, the performance discrepancy is most apparent among smaller firms. Collectively, the results demonstrate that the unique institutional environment of each region and country must be considered in designing industry-university policies. This finding raises some substantial policy implications about public investments in in universities when juxtaposed against localized institutional arrangements.

1.3 FUTURE DIRECTIONS AND CONCLUSIONS

This dissertation opens to the door to a variety of potential studies of entrepreneurial strategy. Below, I describe two such studies that are currently underway but are not formally part of this dissertation.

One study examines the influence of commercialization environment on crowd-funded projects. The project, titled "Clones of Clones: Dynamics in the Crowd-funding Industry", explores the crowd-funded projects in China. As the phenomenon of crowd-funding has taken off in the US (and Europe), clones of popular US based crowd-funding sites have emerged in China. Using data from more than 160 thousand crowd-funded projects across the US and China, this study identifies and studies "twin" projects, where the projects are similar or identical in description but varied in geographic location. Early results indicate that Chinese projects (relative to US projects) attract capital faster and from more diverse investors.

Another project investigates how entrepreneurs exploit differentiation strategy. The study, entitled "Business Model Imitation vs Innovation", investigates how entrepreneurs seek to differentiate themselves among their peers and the performance implications. Using the same dataset of YouTube clones in China, preliminary results suggest that at the margin, entrepreneurs are better off following or copying the current market leader than differentiating themselves. Using detailed proprietary information on bandwidth expenditure, this paper also distinguishes the quality effect from the effect of differentiation and examines whether the performance consequences of differentiation depend on the quality level and the reference firms from which focal firms differentiate themselves.

In conclusion, the overarching ambition of this research is to contribute to the nascent literature on entrepreneurial strategy. This agenda will continue to require innovative approaches,

using various empirical strategies and drawing insights from a number of disciplines. My hope is that this dissertation and continuing research will provide new insights about the drivers of entrepreneurship, organizational performance and economic growth.

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Chapter Two

The Clone Wars: Competitive Dynamics in the Internet Video Industry

2.1 INTRODUCTION

The early stages of an emergent industry are often uncertain as entrants explore different commercialization paths. As a consequence, firms that adopt the eventual winning business model often reach there following different routes. However the few empirical studies that examine startup performance and strategic choice either ignores the dynamic nature of strategy-making or only examine the initial strategic choices made by the startups. Although building blocks are available from prior work on industry renewal or disruption (see for example Anderson & Tushman 1990; Henderson & Clark 1990; Klepper & Simons 2005; Suarez & Utterback 1995), we know relatively little about the long-term implications of strategic choices made as firms navigate the decidedly uncertain startup environment.

While the business world is rife with similar examples of firms that succeeded only after strategic change, a dynamic view is rarely explored in the entrepreneurial strategy literature. One of the reasons why our understanding of this critical process in entrepreneurial strategy is relatively poor is that empirically it is extremely difficult to disentangle the strategic resource from the entrepreneurial idea or opportunity. For example, Tesla's success has been credited to a successful distribution strategy in eschewing the traditional car distributor, thereby securing higher than average margins (Gertner 2012). However, this is also conflated by Tesla's substantial innovation in battery technology, which allows its cars to compete effectively with traditional gasoline based automobiles – the origin of the underlying entrepreneurial opportunity.

This paper undertakes a novel approach to address some of these empirical challenges. I leverage a unique entrepreneurial development in China's emerging Internet video industry to identify a set of ventures that are exploiting the same underlying entrepreneurial opportunity. The enforced exclusion of YouTube and other foreign Internet video websites from the Chinese Internet market inspired a rush of domestic entrepreneurs who surged in to create the dominant Chinese Internet video websites. Between 2006 and 2008, more than 100 Internet video websites were spawned in China. These clones not only capitalized on the original technological idea of distributing videos over the Internet (which had spawned in the US), but also experimented in different business models to exploit the entrepreneurial opportunity (Liu et al. 2011). Aided as well by Chinese Internet users' desire for localized content (Fung 2008), these domestic entrants

arose in an entirely separate and distinctive entrepreneurial context. These unique institutional features in the Chinese Internet space allowed for the simultaneous inception of multiple ventures with varied business models around the common entrepreneurial opportunity of becoming China's dominant Internet video platform – the ideal experimental petri dish to observe entrepreneurial strategy at play.

Consider the case of YouKu.com, China's current dominant Internet video firm that is listed on the New York Stock Exchange. While it started as a pure *User Generated Content (UGC)* firm and sourced content from Chinese Internet users as its only content offering, it dynamically transitioned to a *Mixed* firm which also offers *Professionally Produced Content (PPC)* – content licensed from traditional media producers such as TV and movie studios – after regulatory changes in 2008 severely curtailed the UGC business model. Despite starting with a business model that would be severely challenged by regulatory changes in the future, the firm grew and adapted to be the most successful and dominant Internet video platform in the world's largest Internet market.

In this study, I introduce a new hand-collected dataset tracking all entrants into the Chinese Internet video industry from its inception in 2006 to 2011. My data allows me to follow business model strategies on a dynamic basis, including when firms change or switch from their initial business models. I document how the most successful entrants are those which, despite starting with business models that were eventually challenged by unfriendly regulatory change, successfully adapted their business models to the dominant one. Results are confirmed when the entrants were matched by entry timing, ownership and performance characteristics prior to the regulatory change. My evidence suggests in general that in the Internet video industry, the most successful firms leveraged capabilities gained from commitment to tapping the user community, as they strategically evolved. These capabilities not only allowed them to develop new business models but also directly aided their performance.

This study makes two primary contributions. First, the puzzle of the superior performance of firms switching business models serves as early evidence that firms which successfully adapt and change strategies can actually succeed in a nascent industry. This perspective extends existing work on the importance of organizational flexibility in the face of commercialization uncertainty (Bayus & Agarwal 2007; Eggers 2014; Marx & Hsu 2012). In doing so, this study also adds to our understanding of competing business models in nascent industries, and demonstrates a dynamic approach to understanding the firm-level implications of

strategic choice.

Second, I offer a theoretical mechanism that explains the observed empirical outcome. This mechanism of leveraging the user community extends extant frameworks on user innovation (Von Hippel 2009), complementary assets (Teece 1986; Gans & Stern 2003) and platform strategies (Gawer & Cusumano 2012), by explicating the role of the user community (and their contributions) as complementary assets. I demonstrate how early investment into building a user community plays complementary roles in the websites' eventual switch to offering professional content. This has broad implications beyond the context of this study as researchers seek to understand the strategic role of user communities (Bogers et al. 2010; Boudreau 2010; West & O'mahony 2008). To my best knowledge, this is the first study that explicitly links engagement of the user community to actual performance outcomes.

More broadly, this study complements and extends the literature on entrepreneurial strategy, by introducing a dynamic view of strategy over time, and brings new identification to extant literature by delineating the underlying entrepreneurial opportunity from the strategic choice. Together with recent work on entrepreneurial strategy (Marx & Hsu 2012; Wakeman 2008), this study offers a more complete view of the dynamic processes of entrepreneurial choices in a nascent environment. By suggesting that firms which adapt and switch may be able to benefit from their failed experiences under the right set of circumstances, this paper present a detailed picture of the complex dynamics affecting strategic choices in the context of competing and uncertain options.

This paper is organized as such. Section 2 outlines key theories underpinning the study and lays out the key motivating research hypothesis. Section 3 then introduces my empirical setting and approach, with an emphasis on my empirical approach in delineating the strategic resource from the underlying entrepreneurial opportunity. Section 4 presents the main empirical analysis alongside key robustness checks. The paper concludes in Section 5 with further discussion on my main findings and broader strategic implications for both the entrepreneur and the researcher.

2.2 THEORY AND HYPOTHESIS

Much scholarship has been made of the life cycle of an industry - the number of firms, rate of

entry and exit, innovative activity and performance differences are just a few measures of interest. With regards to the entry of firms, evolutionary economics and strategy has been evoked in much of extant literature - linking performance outcomes of entrants to their pre-entry resources and capabilities (Bayus & Agarwal 2007; Helfat & Lieberman 2002; Klepper 2002). While this view helps us to connect technological pre-determinants with the execution and realization of business models, it is limited by its unaccounting for industry dynamics and strategic shifts. A notable exception to such studies is the observations of Hsu and Marx (2012) - who explore the performance effects of entrants as they alter their commercialization strategies in a nascent industry.

More critically, this missing aspect of firm adaptation and change is crucial because in highly uncertain environments – common to most emergent or nascent industries – few firms would know *ex-ante* what the eventual dominant technology or business model would be *ex-post*. There are naturally some who argue that breakthrough businesses are characterized by a single type of strategy, and emphasize a model for business selection and execution in which a preferred business model is feasible. In contrast, the great bulk of practitioners and academic researchers in strategy would instead emphasize that differences in strategy should reflect differences in the underlying environment facing a firm or organization.

In general, given their typical lack of resources, entrepreneurs are typically faced with choices that they have to decide, either in terms of technologies or business models. However while clearly important, extant work on such competition between emergent technologies or business models have been decidedly limited. Those few studies while privileging us with valuable insights into the dynamics of technological disruption or innovation, are typically limited to examining the dynamics of technological competition between an existing technology and an emerging one (Dosi, 1982; Tushman and Anderson, 1986; Christensen and Bower, 1996; Klepper, 1996). These studies however provide relatively limited insight into the long-term implications of the choices made by entrants facing competing business models or technologies in a nascent industry with highly uncertain future demand. Understanding how success (and failure) of business model choices affects a firm's evolution can provide insight into how managers do and should make decisions under uncertain conditions.

Other schools of managerial disciplines privilege us with distinct views towards the consequence of early entrant choices. The ecological school has been perhaps the most vocal in emphasizing the effects of population dynamics, as well as initial endowments of strategic

variates and resources in the determination of firm success (see for example Stinchcombe 2000). Emphasizing that core strategic change is not only difficult to undertake but may also undermine performance (Hannan & Freeman, 1984), the theory predicts that given the limits on firm-level adaptation, most of these broader changes come from the entry and selective replacement of organizations. The larger implication from this line of inquiry suggests that the eventual winners in an industry should primarily be those firms that correctly picked the dominant (ex post) business model from the inception of the industry.

More generally, this perspective is also largely reflected in advantages outlined in the first mover advantage literature (see Markides and Sosa 2013 for a critical review of recent literature on first mover advantage). Across a broad range of literature drawn from various disciplines, the benefits of building and scaling up faster and earlier has been well documented in situations where economies of scale may be available, thereby lending considerable advantage to entrants which had selected on the dominant (ex-post) business model. In totality, advantages outlined by the preceding lines of literature would suggest that the dominant firms are likely to be those which had begun with the eventual winning business model. As such I derive my formal test hypothesis.

> *Hypothesis: Early entrants who initially selected the successful (ex-post) business model will exhibit better performance than firms who initially selected the unsuccessful (ex-post) business model then switched to the successful (ex-post) model.*

Despite the clear normative implications for entrepreneurs and scholars alike, as alluded to earlier, empirical studies examining dynamics in entrants' strategic choices and their performance implications remain relatively rare. Nevertheless a few notable empirical studies have found early though potentially conflicting results. Murray and Tripsas (Murray & Tripsas 2004) offer an intriguing look into the micro-dynamics of entrepreneurial firms in periods of technological ferment, and argue that "purposeful experimentation" whereby firms eventually switch from their original plans, can be beneficial. Even more broadly, the literature on dynamic capabilities has emphasized and examined how firms change strategies over time (Teece, Pisano & Shuen, 1997; Einsenhardt & Martin 2000). These findings are challenged however by Kaplan, Sensoy and Stromberg's study (Kaplan et al. 2009) who found in their sample of startups which successfully achieved IPO that the majority did not change their strategy between business plan formulation and going public.

One of the reasons for the relative paucity of empirical studies is that it is difficult to observe a nascent industry from inception, with full accounting of the contemporaneous strategic choices of entrants and ultimate outcomes. Furthermore, in order to account for the endogenous nature of strategic decisions, one would want some exogenous source of variation for a subset of firms to change their business model or strategy. Finally, the ideal empirical design for studies of this nature should also establish that the firms are pursuing a common entrepreneurial opportunity, in order to allay concerns that the sampled firms may not be well identified. In the next section, I describe my approach to assembling a dataset in which the consequences of dynamic strategic choice making can be assessed more reliably.

2.3 EMPIRICAL SETTING AND DATA

2.3.1 The Chinese Internet Video Industry

As foreshadowed in the previous section, although existing studies have contributed much to our understanding of the entrepreneurial process, they do not in general account for potential differences in the underlying entrepreneurial opportunity the firms are exploiting, making it difficult to isolate the impact of strategic choices. The difficulty is that variability in the core entrepreneurial opportunity among firms may lead to *bias* due to systematic correlation with explanatory variables. Prior research has typically sought to overcome such bias arising from unobserved heterogeneity by using industry and firm associated controls. While the use of control variables is often effective for settings where firms are easily distinguished by observable characteristics, such as products or resource variates, this approach provides limited value when studying entrepreneurial companies in emergent industries, as they are unlikely to fit well into typical industry categories or possess easily observable characteristics.

The fundamental empirical challenge is therefore an identification problem. The risk is to conflate the marginal impact of the strategic choice with the selection effect of the underlying entrepreneurial opportunity. A simple comparison between different strategic choices might therefore lead to biased results due to unobserved differences in entrepreneurial opportunity's potential. To overcome this problem, we ideally require an empirical setting where there are *multiple new ventures exploiting the same entrepreneurial opportunity*. Furthermore, one would want to follow the full population of entrants from the inception of the industry, with detailed

data regarding strategic choices and ultimate outcomes.

In this paper, I propose that a unique entrepreneurial development in China's emerging Internet video industry provides us with exactly that. Because China practices an active policy of Internet censorship, foreign websites are frequently blocked in China[1]. Among the contentious websites, video websites such as YouTube are probably the most actively censored. The system blocks content by preventing censored websites' IP addresses from being routed through, using standard firewalls and proxy servers. It also engages in DNS poisoning when particular sites are requested. Together with other online video websites such as Dailymotion and Vimeo, YouTube has been completely blocked from the Chinese Internet space from as early as 2006.

The strong enforcement of China's Internet censorship has incidentally provided a fertile ground for the development of China's domestic Internet video industry. Entrepreneurs exploited the exclusion of foreign Internet video firms from the Chinese market, and copied the technological idea of distributing videos over the Internet which had originated in the US, resulting in a deluge of highly similar "clones" emerging in the Chinese Internet video industry. I leverage this unique entrepreneurial development to cleanly identify a set of firms which are exploiting a common entrepreneurial opportunity - that of building China's dominant Internet video platform.

In general, the phenomenon of Chinese clone companies, popularly referred to as "C2C" or "Copy to China", has attracted increasing academic and popular attention.[2] As the Internet industry continues to grow rapidly in China, many domestic companies have been very successful in exploiting entrepreneurial ideas spawned originally in foreign markets. Moreover, aided by the

[1] China practices an active policy of Internet censorship, conducted under a wide variety of laws and administrative regulations. While estimates vary, at least 18,000 websites are blocked from within mainland China, and the number is growing (Edelman & Zittrain 2005). The government of the People's Republic of China (PRC) defends its right to censor the Internet by claiming that the country has the right to govern the Internet according to its own rules inside its borders. A White paper released by the Chinese Government in June 2010, lays out some of the reasons why: it declares the intention to curb the harmful effects of illegal information on state security, public interests and children. "Laws and regulations clearly prohibit the spread of information that contains content subverting state power, undermining national unity [or] infringing upon national honor and interests". Another section of the same white paper reaffirms the government's determination to govern the Internet within its borders according to its own rules. "Within Chinese territory the Internet is under the jurisdiction of Chinese sovereignty. The Internet sovereignty of China should be respected and protected" (Bristow, 2010).

[2] See for example *"Chinese Borrowing"*, The Economist, 7th May 2009

rigorously enforced Internet censorship policy, the Internet video sector is one of the most prominent beneficiaries of this "C2C" phenomenon. The original entrepreneurial opportunity having originated in the US also enables us to strip out the original founder effects from the analysis, allowing us to directly assess the effects of strategic covariates.

My core quantitative dataset traces the development of the Chinese Internet video industry from its inception in 2006 through to 2011. I also collected qualitative data about how organizations responded to regulatory change and, how they made decisions with regards to business models and strategy. Detailed schematics of the video websites across the entire spectrum were reviewed with industry insiders, founders and media analysts, in order to understand changes in business models. This work enabled a careful determination of the nature of business model change and the associated changes in organizational performance. Semi-structured on-site field interviews with founders, investors and media consultants in China were conducted from April 2012 to July 2013 over two waves. In total, 19 interviews were conducted, with interviews lasting from 1 hour to all day. Wherever possible, data have been crosschecked with multiple sources.

My evidence suggest that the Chinese video sites were engaged in fierce competition, particular revolving around distinct business models that emerged rapidly in the overall global industry. The following sub-section will briefly describe these business models, as well as give an overview of the industry's historical development.

2.3.2 Competing Business Models in the Internet Video Industry

The history of the Internet video industry really began with the original conception of streaming media codecs in the 1990s. A succession of different competing technologies appeared, including RealMedia, ActiveMovie and Quicktime. By 2000 however, Adobe Flash became the dominant streaming codec on the Internet (Vaughan-Nichols 2010, p.5). Leveraging this common technological platform, most of the corporate news sites and certain TV and movie studios in the US were already putting their content on the Internet (Manovich 2009). However, the Internet video industry truly took off with the emergence of YouTube in the US. Three former PayPal employees founded YouTube in September 2005: Chad Hurley, Steve Chen and Jawed Karim. The website was founded on a relatively simple technological idea: clever software coding by the founders allows users to upload and share Adobe Flash based videos through the Internet, and anyone with Internet access is able to view them free of charge. YouTube became an Internet and

cultural phenomenon. In November 2006, barely eleven months after being launched, Google acquired YouTube in exchange for 1.65 billion dollars in stock.

YouTube and its success gave energy to the nascent industry, popularized the practice of videos hosted on the Internet (Gannes 2009) and established the dominant platform for Internet videos. It also demonstrated that the distribution and consumption of videos over the Internet could be economically viable. YouTube however was also among the first successful example of a *User Generated Content (UGC)* driven venture (Kaplan & Haenlein 2010). It popularized the publishing of content on publicly accessible websites, while also being among the first to introduce and institutionalize the concept of a participatory user community. By providing an outlet for users to upload content, YouTube became one of the most well-known and widely discussed sites of participatory media in the contemporary Internet environment (Burgess & Green 2009).

Built on the same technology platform of Adobe Flash-based videos over the Internet, two dominant types of content offerings representing distinct business models rapidly emerged (Artero 2010). The first is the aforementioned UGC model where content is sourced from users and then relayed back to other users. The second is the *Professionally Produced Content (PPC)* model, where content is licensed from professional media producers (such as movie and TV studios) then relayed to the users. In the US, this is popularly referred to as the Hulu model. These two kinds of content offerings represent the bulk of content offered by the websites and embody distinctly different business model approaches.

While the industry originally spawned and developed in the US, developments in China took place almost in parallel. Entrants to the nascent industry in China grappled with developing the optimal business model as they sought to become China's dominant Internet video platform. In particular the contest between the UGC and PPC models was fierce. While many sites began as pure clones of YouTube in only offering UGC, competing sites that focused on offering PPC rapidly emerged. Field interviews attest to the dichotomous nature of these two forms of content, and how they are the dominant competing forms of business models. A co-founder of a successful video site described their differences:

> *"UGC and PPC are the two distinct forms of content... UGC is content sourced from users while PPC is content pushed to users. YouTube popularized UGC but PPC had rapidly emerged as another form... The state stations had been putting content on the web for sometime. Other private companies also started licensing material and putting*

on the web... for example Korean drama serials and Taiwanese variety shows."

Another media consultant opined:

"PPC emerged very rapidly in China... maybe even before Hulu in the US. The state stations were active in putting their content online... private companies also started doing the same. UGC comes from users themselves while PPC is content that is put up by the websites themselves."

While the UGC and PPC business models are based on the same technological platform, operationalizing them requires different sets of capabilities. In particular, maintaining a UGC site requires the development of specific capabilities to support a viable user community. Websites need to develop infrastructure to enable the uploading and publishing of content by users, while providing incentives to encourage contribution and production of the content (Milliken & O'Donnell 2008). Furthermore, websites need to develop capabilities to curate the content to screen out potentially offensive material, which also entailed understanding of the content. These infrastructural capabilities demand significant investment by the firm, both in terms of financing and time (Bharadwaj et al. 2013). On the other hand, PPC sites rely less on capability development and more on just maintaining licensing agreements with the original content providers. Field interviews again attest to these views. A venture capitalist shared the following:

"It is not clear which is the easier model. On one hand UGC is relatively cheap to acquire content but it is tough to maintain [the site]... and it is difficult to ensure a constant supply of content. On the other hand, PPC requires licensing fees to be paid but at least you are guaranteed content. Regardless, it is clear that a specific set of investment and commitment needs to be made to support the UGC model."

An executive at a PPC site added this perspective:

"We were really unsure if the UGC movement would even take off in China. We saw how popular YouTube became but that is in the US... And in a sense, I would argue that UGC is not popular in China. Chinese are just more interested in watching drama serials and movies. That's why we chose to focus on doing only PPC."

As I will demonstrate later, my quantitative data suggest that early entrants between 2006 and 2008 were evenly split between the competing business models. The dichotomous nature of these two business models forms the overarching competitive backdrop of my analysis.

2.3.3 Regulatory Change

A quasi-exogenous event radically changed this competitive landscape. On 31st January 2008, China's State Administration of Radio, Film and Television (SARFT) and Ministry of Information Industry (MII) introduced the *Regulations for Online Audio and Video Services*, which took place with immediate effect. These regulations covered the production, editing, and aggregation of audio and video content, and legislated public access of both Internet and mobile networks.

The new regulations defined SARFT as the authority to administer, monitor, and regulate the industry's development; while the MII, holding authority over the Internet and mobile industry, would take related monitoring responsibilities and provide a set of service guidelines. The regulations also required all online audio and video service providers to apply for an "Online Audio-Visual Broadcasting License", key qualifications for which include submission to a standardized content censoring system, legal funding sources, and 'standardized technology'.

Furthermore, broad powers were conferred or transferred to the regulatory bodies, as well as to the major (largely state- owned) media producers, such as TV and movie studios. These entities were now able to censor and police content found on all Internet video sites, with a focus on censoring UGC sites. For example, the regulations required all UGC websites to delete any illegal or undesirable content as soon as it is found, keep a record thereof, and report the details to the relevant authorities. Violations of the regulations would result in a withdrawal of the license to operate, and a penalty of up to RMB 30,000.

The effects of these changes were profound. While UGC had offered a relatively cost-effective way to source content and enter the industry, the strong enforcement of the new regulations placed severe curtailments on the effectiveness of UGC as a business model. Interviewees made consistent reference to how the regulatory changes of 2008 affected the industry and forced them to adapt. As the co-founder of a previously pure-UGC site recalled:

> *"The 2008 regulations really changed the market... it isn't so much that we were hosting illegal content... but the threat is scary. We hear tales of competitor sites being pulled offline for hosting undesirable content... it really forced us to start thinking about alternative business models..."*

A media consultant remarked:

"UGC is a cheap way to acquire content that matches licensed content, but it became really expensive to maintain after the regulatory change. Monitoring the content is expensive and the consequences of not doing so became increasingly frightening."

A senior employee of an initially pure UGC site further added:

"After 2008, it became quite clear to us that UGC has had its run. We needed to transition to PPC... not only because of the censorship environment which made our business very difficult... but also we had increasingly thought that the UGC novelty has run its course."

I leverage this event as an exogenous source of variation to identify two distinct commercialization environments. Because UGC as a business model was severely curtailed by central regulatory changes, there was pressure for these sites to adapt to offering PPC. In other words, regulatory changes provided an exogenous source of variation in incentives for the subset of UGC firms to change their business models. I take advantage of this important event to study the performance effects associated with these firms switching their business model, compared to those firms that had started with the PPC model, that was exogenously picked as the advantageous one.

2.3.4 Quantitative Data

The core of this study centers on a new, hand-collected dataset of the Chinese Internet video industry, which contemporaneously captures its development from inception in 2006 through to 2011. First, working in conjunction with SARFT and China Telecom (China's main Internet Service Provider), I developed a complete list of active Chinese online video websites. While the industry may have spawned slightly earlier, as anecdotal evidence suggests, 2006 was the earliest year the Chinese authorities started keeping records of this industry. This list is further refined by reference to various practitioner and industry literature (see for example Gannes 2009). While it is possible that some websites may be omitted from my list, they are likely to be obscure or unregistered with the State Administration, which renders their legitimacy questionable.

Using the *Internet Wayback Machine*, I collected the historical cached pages of each firm on the list. The Internet Wayback Machine is a digital time capsule created by the Internet Archive, a non-profit organization, based in San Francisco, California. It is maintained with content from Alexa Internet. This service enables users to see archived versions of web pages across time. Together with research assistants, I coded each webpage individually by direct observation and categorization, recording data for each website that delineates their specific bundles of content, activities and resources. Since these firms changed their business models rapidly, I collected and analyzed data by each quarter of the year. In all, I recorded data for 19 quarters, from July 2006 to March 2011.

While the Internet Wayback Machine allows us to contemporaneously examine the business model changes as well as the survival / failure of the firms, we still need other measures of interim performance. Hence, I obtained interim outcome variables from *iResearch*, a research consultancy in China. iResearch is a commercial media consultancy that has been consistently tracking Chinese Internet users' user behavior and website performances since July 2006 when the service was launched. The consultancy fulfills similar functions as its noted counterparts in the US such as ComScore and Google Analytics. A full set of web metrics was obtained from them, and they will serve as interim outcome variables. Firm names were matched manually to our original list, with a virtually 100% success rate. In all, a total of 150 firms are observed in my dataset.

2.3.5 Variables

For my main explanatory variables, I coded the content offerings undertaken by each firm. The adoption of a particular content offering was coded as having taken place the quarter it was reflected in the cached webpage. Firms that competed directly for viewers using content that is sourced exclusively from users – YouTube's original model – are coded as offering *User Generated Content (UGC)*. On the other hand, firms that only used content licensed from TV studios and other professional content providers – similar to Hulu's original model – were coded as offering *Professionally Produced Content (PPC)*. Further details on my coding are documented in Appendix A.

For my firm-performance analysis, I examined both *survival* and *interim* performance. With regards to survival analysis, the primary outcome variable was coded from measures of

failure. Going offline for 6 or more months consecutively was coded as having *failed.* While there were some websites that came back online after an extended period of dormancy, these were relatively few in number. Among all sites that went offline for 6 or more months, less than 15% were eventually restored. My results are robust to exclusion of these sites.

When analyzing interim performance, the selection of appropriate performance measures for examining websites is not straightforward (Turban et al. 2003) - primarily because of the large array of measures that can be potentially used to evaluate effectiveness (Huang et al. 2009). Profitability is available for very few websites, so it has yet to be used in a large sample study. Revenues have not proven to be a consistent measure of e-business performance, given the infancy of revenue-generating measures; operating revenues are frequently limited to banner advertising sales. Where Internet sales are a small (albeit increasing) portion of a firm's overall sales, the use of composite or aggregated measures, such as return of investment or market share, would be inappropriate.

Accordingly, instead of using common financial performance measures, such as stock market performance, I examined the most common measure of website operating performance: *Number of Visits* (Huang et al., 2009). This measure has already been extensively used as a gauge for estimating users' behavior, which ultimately determines website operational performance (Montgomery et al. 2004). This is because the primary source of revenues for these firms is in advertising; hence the higher the number of website visits, the more attractive the website would be to potential advertisers (Jarboe 2011). I used its natural logarithm in my analysis. Other website metrics collected include the average time spent on each video by viewers for each website, and they will play an important role in my robustness checks.

My models include controls for both initial conditions and subsequent competition between the websites. Regarding initial conditions, I exploited the unusually rich institutional environment of China, and controlled for the ownership type of the websites. Ownership type has been recognized as one of the most important institutional arrangements because it represents the way the government can effectively exercise control and impact a firm's choice of competitive position and subsequent performance (Tan et al. 2007). Similar to other industries in China, the online video websites represent a varied set of ownership structures, from pure private startups to state-owned ventures. Empirically, I used an indicator variable *State* to denote firms that are owned by the Chinese state government.

As for firm characteristics, I have also collected a list of venture capital investment

events, which are publicly reported on China-specific investment media. Thus I was able to create an indicator variable *Invest* which denotes if the firm has been invested by a venture capital company. Unfortunately as most of these firms are private, other firm level specific data such as employment count were not publicly available. Last, I also modeled competitive dynamics in my estimations. I incorporated the number of websites active in each time period, as a measure of the population density which is believed to be correlated with firm failure (Carroll & Hannan 1989). This is recorded as *Number of Active Firms.*

It is important to emphasize here again that these firms all leveraged the common technological platform of Adobe-flash based videos. As a consequence, this setting enables us to track not only the initial business model decision, but also how the firms evolve over time without the confounding factor of technological changes. Note that I drop from our sample all websites that were merely mirror sites and do not actually host video files.

2.4 ANALYSIS

Figure 1 shows the distribution between the 3 models – *pure UGC, pure PPC and Mixed* (hosting both UGC and PPC) – from 2006 to 2011. Time is represented in units, to indicate the number of quarters from the earliest entry in the dataset. For example 3rd quarter 2006 is represented as Time "1". The distribution is fairly evenly split between *pure UGC* and *pure PPC* before 2008. Post 2008, the distribution skews sharply towards *pure PPC* and *mixed*, in line with our expectations following the abovementioned regulatory change.

Insert Figure 1 about here

Figure 1 also shows the pattern of entry and exit. We see that there is a sharp increase in firm failure immediately following regulatory change in 2008. We can also discern that this seems to be driven largely by *pure UGC* firm failure, which is again in line with our expectations. Pre-regulatory change however, there appears to be no discernible difference in failure rates between the different business models. My regression analysis will provide a more detailed picture. Figure 1 also describes the overall population density (i.e. number of active websites)

over time. As we can see, immediately after regulatory change there was a massive shakeout in the industry, before picking up in founding intensity.

Formally, I will now present a set of empirical analyses relating the business model choices to eventual firm performance. I do this in the context of both ultimate failures by the firm (across-form variation in outcomes) and interim performance in unique view counts (within-firm variation over time). I then examine how the firms' initial choices of business model – UGC or PPC – are related to the firms' dynamic performances under different competitive environments.

For the first set of analysis, the key explanatory variable is *UGC_only* that describes firms that offer only UGC. This is a dummy variable set to one if the firm exhibits that behavior in that quarter. The reference set of firms comprises of those that offer some form of PPC. For the second set of analysis, to describe the firms' initial business model choice, I code a separate indicator variable *UGC_initially*, which describes firms that started out offering only UGC as opposed to offering PPC. I then examine the interaction of this starting strategy with subsequent strategy employed by the firm. The full set of variables and their descriptions are listed in Table 1, Panel A. Descriptive statistics and correlations for the variables used in analysis are in Panel B.

Insert Table 1 about here

2.4.1 Baseline Regression Results

I first present a set of empirical analyses that examine the determinants of firm failure of among these websites. The empirical pattern we should observe is that firms that continue to pursue a pure UGC strategy after regulatory change in 2008 should be expected to have a higher hazard rate for failure.

To do this, given my longitudinal, right-censored data, I first estimated a discrete-time hazard model, implemented with a logit where the failure state is going off-line for 6 months or longer. The dependent variable is the log-odds of website i failing at time t. In addition to the constant, there are two main terms on the right hand side of the equation. The first term captures the effect of the business model; the variable *UGC_only* is the measure of exclusively offering UGC as the business model. The second term *post2008* captures the temporal effect stemming

from the regulatory change. The interaction term between *post2008* and *UGC_only* then captures the differential effect of adopting a pure UGC strategy post-regulatory change in 2008. The last term includes control variables in the vector ***X***.

$$\ln\left(\frac{p_{it}}{1-p_{it}}\right) = \alpha + \beta 1 UGC\_only_{i,t} + \beta 2 post2008_t + \beta 3 UGC\_only_{i,t} \cdot post2008_t + \gamma X_{i,t}$$

I incorporate both firm-quarter level and industry-quarter level controls, including the entry quarter of the firm, interim performance, investment status, and the number of firms active at each time period. Errors are clustered at the firm level, to take into account potential serial correlation between observations within the same firm.

Insert Table 2 about here

Table 2 presents results, starting with control variables alone in Column (1). Exponentiated coefficients are shown. The results show that the hazard of failure is higher later in the sample, although the time of entry does not appear to be significantly related. Companies that received investment by VCs or PE groups are negatively associated with failure, in line with our expectations. The results also show as expected, that higher number of visitors is negatively associated with failure.

In Column (2), I add the indicators *UGC_only* and *post2008*, which denote the firms' employment of a pure UGC content strategic profile, and time periods post regulatory change respectively. The coefficient on the *UGC_only* variable is statistically significant at the 1% level, indicating that pure UGC websites were more than 4x more likely to fail than other websites. We see that firms post 2008 are also more likely to fail than before.

Results in Column (3) reflect the full model I am trying to estimate. I included the interaction between *post2008* and *UGC_only*, the coefficient on which reflects the differential effect of adopting *UGC_only* profile post-regulatory change. This is as expected significantly positive, suggesting that sites which persist with a pure UGC model post-regulatory change are

associated with a higher failure rate than other sites. In Column (4), I only considered firms, which entered prior to the regulatory change in 2008, to partially address the potential endogeneity of strategic choice making. We have very similar results to that in the full sample. Overall, my results suggest that firms that persisted with a pure UGC model post-regulatory change are 4- 5x more likely to fail than other firms.

The story is strengthened by the trends we see in the short-run performance analysis. I do this by considering a simple OLS model of the short run performance of the individual firms, in which the performance measure is regressed on the same variables of our interest.

$$Y_{i,t} = \alpha + \beta_1 \cdot post2008_t + \beta_2 \cdot UGC\_only_{i,t} + \beta_3 \cdot UGC\_only_{i,t} \cdot post2008_t + X_{i,t} + \Omega_i + \varepsilon_{i,t}$$

Similar to my earlier survival analysis, the coefficient β_3 measures the differential effect of using a pure UGC model respectively on the *Number of Visits* (logged) post-regulatory change. In other words, if β_3 is negative it implies that firms that adopted a pure UGC model are more likely to be associated with a performance decline post-regulatory change, relative to those that had not. Again, I incorporate both firm-month level and industry-month level controls, including the age of the firm, its investment status, and the number of firms active at each time period. Fixed effects at the firm level are incorporated, with errors clustered at the firm level, to take into account correlation between observations within the same firm. Table 3 shows the results.

Insert Table 3 about here

In Column (3), using *Number of Visits* (logged) as my performance measure, we see that the coefficient on the interaction term between *UGC_only* and *post2008* is statistically significant and negative. This supports the earlier survival analysis, by suggesting that firms that utilized a pure UGC model post-regulatory change experienced a performance decline in Number of Visits over those that had not. In Column (4), we considered only firms that entered prior to the regulatory change, obtaining very similar results. These results are consistent to the inclusion of a battery of fixed effects, at both firm and quarter levels as reflected in Columns (4) and (5).

Overall, my analysis suggests that *UGC_only* firms suffer a performance decline of 40-60% in terms of Number of Visits on average post-regulatory change. In other words, results suggest that the winning business model is indeed to offer PPC, in line with the intended regulatory effects.

2.4.2 Strategic Adaptation and Firm Performance

The earlier analysis gave us some indication that firms which continued with a pure UGC business model experienced significant performance decline post-regulatory change. Now I will examine firms that began with the pure UGC model and switched to adopting PPC, and the relation of this strategic adaptation with the subsequent firm performance. We begin with looking at descriptive statistics of strategic change of the firms.

Insert Table 4 about here

Table 4 shows how strategic change of firms after the regulatory change in 2008. In line with our expectations with regards to the new regulatory environment, 40% of all firms that began with a pure UGC business model, started to offer PPC post regulatory change. On the other hand we see that no firm that started with a PPC strategy, switched to offering UGC and had essentially remained unchanged in the business model. Again this is in line with our expectations following the regulatory changes.

Similar to my initial analysis, I first estimate a discrete time survival model post regulatory change. First, to establish a direct comparison between the switching firms and firms that had started and persisted with the PPC model, I exclude all firms that had stayed with a pure UGC model. Then I define an indicator variable $UGC\_initially_i$ that records all firms that had started with UGC model initially. I finally include the indicator $PPC_{i,t}$ that denote an offering of Professionally Produced Content by firm i in quarter t. It is recorded as 1 when the firm offers PPC in that quarter of observation. The interaction of $UGC\_initially_i$ with $PPC_{i,t}$ is our main

variable of interest. In other words, I am measuring the differential effect of the firms offering PPC in the new competitive environment, based on their initial strategy. Formally, I specify:

$$ln\left(\frac{p_{it}}{1-p_{it}}\right) = \alpha + \beta_1 \cdot UGC\_initially_i + \beta_2 \cdot PPC_{i,t} + \beta_3 \cdot UGC\_initially_i \cdot PPC_{i,t} + \gamma X_{i,t}$$

Table 5 shows the results.

Insert Table 5 about here

The results are interesting. In Column (3) we see that on average, sites that started as pure UGC sites and adapted to offer PPC post regulatory change are 90% less likely to fail relative to our baseline sites, which are those that had started and continued with PPC. In other words, sites that had started with the disadvantaged pure UGC model and subsequently adopted PPC are *less likely to fail* than sites that had stayed as PPC. In Column (4) I repeat the same analysis but only for firms that entered before the regulatory change, obtaining similar results although I lose some statistical significance.

I repeat the same analysis for the interim performance measures. As I use firm level fixed effects in my specifications, time invariant variates are absorbed. Formally I specify:

$$Y_{i,t} = \alpha + \beta_1 \cdot PPC_{i,t} + \beta_2\, UGC\_initially_i \cdot PPC_{ti,t} + X_{i,t} + \Omega_i + \varepsilon_{i,t}$$

The results are shown in Table 6.

Insert Table 6 about here

The results resonate with my earlier survival analysis. In Column (2) we see that on average among PPC sites post regulatory change, sites that started as pure UGC sites and transited to also offering PPC post regulatory change, experience a boost of between 30 to 50% in *Number of Visits (logged)* relative to the baseline sites. The result is significant at the 5% level. In Column (3) I repeated the analysis for only firms that entered prior to the regulatory change, obtaining similar results. In Column (4) I added time fixed effects; in Column (5) analysis was conducted using a conditional fixed effects Negative Binomial regression on the non-logged *Unique Visits* counts. The results are consistent in pattern – the coefficient on the interaction term between *UGC_initially* and *PPC* remains consistently positive and significant.

In totality, my results suggest surprisingly that firms that started with the UGC model and successfully adapted to offer PPC, outperform firms that had started with PPC. In other words, despite being disadvantaged by unfriendly regulatory changes, *firms that adapted and changed their business model to the eventual dominant one outperform those that had started with the dominant model.*

2.4.3 Coarsened Exact Matching

In previous sections, I presented evidence suggesting that the initial choice of UGC coupled with strategic adaptation to PPC post-regulatory change is associated with both survival and interim performance benefits. However, like any strategic decision, business model choices are generally endogenous, and so establishing the causal direction of the strategic choices and performance is difficult. Although the shift in the regulatory environment facilitates greater confidence in the direction of strategic choices and performance, this paper still inherits (justifiable) concerns that there are significant imbalances between the groups of firms. To allay these concerns, I attempted to perform a more rigorous test on the observed empirics by using a nonparametric method of preprocessing data to control for some or all of the potentially confounding influence of pretreatment control variables, thereby reducing imbalance between the treated and control groups.

As such, I further refined the sample by performing a *Coarsened Exact Match* (CEM) procedure (Iacus et al. 2012) to identify a control for each "treated" firm. Here, the sites that started with a pure UGC strategy and adapted to offer PPC post-regulatory change are our treated set of firms; while the sites that had started with a PPC strategy form the control set. I identified

controls based on the following set of covariates: firm entry quarter, ownership and the firm's unique visit count for the last 4 quarters prior to regulatory change in January 2008. I then coarsened the joint distributions of these covariates by deciles. In other words, I matched the firms by their pre-regulatory change performances.

I managed to match 18 of 22 treated firms. Table 7 shows the covariate balance between firms in each quarter, based on their initial strategy (*UGC_initially* or not). It basically shows that differences between the two groups of firms are statistically insignificant, both as a difference in means (t-test) and as a difference in distribution (Kolmogorov-Smirnov test). As such, we have added confidence that these firms are essentially well matched in performance, prior to the change in competitive environment.

Insert Table 7 about here

The matched sample allowed us to perform a deeper robustness check on the earlier results. While we lose significant statistical power due to the smaller sample, we still see similar data trends as observed before. The results are again very similar for all models. Results of these robustness checks are shown in Table 8 Panel A and Panel B, which describe the survival and intermediate performance analyses respectively.

Insert Table 8 about here

The results resonate with my earlier full-sample analysis. While we lose some statistical significance for the failure analysis, firms that started with an initial UGC strategy – matched on entry timing, ownership and previous quarters' visit counts – still fail at a substantially lower rate than firms that started with an initial PPC strategy. For our intermediate performance analysis, we see that these same firms perform substantially better than the matched controls.

2.4.4 Mechanism

The results are puzzling and demand a mechanistic explanation. One plausible way is to consider the complementary assets required in a successful commercialization strategy. A central premise in many technology commercialization studies is that in an emerging industry, complementary assets are key drivers of a successful entrepreneurial strategy (Gans & Stern 2003; Teece 1986). These complementary assets may represent firm-level resource or capability endowments (Helfat 1997; Tripsas 1997). They may also represent ecosystem-level complementary activities and technologies that are required for value creation by the focal technology.

Casting the users as complementary assets allows us develop some key insights towards into unpacking the performance variance between the entrants. While firms that started with an UGC business model were technically disadvantaged in the post- regulatory change environment, their initial foray into the UGC world may have allowed them to develop key capabilities that which they can could leverage, even as they moved away from their original model. This is especially as we consider the potential role that engagement of the user communities via support for UGC initially might have played. In an interview, YouKu's co-founder Victor Koo (2011) attested to the subtle value of users – developed from their initial support of the UGC business model – and described them as complementary assets that supported their eventual PPC content offering in an interview:

> *"Users (who participate in) the production, uploading, browse, collections, reviews, ratings, interactive behavior, are involved in the (development) of the platform architecture... The users' participations, in fact, have helped other users and us to better choose the content to license in the future."*

The potential capabilities and complementary assets, derived from supporting and engaging users, leads one to hypothesize that entrants which successfully transitioned from a UGC to a PPC model might be more successful than those which started without investing in these capabilities, even to the extent of such firms overcoming a disadvantageous shift in the commercialization environment. To unpack this, I further examined the performance effects between those that switched to *Mixed* sites (offering both UGC and PPC), and those that switched to *pure PPC* sites (offering only PPC). If UGC is indeed contributing complementary assets to firms subsequently offering PPC, then we should expect *Mixed* sites to perform better than *pure PPC* sites. To do this, I repeated the earlier analysis, using the indicator *Mixed* to denote sites

that offer both PPC and UGC post-regulatory change. I restricted the sample to only include sites that had started with a pure UGC model and adapted to offer some form of PPC. Results are shown in Table 9.

Insert Table 9 about here

We see that *Mixed* firms significantly outperform *pure PPC* firms. In other words, firms that continued to offer UGC together with PPC, outperform those that had given up UGC completely. This suggests that UGC potentially plays a complementary role in the successful deployment of PPC.

I performed another set of analysis to further ascertain this mechanism. I separately distinguished between *Self-Created Content* (SCC) and traditional PPC. Self-Created Content is licensed content that is produced by amateur filmmakers and licensed by the firm for distribution. This can be in the form of short films, drama series or movies. Intriguingly, a co-founder of a previously pure UGC site shared in an interview that he had foreseen the rise of this form of content:

> *"(To me) UGC is not only about the content... It is about engaging the users and understanding them. And I thought maybe one day the users could become producers of professional content... like you see in the US now with sites like Vimeo. And we would then be first placed to engage them."*

SCC provided an important competitive edge by providing additional sources of content at relatively low cost, thus helping to alleviate heightened operating costs due to soaring licensing fees for traditional PPC (Wei 2013). If users carried over from embracing UGC are indeed complementary assets, they should provide their associated firms with a competitive edge over pure PPC firms that never developed access to a user community, by facilitating development of SCC. As such, I coded for an additional binary indicator *SCC* that denotes if firms are offering licensed content sourced from amateur filmmakers. I then examined the incidence of *SCC* using a linear probability specification, with the explanatory variables as the strategic profiles of the firms i.e. *Mixed and PPC_only*. Results are shown in Table 10.

Insert Table 10 about here

The results resonate with our earlier findings. The coefficient on *Mixed* is both positive and significant, which suggests that firms that offer both UGC and PPC are more likely to develop SCC with amateur users, than pure PPC firms. The results hold for the CEM matched sample as well, giving us greater confidence that users from UGC are functioning as complementary assets to firms.

2.4.5 Further Robustness Checks

First, I performed analysis using alternative measures of performance, including *Number of Pages Viewed*, and *Percentage Share of Total Visits*. The results are very similar for all models. Second, I performed all analyses on only a subsample of the earliest entrants, which entered either before or in 2006. The biggest advantage of focusing only on the earliest entrants is that it eliminates any concerns about the endogeneity of entry timing. The results are very similar for all models again. These results are available upon request.

Another crucial challenge to my results is that these sites are fundamentally different from each other and cater to different sets of viewers. Critically, this alternative explanation challenges our original empirical premise of a common entrepreneurial opportunity. As this is one of the paper's key motivations, it is important to establish if the websites were all exploiting a common entrepreneurial opportunity and thus attracting a common set of viewers.

To do this, I obtained data for the *Average Time Spent on a Video* from iResearch. iResearch tracks this using a representative sample group of consumers and their video consumption behavior. The statistic is recorded in seconds. I use this as an alternative outcome variable in my regressions. The challenging argument predicts that the average time spent on a video should be correlated with the differing strategic profiles. The intuition behind this is that the time spent on each video should be different, if indeed they are catering to different viewers. In other words, the websites are offering different kinds of videos. Although this measure is

imperfect, the time spent on videos are usually regarded as a good measure of the kind of videos (Artero 2010; Kumar & Tomkins 2010). I fitted a fixed effects OLS specification in this portion of my analysis. Results are shown in Table 11.

Insert Table 11 about here

In Column (1), we see that the coefficient on *UGC_only* is insignificant, indicating that there is no statistical evidence that these sites have a different user profile from pure PPC sites. The same trend holds true even when we decompose the sample according to the regulatory changes as shown in Column (2). This lends weight to our empirical claim that these websites were all pursuing a common entrepreneurial opportunity when they entered the nascent industry. In other words, these sites are likely to be competing using the same kind of content, helping to justify my claims of a common entrepreneurial opportunity.

2.5 DISCUSSION

Leveraging a new dataset of all entrants to the Chinese Internet video industry between 2006 and 2011, I present both quantitative and qualitative evidence which documents how entrants that switch to the eventual dominant strategy are more positively related to subsequent firm performance, than entrants that started with the dominant strategy. To explain this empirical puzzle, my evidence further suggests a unique strategic role that engagement of the user community plays in the development of a successful platform strategy. I document how engagement of the user community by certain Internet video sites allowed them to build sustainable performance advantage, even in overturning disadvantages brought on by a quasi-exogenous shock in the regulatory environment. Furthermore, to my best knowledge, this is the first large-scale entrepreneurial strategy study where a common entrepreneurial opportunity is identified; and following in the footsteps of recent work (see for example Hsu and Marx 2012), it is also one of the first studies to explicitly link firm performance to entrepreneurial strategy.

The observed empirics resonate with extant literature on the importance of complementary assets that underlie a given technology's commercialization (Teece, 1986, 2000). Scholars have emphasized the important role of complementary assets and their interaction with the appropriability environment in influencing the strategic choices (see e.g. Gans and Stern 2003). While the availability and consideration of these firm-level assets cohere with traditional explanations of industry evolutionary dynamics, they also stress a dynamic approach to the entrepreneurial strategy process. That firms are firstly sensitive to the environment in making their core strategic commitments, and secondly adaptive in identifying, adapting and building the unique and tailored capabilities, resources and market positions that allow the firm to realize that broad strategy choice on a sustainable basis.

Adopting such a view of entrepreneurial strategy allows us to develop a logic of capability investment and asset re-deployment to explain the empirical pattern we see in the Internet video industry. There has been increasing research on the potential strategic role that the user community can play (see for example Bogers, Afuah, and Bastian 2010; Dahlander and Magnusson 2008; Dahlander and Wallin 2006; West and O'mahony 2008). Users can be contributors of code or content, as well as early adopters of downstream products (Boudreau 2010; Von Hippel 2009; Kaplan & Haenlein 2010). The varied roles of users suggest that the user community can be viewed as a complementary asset that can be redeployed and repurposed as a firm adapts its strategy or business model. And as my study suggest, they can enhance the resilience of a start-up to a disadvantageous shift in their environment.

One key limitation to my results is that strategic choice is endogenous, and hence they should be interpreted cautiously. Nevertheless, I demonstrate methodological advancement from current literature by controlling for the underlying entrepreneurial opportunity; and then by approximating a quasi-experiment to examine the impact of strategic adaptation and change using matched sets of firms. The results point to the dynamic role of entrepreneurial strategy making. While some threads of literature tend to depict each firm as a single un-adaptive entity - focusing either on initial strategies and products of firms in their depictions of industry evolution, or on the entry and selective replacement of organizations - my results instead suggest that entrepreneurial strategy needs to focus on the process of how firms and managers respond to and exploit environmental signals.

More generally, my findings raise fundamental questions with regards to our understanding of entrepreneurial strategy. Are successful startups in a nascent industry lucky or

are they smart? I propose that the inherent uncertainty in nascent industries should suggest that the entrepreneurial firm is more likely to incorporate future considerations into their commercialization decisions than not, as certain scholars have suggested (Gans 2011). In other words, startups are more likely to have already considered changing their business models as a necessity given the uncertainty surrounding the commercial value of new ideas or innovations. Indeed, my results suggest that firms that committed to building flexible capabilities, which can be adapted and redeployed under new or different business models, are most successful. As a consequence this may tip firms to choose to invest in capability development, if these capabilities or complementary assets are expected to retain value even in the event of future strategic change.

Furthermore, my results reinforce early findings from practice-oriented literature on platform strategies, while also sharpening them. For example, there are several anecdotal studies published on the value of Web 2.0 and other forms of social media, especially as it relates to the engagement of the user community and user generated content (Wirtz et al. 2010). However merely supporting UGC may not be what drives ultimately superior organization outcome; rather my results suggest that the role played by UGC is more nuanced. They suggest that users from supporting UGC may act as complementary assets to improve the delivery of other professional services, such as in this case, the delivery of professionally produced video across the Internet. In this vein, this user community strategy may generalize to any setting where there is uncertainty with regards to the future demand of the customers.

From a research perspective, this study extends the literature on industry transitions and entrepreneurial strategic choices by highlighting the importance of the messy and uncertain period before the dominant design takes off. Unlike traditional measures of pre-entry experience that focus on experience in a different industry or a related market space, the focus of this study is on the choices entrepreneurs make *after* they choose to enter the industry. Given that entrepreneurial strategic choices have significant and long lasting implications, future research should focus more attention on how firms develop strategies and make choices during the initial uncertain and dynamic periods that define the beginnings of nascent industries.

Additionally, the research offers implications for new directions of research in taking advantage of similar institution barriers that preclude founders from exploiting their original entrepreneurial ideas. This is especially common in the digital age, where business models can be rapidly copied and modified while leveraging the same technological platform. Similar clone phenomena have been observed in collective buying sites (Groupon clones such as Coupang.com),

social media websites (Twitter clones such as Weibo.com) and social networking sites (Facebook clones such as RenRen.com). China is a particularly fertile ground for study due to the combination of enforced institutional barriers such as the Chinese Internet Firewall, as well as softer barriers such as culture and language. Leveraging the development of clones of original ideas spawned in other geographies, allows the researcher to artificially strip out key confounding factors such as founder and technological effects. This lends us greater identification in isolating the causal impact of strategic variates.

Like any study, this work has its limitations. First, this study offers a broad theory of entrepreneurial strategy but utilizes only a single industry context. Thus it represents more of an instructive industry case study, rather than a strong test. Second, the data do not provide a full picture of the time variant organizational capabilities and resources possessed by the firms, due to inherent limitations in the industry setting. Future work could pursue finer grained measures of both technical and market capabilities and resources.

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2.7 Tables and Figures

Figure 1 **Strategy density (percentage of firms with a particular business model) and, patterns of entry and exit**

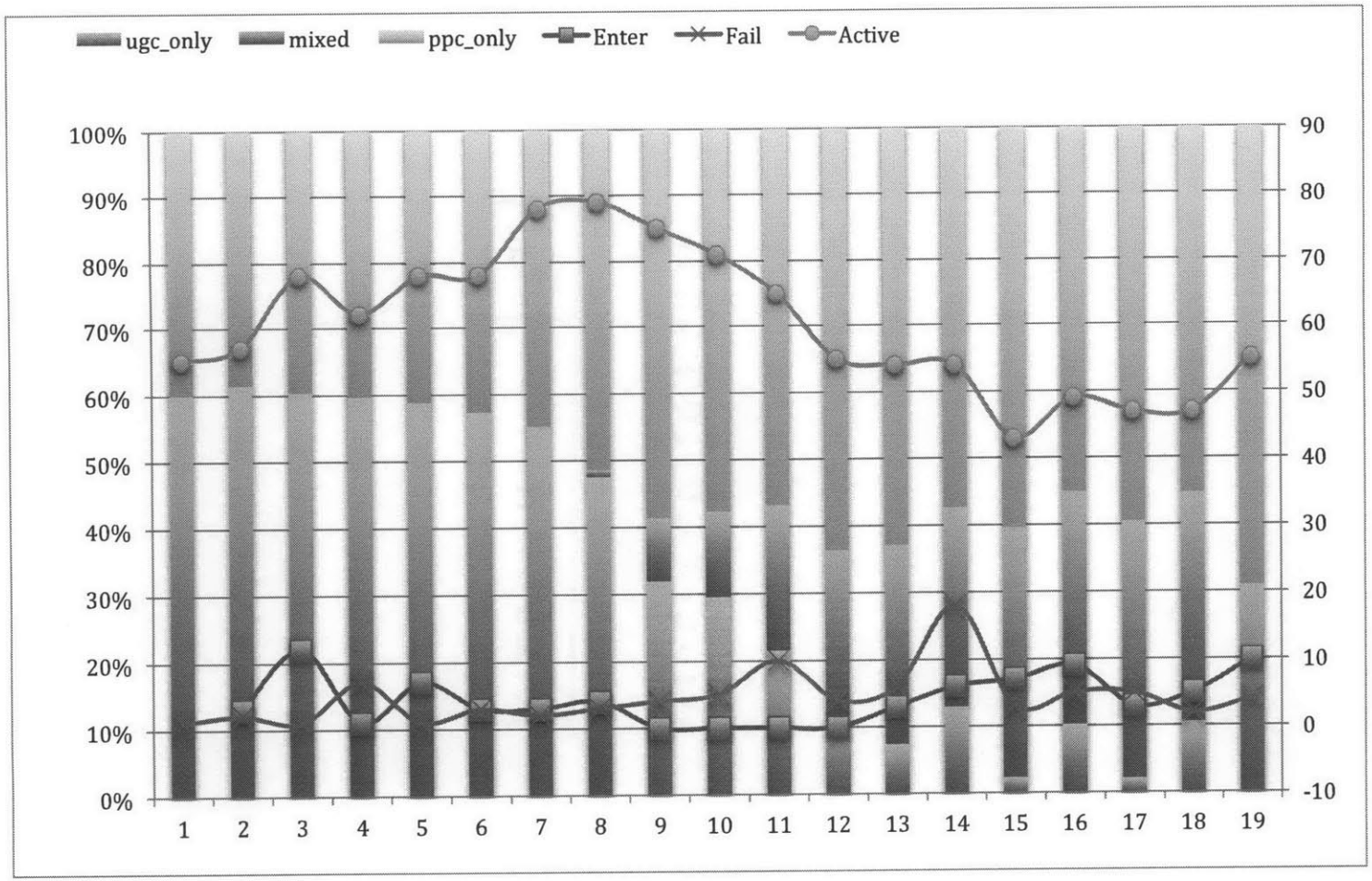

Table 1

Panel A Description of variables used

Variable	Definition	Source
Strategic Variables		
UGC_only	Dummy variable, set=1 if firm employs only User Generated Content	Internet Wayback Machine
PPC_only	Dummy variable, set=1 if firm employs only Professionally Produced Content	Internet Wayback Machine
Mixed	Dummy variable, set=1 if firm employs both User Generated Content and Professionally Produced Content	Internet Wayback Machine
PPC	Dummy variable, set=1 if firm offers Professionally Produced Content	
UGC_initially	Dummy variable, set=1 if firm started operations with a *UGC_only* business model	Internet Wayback Machine
Firm characteristics		
Post2008	Dummy variable, set=1 if firm is operating post regulatory change	Internet Wayback Machine
State	Dummy variable, set=1 if firm is owned by state/ provincial government	SARFT, Internet Wayback Machine
Invest	Dummy variable, set=1 if firm is invested by VC or PE company	Investment news sites
Age	Number of quarters the company has been active since founding	Internet Wayback Machine
Quarter of entry	Quarter in which firm first entered industry	Internet Wayback Machine
Other controls		
Number of Active Firms	Number of firms active in the industry in the quarter	Internet Wayback Machine
Quarter of observation	Quarter in which firm is observed	Internet Wayback Machine

Variable	Definition	Source
Performance variables		
Fail	Dummy variable, set=1 if firm goes offline for more than 6 months	Internet Wayback Machine
Number of Visits	Number of visits received by the firm in the quarter	iResearch
SCC	Dummy variable, set=1 if firm offers Self Created Content	Internet Wayback Machine

Table 1

Panel B Descriptive statistics and correlation matrix

Variable	Obs	Mean	Std. Dev.	Min	Max
UGC_only	1134	0.34	0.47	0	1
PPC_only	1134	0.52	0.50	0	1
Mixed	1134	0.14	0.35	0	1
SCC	1134	0.01	0.11	0	1
PPC	1134	0.66	0.47	0	1
UGC_initially	1134	0.47	0.50	0	1
Post2008	1134	0.67	0.47	0	1
State	1134	0.12	0.32	0	1
Invest	1134	0.14	0.35	0	1
Age	1134	6.86	3.38	0	19
Number of active firms	1134	60.50	10.50	55	79
Quarter of observation	1134	9.46	5.23	1	19
Quarter of Entry	1134	3.62	4.08	1	19
Fail	1134	0.12	0.25	0	1

Table 2 Discrete-time estimation results of Chinese Internet Video firm failure

	(1)	(2)	(3)	(4) Entry before 2008
UGC_only		5.302***	1.307	1.241
		(1.619)	(0.705)	(0.683)
post2008		4.802***	1.245	1.030
		(2.266)	(0.787)	(0.736)
UGC_only x *post2008*			5.330**	4.205**
			(3.218)	(2.736)
Control Variables				
State	0.786	1.146	1.072	1.017
	(0.271)	(0.403)	(0.372)	(0.413)
Invest	0.424*	0.429**	0.426**	0.332**
	(0.191)	(0.179)	(0.180)	(0.166)
Number of active firms	1.032***	1.006	1.005	1.009
	(0.00959)	(0.0114)	(0.0115)	(0.0145)
Quarter of observation	1.145***	1.120***	1.136***	1.177***
	(0.0316)	(0.0384)	(0.0391)	(0.0517)
Quarter of entry	0.930*	0.966	0.967	0.901
	(0.0286)	(0.0281)	(0.0286)	(0.0756)
Number of visits (L)	0.531***	0.614***	0.618***	0.590***
	(0.0352)	(0.0442)	(0.0447)	(0.0535)
Observations	1134	1134	1134	888
X^2 (df)	175.0 (6)	186.3(8)	203.5(9)	197.0(9)
Log-likelihood	-389.6	-362.9	-359.2	-262.3

Notes: Exponentiated coefficients; Robust standard errors clustered by firm in parenthesis. *p<0.1, **p<0.05, ***p<0.01.

Table 3 Firm fixed effects estimation results of Chinese Internet Video firms' view counts

Dependent variable	(1) Number of Visits (L)	(2) Number of Visits (L)	(3) Number of Visits (L)	(4) Number of Visits (L) [Entry before 2008]	(5) Number of Visits (L)]Entry before 2008]
UGC_only		-1.440***	-1.141***	-1.300***	-1.308***
		(0.267)	(0.344)	(0.352)	(0.370)
post2008		-0.495***	-0.245	-0.199	-0.551
		(0.117)	(0.162)	(0.163)	(0.469)
UGC_only			-0.446**	-0.535**	-0.562**
X post2008			(0.221)	(0.214)	(0.205)
Control Variables					
State	-1.024***	-1.374***	-1.219***	-1.237***	-1.253***
	(0.157)	(0.132)	(0.157)	(0.165)	(0.176)
Invest	1.208***	0.943***	0.949***	0.971***	0.923**
	(0.345)	(0.238)	(0.244)	(0.269)	(0.278)
Number of firms	-0.00761**	0.00403*	0.00420*	0.00456*	0.0545*
	(0.00364)	(0.00358)	(0.00350)	(0.00416)	(0.0243)
Age	-0.0290	-0.0124	-0.0143	-0.0161	0.0393
	(0.0248)	(0.0146)	(0.0158)	(0.0375)	(0.0487)
Quarter of observation	0.0416	-0.0185	-0.0171	-0.0188	-0.160
	(0.0707)	(0.0380)	(0.0418)	(0.103)	(0.123)

Constant	5.900***	6.164***	5.950***	6.138***	3.372*
	(0.346)	(0.264)	(0.266)	(0.282)	(1.317)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	No	No	No	Yes
Observations	1134	1134	1134	888	888
Number of firms	150	150	150	83	83
Adjusted R^2	0.04	0.11	0.12	0.19	0.20

Notes: Robust standard errors clustered by firm in parenthesis.
*p<0.1, **p<0.05, ***p<0.01.

Table 4 Pattern of strategic adaptation post-regulatory change, segmented by initial strategy choice

	UGC Initially	PPC Initially
Strategic action post 2008		
Offer PPC	39.6%	
Offer only UGC	60.4%	
Offer UGC		0%
Offer only PPC		100%

Notes: Table should be read such that among firms which started with a pure UGC strategy and which were operating post regulatory change in January 2008, 39.6% of them eventually adapted to offer PPC.

Table 5 Discrete-Time estimation results of Chinese Internet Video firm failure and strategic adaptation

	(1)	(2)	(3)	(4) Entry before 2008
UGC_initially		0.270**	1.799	1. 730
		(0.140)	(1.514)	(1.711)
PPC		0.0384***	0.219**	0.126**
		(0.0273)	(0.155)	(0.0993)
UGC_initially X PPC			0.0917**	0.0741*
			(0.0965)	(0.0635)
Control Variables				
State	0.850	0.872	0.819	0.948
	(0.358)	(0.404)	(0.388)	(0.506)
Invest	0.445*	0.411	0.388*	0.293*
	(0.182)	(0.187)	(0.182)	(0.173)
Number of firms	0.987	0.993	0.992	0.992
	(0.0135)	(0.0129)	(0.0131)	(0.0168)
Quarter of observation	0.984	1.116*	1.123*	1.129*
	(0.0419)	(0.0492)	(0.0512)	(0.0670)
Quarter of entry	0.958	0.945	0.941	0.917
	(0.0314)	(0.0316)	(0.0316)	(0.0925)
Number of visits (L)	0.649***	0.672***	0.675***	0.658**
	(0.0472)	(0.0597)	(0.0615)	(0.0849)
Observations	643	643	643	424
X^2 (df)	57.8 (6)	51.8 (8)	49.7.6 (9)	31.8 (9)
Log-likelihood	-248.8	-225.2	-221.8	-140.2

Notes: Exponentiated coefficients; Robust standard errors clustered by firm in parenthesis. *p<0.1, **p<0.05, ***p<0.01.

Table 6 Firm fixed effects estimation results of Chinese Internet Video firms' strategic change post regulatory change

Dependent variable	(1) Number of Visits (L)	(2) Number of Visits (L)	(3) Number of Visits (L) [Entry before 2008]	(4) Number of Visits (L) [Entry before 2008]	(5) Number of Visits [Entry before 2008]
Model	OLS	OLS	OLS	OLS	Negative binomial
PPC		1.029***	0.910**	0.895***	-0.338
		(0.221)	(0.275)	(0.232)	(0.448)
UGC_initially		0.389**	0.348**	0.335**	1.560***
X PPC		(0.362)	(0.303)	(0.285)	(0.0876)
Control Variables					
State	-1.149***	-1.459***	-1.500***	-1.550***	0.321
	(0.122)	(0.109)	(0.128)	(0.207)	(0.480)
Invest	0.407*	0.270*	0.267**	0.243**	0.659
	(0.275)	(0.203)	(0.115)	(0.102)	(0.384)
Number of firms	0.00730	0.00462	0.00515	0.00102	-0.000429
	(0.00387)	(0.00320)	(0.00337)	(0.00953)	(0.00184)
Age	-0.0391*	-0.0399***	-0.0636**	-0.0623**	-0.00741
	(0.0175)	(0.00830)	(0.0226)	(0.0220)	(0.0320)
Quarter of observation	0.148***	0.0837***	0.145**	0.140**	0.0121
	(0.0449)	(0.0213)	(0.0469)	(0.0479)	(0.0487)

Constant	5.157***	4.626***	5.863***	6.324***	1.090***
	(0.453)	(0.370)	(0.383)	(0.787)	(0.366)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	No	No	Yes	
Observations	643	643	424	424	424
Number of firms	106	106	49	49	49
Adjusted R^2	0.004	0.006	0.05	0.05	

Notes: Robust standard errors clustered by firm in parenthesis.

IRR reported for column (4)

*p<0.1, **p<0.05, ***p<0.01.

Table 7 Covariate balance demonstrating viability of CEM procedure

	Initial Strategy		Difference Significance	
Covariates	UGC Initially	PPC Initially	T-Test	KS-Test
Quarter of Entry	2.058	2.012	0.762	0.737
State	0.000	0.000	1.000	1.000
Number of Visits (L), t-4	6.649	6.450	0.746	0.781
Number of Visits (L), t-3	6.414	6.348	0.887	0.999
Number of Visits (L), t-2	6.230	6.379	0.738	0.895
Number of Visits (L), t-1	6.425	6.420	0.991	0.921

Notes: 2-tailed p-values reported for T-Test and KS-Test results

Table 8 Performance analysis using CEM matched sample

Panel A Discrete time estimation results of firm failure

	(1)
UGC_initially	1.194
	(1.060)
PPC	0.147**
	(0.107)
UGC_initially X PPC	0.0698*
	(0.0867)
Controls	Yes
Observations	321
Number of firms	38
Log pseudolikelihood	-156.3

Notes: Exponentiated coefficients; Robust standard errors clustered by firm in parenthesis.
*p<0.1, **p<0.05, ***p<0.01.

Panel B Firm fixed effects estimation results of unique visit counts

	(2)
Dependent variable	Number of Visits (L) [Post 2008]
PPC	0.950**
	(0.251)
UGC_initially	0.494**
	(0.327)
Controls	Yes
Firm fixed effects	Yes
Observations	321
Number of firms	38
Adjusted R^2	0.10

Notes: Robust standard errors clustered by firm in parenthesis.
*p<0.1, **p<0.05, ***p<0.01.

Table 9 Performance analysis of strategic adaptation for firms that began with pure UGC model

	(1)	(2)
Dependent variable	Number of Visits (L)	Number of Visits (L)
Mixed	0.475***	0.480***
	(0.160)	(0.196)
Controls	Yes	Yes
Firm fixed effects	Yes	Yes
Time fixed effects	No	Yes
Observations	293	293
Number of firms	42	42
Adjusted R^2	0.23	0.10

Notes:

Reference group is firms which started with pure UGC and switched to pure PPC model.

Robust standard errors clustered by firm in parenthesis.

*p<0.1, **p<0.05, ***p<0.01.

Table 10 Incidence of Self Created Content (SCC) on strategic profiles of firms

	(1)	(2)
Dependent variable	SCC	SCC [CEM matched sample]
Mixed	0.038**	0.085**
	(0.012)	(0.030)
Controls	Yes	Yes
Firm fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
Observations	643	321
Number of firms	106	38
Adjusted R^2	0.07	0.10

Notes:

Reference group is firms which started with pure PPC model.

Robust standard errors clustered by firm in parenthesis.

*p<0.1, **p<0.05, ***p<0.01.

Table 11 Fixed effects estimation results of Time Spent on Videos segmented by business models

Dependent Variable	(1) Average time spent on video (L)	(2) Average time spent on video (L) [Post 2008]
UGC_only	-0.130	-0.0687
	(0.0722)	(0.0828)
Mixed		-0.0241
		(0.0836)
Control Variables		
State	0.140*	-0.00903
	(0.0620)	(0.0118)
Invest	0.00481	0.0459
	(0.0686)	(0.0350)
Number of firms	-0.00169**	-0.0000713**
	(0.000511)	(0.000306)
Age	0.0000315	-0.000634
	(0.00161)	(0.00140)
Quarter of observation	-0.00973*	-0.00193
	(0.00378)	(0.00377)
Constant	0.574***	0.351***
	(0.0602)	(0.0821)
Firm fixed effects	Yes	Yes
Observations	1134	758
Number of firms	150	123
Adjusted R^2	0.02	0.02

Notes:
Reference group is PPC_only firms
Robust standard errors clustered by firm in parenthesis.
*p<0.1, **p<0.05, ***p<0.01.

Appendix: Dataset Construction

We first worked with the State Administration of Radio, Film and Television (SARFT) to obtain a list of Internet video websites, which are based and regulated in China. This list is then refined by working with *iResearch*, a media consultancy based in China and the US, to screen out mirror sites and other illegitimate entities. SARFT started maintaining the list since July 2006, and we obtained the list that records all Internet video websites from July 2006 to March 2011. The list includes data on the website founding dates as well as basic data on the founders.

We then used the Internet Wayback Machine, a digital archive of the World Wide Web created by the Internet Archive, a non-profit organization based in San Francisco, California. The service enables users to see archived versions of web pages across time. Using the service, we worked with multiple research assistants in to collect cached pages of each website on the list from July 2006 to March 2011. These cached pages do not allow access to the actual content that may be hosted. However they provide contemporaneous snapshots of the business models utilized by the firms.

Using the cached pages, key details on each firm's business model were collected. Key words in Chinese describing the business models were collected. Figure A describes a typical cached website page and how coding was performed. Coding was distributed between the author and multiple research assistants, and repeated independently and repeatedly among the team to calibrate accuracy. The data collected included the following fields (together with example of code in Chinese for each field):

- *User Generated Content* – Does the website allow users to upload and publish content? [上传功能]
- *Professionally Produced Content* – Does the website publish licensed content from traditional media houses? Traditional media houses include TV stations and movie studios. [电视剧，综艺节目]
- *Self-Created Content* – Does the website license and publish licensed content from amateur film makers? [自制节目]
- *State ownership* – Is the website affiliated with the local / state / provincial government? [国营企业]

We then worked with *iResearch* in obtaining performance data for the individual websites. As described earlier, the media consultancy has been collecting a variety of key performance metrics of Chinese Internet websites. Following which, we then did searches on the Chinese Internet VC/PE news websites for the websites, to collect investment events.

The sum of these separate pieces of data were sorted by firm and date in Excel, and then exported to Stata for analysis.

Figure A
Example of Coding – Tudou.com on 2nd June 2009

Chapter Three

Control versus Execution: Endogenous Appropriability and Entrepreneurial Strategy
(with Joshua Gans, Fiona Murray and Scott Stern)

3.1 INTRODUCTION

This paper is motivated by the observation that contrary to what extent theory would predict, there exist substantial difference in appropriability strategies undertaken by entrepreneurs. While extent literature has typically framed appropriation problems in terms of a set of exogenous parameters that shape the decision making underlying value creation, it is plausible to assume that the strategically sophisticated innovator – while undoubtedly influenced by the strength of the external intellectual property rights regime and the existence of complementary assets when attempting to innovate – will exercise considerable discretion and choice in deciding on her optimal appropriation strategy.

Consider the emerging field of touch-based user interface technologies for use in portable devices such as smartphones and tablets. Within the field, we have seen the emergence of a broad range of possible technological trajectories and development. For example, the startup *Tactus* has focused largely on the development of an extensive intellectual property portfolio, before the development of working prototypes. "We filed 20 applications before even doing our first round of outside funding," Founder Craig Ciesla says. "Our main office was my dining room table." (Vance 2012) On the other hand, another startup *Swiftkey* has instead focused on developing a ready to market product almost from inception. Eschewing the development of an extensive intellectual property portfolio, their first commercial product was released within a year from the company's inception. Both startups are founded by recent PhD graduates around the same time in 2008, broadly around the same technological area and entrepreneurial opportunity, yet have chosen radically different commercialization paths and strategies.

More critically, this aspect of firm's choice in strategy is crucial because in highly uncertain environments – common to most emergent or nascent industries – few firms would know ex-ante what the eventual dominant or correct strategy should be ex-post. There are naturally some who argue that breakthrough businesses are characterized by a single type of strategy, and emphasize a model for business selection and execution in which a preferred business model is feasible. In contrast, the great bulk of practitioners and academic researchers in

strategy would instead emphasize that differences in strategy should reflect differences in the underlying environment facing a firm or organization.

We aim to both extend and reshape this debate by focusing on the endogenous nature of appropriability. This paper examines the different choices research-oriented start-up firms make while facing exogenous conditions. We focus on the important decision entrepreneurs must make in deciding how and when to disclose their ideas, a strategic tension we frame as *Control* versus *Execution*. The paper examines how these different choices in managing appropriabiity impact the start-up's entrepreneurial strategy, while presenting some key insights as to the consequences of endogenous appropriability for performance and the dynamics of innovation. While recognizing the limitations of our small dataset, our study suggests that there exist significant differences between founder types and strategic behavior among "similar" types of ventures in academic entrepreneurship. Our results suggest that *Faculty managed* (and founded) startups exhibit strategic behavior consistent with a *Control* orientation relative to comparable startups of different founding and management types.

The remainder of this paper is organized as follows: the next Section motivates the study by highlighting recent studies that relate to the endogenous nature of appropriability. In Section 3, we then develop a simple conceptual model that explores the endogenous nature of appropriability regime strategy by relating it to the aforementioned Control versus Execution strategic tension. In Section 4, we first briefly describe our empirical strategy that centers on academic entrepreneurship, then present our results. The paper concludes in Section 5 with further discussion on the main findings and broader strategic implications for both the entrepreneur and the researcher.

3.2 THEORY AND RECENT LITERATURE

At its heart, appropriability simply refers to the degree to which a firm captures the value created when it introduces innovations. Based on this general definition, scholars have developed a broad range of work, expounding on potential strategies that influence the degree to which firms may appropriate value (see Winter 2006 for a broad review of the literature). Common strategies include informal intellectual protection (such as trade secrecy), formal intellectual protection (such as copyrights and patent protection), and more general marketing strategies (such as ownership of key complementary assets and market timing).

Perhaps the most important recent work on appropriability regimes has been the original Teece (1986) Profitability For Innovation (PFI) framework. In the original formulation, appropriability regimes are taken as a given. They are determined exogenously by a convergence of the external intellectual property protection environment and the nature of the technology itself. The PFI framework then essentially offers an analytical lens to help entrepreneurs choose the best complementary assets given its appropriability regime.

In line with recent work such as Pisano (2006), we propose that Teece's original conception may be insufficient and fail to explain the broad range of strategic behaviors among entrepreneurs who are technically facing the same appropriability regimes. Underpinning this is the fact that for most entrepreneurs at the moment of entrepreneurship, both the social and private values of innovation are typically uncertain. Innovators cannot precisely forecast the impact of their innovations or the level of appropriability they will enjoy (Rosenberg, 1994). As a consequence, the entrepreneur faces multiple (uncertain) commercialization paths; while a single innovation can be potentially commercialized and developed along multiple (equally viable) paths, the entrepreneur may only be able to pursue a limited number of options.

More critically, this missing aspect of firm choice is crucial because in highly uncertain environments – common to most emergent or nascent industries – few firms would know ex-ante what the eventual dominant technology or business model would be ex-post. There are naturally some who argue that breakthrough businesses are characterized by a single type of strategy, and emphasize a model for business selection and execution in which a preferred business model is feasible. In contrast, the great bulk of practitioners and academic researchers in strategy would instead emphasize that differences in strategy should reflect differences in the underlying environment facing a firm or organization.

If there is a strategic or resource cost to simply selecting the path with the highest level of appropriability, then the choice by the entrepreneur among alternative commercialization paths also implies a choice of the appropriability regime. In other words, when innovation is uncertain and can be commercialized in multiple ways, and establishing strict appropriability is costly, the appropriability regime will be *endogenous* to the choices and strategy of the entrepreneur.

To shed light on these potential tradeoffs we have developed a simple model that explicitly considers the entrepreneur's choices of strategy (control vs execution) in executing on entrepreneurial opportunities. We use the model not only to inform the empirical approach, but also to sharpen the inferences that might be drawn from the empirical findings.

3.3 CONCEPTUAL FRAMEWORK

3.3.1 Control vs Execution

Perhaps the most fundamental dilemma facing the entrepreneur at the inception of his venture arises from the paradox of disclosure (Arrow, 1962). Simply put, when trading in ideas, the willingness-to-pay of potential buyers depends on their knowledge of the idea, yet knowledge of the idea implies that potential buyers need not pay in order to exploit it (Gans and Stern 2003). Disclosure increases the buyer's intrinsic valuation but reduces the inventor's bargaining power. In the absence of formal intellectual property, potential buyers can claim that an idea was known, expropriating innovators once they have disclosed their technology. Because the disclosure of ideas shifts bargaining power from the sellers to the buyers of knowledge, the severity of the disclosure problem reduces the returns of technology entrepreneurs in the market for ideas relative to a product market competition strategy

As a consequence, the first core choice any entrepreneur must make is how and when to disclose their idea to others. We characterize this as a strategic tension, that of deciding between *Control* versus *Execution*. On one hand, there are start-ups who prioritize the development of a thorough and secure intellectual property protection scheme over their ideas, before they are willing to enter the market. This we refer to as a *Control* oriented strategic orientation. This is typically seen in an orientation towards investments in formal intellectual property protection[3], which though expensive, can allow a start-up to exclude others from direct competition or enter negotiations with a supply chain partner with a significantly enhanced degree of bargaining power. As a consequence, as the startup focused on her control over the entrepreneurial idea, the transaction costs of effectively brining the "idea" to the market is increased and market entry is likely to be delayed. The investments in protecting the idea should however also enhance the ability of the start-up to capture the share of future value that is being created.

On the other hand, many start-up companies, excited by their idea and desirous of figuring out how to make their idea "better" through contact with real customers and the marketplace, prioritize the ability to popularize and test their ideas with others in the marketplace.

[3] Of course, formal intellectual property protection such as patents is not the only way that the founders can maintain "control" over their idea. Trade secrecy, proprietary methods or algorithms, and even employment practices such as non-competes can all contribute to allowing the founders to enhance their ability to control who has access to the technology or not, even as they share the basic "idea," early prototypes, or even commercial products with others.

In other words, rather than engage in overly complicated negotiations with anyone over issues of control, the founding team simply works with customers, suppliers, and investors who can contribute to the venture's success, with issues of intellectual property or ultimate control over the "idea" put off for future discussion. This we refer to as an *Execution* orientation.

In many cases, this free form approach works. The entrepreneur will be actively searching for new information and flexibly adjusting activities and targets to this new information, testing and refining her idea in the marketplace. Scholars have documented that this behavior may be common in startup companies (Loch, Solt, and Bailey 2008). This type of flexible adjustment to unforeseen changes has characterized the development of many breakthrough technologies such as for example, Corning's fiber optics (Lynn, Morone, and Paulson 1996), Apple and HP's personal digital assistants (Leonard-Barton 1995), and integrated circuit design (Thomke and Reinertsen 1998).

For example, Mark Benioff, the founder of Salesforce.com, has been a longtime evangelist of "The End of Software" and both he and his company have been relatively transparent about how they were going to deliver on the underlying value proposition of Software as a Service (SaaS). Salesforce.com scaled quickly and aimed to improve on their idea over time through experimentation, learning, and feedback from their core customers (which, importantly, were not in the earliest days the same customers as those of more traditional CRM software vendors). At the same time, it is useful to note that for certain startups, prioritizing "control" over the idea (either through an emphasis on trade secrecy or even through aggressive acquisition of intellectual property) would have significantly hampered their ability to engage a wide variety of early customers, and draw on that experience in refining their service offering and technology platform over time.

3.3.2 Conceptual Model

In this section, we develop a simple conceptual model aimed at understanding the factors that drive a Control as opposed to Execution based entrepreneurial strategy choice by the entrepreneur. Consider a start-up entrepreneur, E, who has developed a commercializable innovation. E then faces a choice of entering the market immediately – the *Execution* strategy – or "delaying" the innovation to a period in the future by further investment in "controls" – the *Control* strategy. To denote the difference in payoffs associated with execution or control, let $a = 1$ if the entrepreneur

enters the market immediately (i.e. *Execution* strategy) and 0 otherwise (i.e. *Control* strategy).

Furthermore, E has a choice of investments K. On one hand E can invest m in "market learning" to aid follow-on innovations. For example, E can invest in early prototyping to seek feedback from the market, and/or invest in different market experiments to develop further insight on her innovation. On the other hand, E can also invest c in "control" mechanisms to also aid follow-on innovations. These would be mechanisms such as patent protection and/or further research to secure the original innovation. The investment in such controls though will delay market entry; hence E will not be entering the market if she chooses to invest in c.

These choices are made under the expectations of future profits. Let the expected profits from entering the market immediately be α; let the expected profits from any follow-on innovation be δ.[4] We further assume that the profits from the follow-on innovation accrue only in the period after the initial market entry period.

Under these combinations of market entry timing, expected profits, and investments, we see that there are 4 possible scenarios. Let $\pi K\ (a)$ equal the level of expected profits that arise under each scenario.

$$\pi_{K=0}(1) = \alpha$$

$$\pi_{K=m}(1) = \alpha + \delta - m$$

$$\pi_{K=c}(0) = \delta - c$$

$$\pi_{K=m+c}(0) = \delta - m - c$$

This simple model holds several insights about the determinants of start-up strategy. First and most critically, since $\pi_{K=m+c}(1) < \pi_{K=c}(1)$ and $\pi_{K=m+c}(1) < \pi_{K=m}(0)$, the entrepreneur E will not choose to invest in both market learning and controls. In other words, *Execution* and *Control* strategies are actually *substitutes*. This is reflective of the high costs of pursuing both

[4] For parsimony, we assume that the expected profits from follow-on innovation to be the same for both a=1 or 0 (i.e. either immediate market entry or delayed market entry).

sets of strategies relative to the benefits, which is probably realistic for resource-constrained entrepreneurs. While firms may attempt to execute on a "dual-track" strategy, technology entrepreneurs usually lack the financial, management, or organizational resources to pursue two tracks simultaneously (Bhide 2000; Veugelers and Cassiman 1999). Further, elements of an effective product market strategy (such as avoiding detection by the established players) conflict with key elements of an effective ideas market strategy (such as broadcasting the value of the innovation)

Second, the model also suggests that commercialization strategy depends on the relative returns to *Control* versus *Execution*. In our model, the key condition for choosing *Control* over *Execution* occurs when $\pi_{K=c}(0) > \pi_{K=m}(1)$. This occurs when $m - c - \alpha > 0$

As α rises, even if IPR are perfect and costless (in other words $c = 0$), the entrepreneur E may still choose an *Execution* strategy so long as the near-term payoffs are sufficiently high. On the other hand, as m rises, the probability for E choosing a *Control* strategy rises. Again, this is not surprising. The high cost of learning from the market will necessarily result in E wanting to invest in more controls or protection of her idea, before she is willing to enter the market i.e. choose a *Control* strategy.

These insights lead us to a set of implications. Because firms will necessarily have to choose between the two substitute sets of strategic orientations, we should expect a divergent set of behaviors and outcomes.

Proposition 1

- *Control*-oriented firms will invest in more controls or protection of their ideas before entering the market. As a consequence they will enter the market later, and will take longer to seek financing.

Proposition 2

- *Execution*-oriented firms will invest less in control or protection of their ideas before entering the market. As a consequence they will enter the market earlier, and will seek financing earlier.

3.4 EMPIRICAL TEST

The empirical challenge in documenting the potential endogeneity of appropriability is multifold. First, we need an empirical design that allows us to clearly determine whether firms were choosing between execution and control. Furthermore, our design should allow us to frame this choice as complementary to other early entrepreneurial strategy choices. Finally we need to be able to measure and assess the performance profiles of firms, that they do follow the consequences of the control versus execution choice-making.

The traditional approach will typically involve the assessment of a population of firms, develop appropriate measures of their strategies and relate them to some performance measures. However it is clear that there exist huge exogenous differences across firms, whether it is in the degree of patentability for the innovations, or the relative affinity and importance of agility and early learning. Unless we account for these differences, we run the risk of conflating the marginal effect of the strategy with the selection effect of the underlying entrepreneurial idea.

We ideally require a population of entrepreneurial "ideas", and allow a random allocation of start-up firms to execute or control these ideas. We will then track related measures of entrepreneurial strategy, and measure their impact on short-term and long-term performance of the firms.

As the ideal randomized experiment is unlikely to exist empirically, we propose a partial solution by leveraging a population of start-ups, which are situated in an institutional set-up that induces natural and exogenous variation in the relative costs of adopting execution versus control oriented strategies. These startups should be at "risk" of adopting either a Control or Execution strategy. We propose that the setting of academic entrepreneurship provides us with exactly that.

3.4.1 Academic Entrepreneurship

The rate of spin-offs from university research has accelerated in the last forty years with an increasing proportion of academics participating in entrepreneurial activities (Thursby and Thursby 2007). This dramatic growth has been taken place for several reasons: the inception of biomedical research in the 1970s, the passage of the Bayh-Dole act in 1980, improved research financing by industry, changes in university guidelines and behaviors, and large shifts in the

scientific ethos of faculty and researchers (Mowery 2004; Astebro et. al. 2012).

Of note the Bayh-Dole Act, by incentivizing firms and universities to commercialize their proprietary technologies, was both a reaction to and consequence of this changing environment. This piece of legislation defined a sweeping patent policy for federal agencies and removed licensing restrictions. Moreover it permitted universities to own patents originating from federal research grants. Bayh-Dole also mandated federally-funded researchers to disclose their inventions to the technology licensing office (Grimaldi et al. 2011; Mowery 2004). The Bayh-Dole Act will serve as one of the key pieces of our empirical strategy; we will discuss this further in the next section.

As alluded to earlier, scholars have documented that university led commercialization has been a growing and global phenomenon. Research on this process has generally focused on the Technology Licensing process, whereby new research or technology developed in the laboratory is documented and marketed by the Technology Licensing Offices (TLO), which in turn will transfer the technology via licenses (Rothaermel, Agung, and Jiang 2007). Studies centered on the Technology Licensing process and arrangements typically focus on *faculty* as the main driving agents in academic entrepreneurship.

However, there are recent university-specific surveys of alumni identifying university students as key players (see for example Hsu, Roberts, and Eesley 2007 and Eesley, Roberts, and Yang 2009). More recently, research has shown that start-ups by recent university graduates in general greatly outnumber that of their faculty and staff (Astebro, Bazzazian, and Braguinsky 2012). The authors found that students are about twice as likely to start new businesses as their faculty on an individual basis. Their results also suggest that these student-founded startups are of high quality, as measured by their eventual outcomes such as liquidation events and entrepreneur remuneration. The combination of the magnitude and quality of these start-ups makes a compelling case against researchers and policy makers ignoring students as a relevant conduit for entrepreneurial economic development.

Nevertheless it has been difficult to observe student entrepreneurship on a more systematic and in-depth level. One of the reasons is that the TLO may not have ready access to students as they do with faculty members (Astebro et al. 2012). As such TLO data typically excludes the formation of new firms by students and graduates. This actually works to our advantage as we exploit this key difference between faculty-founded and student-founded startups.

3.4.2 *Empirical Strategy*

As foreshadowed earlier, the Bayh-Dole Act acts as a key institutional influence in constraining the behavior of a subset of actors namely would-be faculty founders. Because the Act stipulates that researchers must disclose their inventions to the TLO, this has resulted in faculty-founded firms being subjected to the institutional influence of the TLO if they are to commercialize their inventions, relative to student-founded firms. The TLO typically exerts strong requirements for the technological innovation in question to be well protected (Mowery, Sampat, and Ziedonis 2002). Their influence is stronger as the founder is more entrenched in the university system; hence faculty members as full time employees of the university are much more subject to the influence of the TLO relative to students. As a result, the passage of the Bayh-Dole Act has in essence imposed a "*Control*" regime on faculty-led startups while allowing significant discretion for student-led start-ups (even those that initially involved faculty involvement).

We exploit this confluence of institutional factors in our empirical strategy to assess the endogeneity of appropriability. The heart of our empirical strategy is the documentation and exploitation of *firm-paper pairs*. A firm-paper pair describes a firm that is formed from research resulting from collaboration between faculty and student, and that is disclosed in the form of a public academic paper. Consider the following example of research undertaken in the Media Lab department at the Massachusetts Institute of Technology in the field of data analytics.

PhD student Anmol Madan was a researcher in big data analytics, and for his dissertation, developed novel algorithms that measure exposure and adoption of opinions in social networks are important questions in education, business, and government. In a paper published in 2010, he and his co-authors which included his PhD supervisor proposed using mobile phone based co-location and communication sensing to measure characteristic behavior changes in symptomatic individuals, reflected in their total communication, interactions with respect to time of day (e.g., late night, early morning), diversity and entropy of face-to-face interactions and movement. Using these extracted mobile features, they demonstrated that it is possible to predict the health status of an individual, without having actual health measurements from the subject.

In January 2011, Anmol founded Ginger.io around the insights from his paper. His advisor was not part of the founding team, and do not participate on the Scientific Advisory Board. Ginger.io rapidly garnered media attention as a high impact startup, as their technology allows pervasive yet non-invasive monitoring, which is especially useful when monitoring

patients with chronic issues like diabetes, depression, and cardiovascular disease. As of now, Ginger.io counts customers who include Cincinnati Children's Hospital's Chronic Collaborative Care Network and the Carolinas-based hospital system Novant, and has now raised a total of $8.2 million.

In other words, the scientific discovery of Anmol Madan and his co-authors, has been instantiated as both a publication emphasizing its scientific contribution and as a firm emphasizing its utility. Even more critically, because the paper was co-written by the student and the faculty, the disclosed idea in the paper is at risk from being commercialized by the student and/or the faculty. Our empirical approach essentially exploits these firm-paper pairs that result from collaboration between faculty and students. For each idea disclosed in a paper, the faculty member can choose whether to participate in the venture based on idiosyncratic circumstances and "costs" of negotiating university-specific TLO process. Our identification assumption then, is that for those ventures with faculty participation, TLO requirements essentially "impose" a *Control* strategy upon the startup. On the other hand, student-led ventures – free from influence TLO -- are "free to choose" their strategy.

The first step in our approach is to collect a sample of technology-based startups from which we can systematically examine key founding information and most critically their underlying technologies. We utilized the *CrunchBase* database to develop our sample. *CrunchBase* is an open-source database of technology companies and start-ups, which comprises around 500,000 data points profiling companies, people, funds, fundings and events. The website claims to have more than 50,000 active contributors. Members of the public, subject to registration, can make submissions to the database; however, all changes are subject to review by a moderator before being accepted.

We then focused on venture-funded startups listed on *CrunchBase*, which were founded within a relatively narrow time period between 2011 and 2012, to ensure that the firms share some affinity in founding experience. This inherently presents issues of sample selectivity that we readily acknowledge. Nonetheless, for the purposes of this paper, we focus on a smaller selected dataset due to a number of reasons. First, we needed to trace the underlying technologies and link them to scientific disclosures across a wide range of fields. At the risk of overstating the phenomenon, we chose to restrict our analysis to a smaller but well-selected dataset that we have relatively greater confidence in our understanding of the underlying technologies. Second, we chose to focus initially on venture-funded startups because these startups tend to have more

information available.

The first author together with two research assistants, then systematically traced the history of the startups and their founders. We first collected key information about these firms, including their underlying technologies, year and month of founding, and funding histories. Where possible, we cross-reference the information using public incorporation data, SEC filings, public reports and the corporate websites of the firms themselves. We also collected patenting information from USPTO and complementary patent database searches.

We then systematically collected the educational history of the founders and other key members especially the Chief Scientific Officers (and its equivalent). We pay special attention to the status of the founders at the founding of the company, whether they were students or faculty. The names of these key personnel are then cross-referenced using Google Scholar, Web of Science and other domains of scientific knowledge. Where they exist, we then collected the papers authored by these personnel. We noted key information for these papers, including the author list, journal, publication year, keywords and abstracts.

Finally we link these papers to the startups. We do this by manual inspection, focusing on the specificity of the startup's technologies. Each firm-paper pair must satisfy two conditions. First, each company must reflect a narrow "idea" published in an academic paper. As such we do not consider companies that are too broad in scope where identification of the underlying technologies are not specific. Second and most critically, each paper must be a Faculty-Student collaborative work. In other words, each paper must include at least one full-time faculty and one student at the time of publication.

The final sample consists of 63 firm-paper pairs, drawn across a broad range of industry sectors. As expected, firms from biotechnology and medical technologies represent just over 60% of the projects. Interestingly, it is worthwhile to note that analytics firms make up almost one sixth of the total. Other sectors include clean-tech and mobile applications.[5]

3.4.3 Empirical Analysis

[5] There were several firms that were formed around several disparate pieces of technologies, which may span several disclosures. Cleantech is one of the sectors where this is a typical issue. For the purposes of this paper, we have chosen to exclude these firms from our analysis.

Tables 1 and 2 report variable definitions and summary statistics. The main goal of our empirical exercise is to relate faculty and/or student involvement to variables proxying for the theorized characteristics of firms practicing either *Control* or *Execution* oriented strategy.

Insert Table 1 about here

Insert Table 2 about here

Our key independent variables are those that describe the founders. These variables are individual dummy variables equal to 1 if there exist founders in the companies that fit the description. On the other hand, PROFESSOR describes if the founder of the firm held an active faculty position in a research university. PROFESSOR_EXECUTIVE describes if the faculty member after incorporation of the company, continued to hold an executive position with the firm after founding. We define executive position at Chief executive level. As such we distinguish between faculty founders who are not active executives, and participate only at the Board level. As can be seen in Figure A, about 40% of all companies had no faculty involvement at all. On the other hand, active faculty who were also involved at an executive level founded just over 35% of all companies.

We examined the relationship between PROFESSOR_EXECUTIVE and 4 different measures of firm behavior. First, we examine their patenting behaviour using the collected data on the firms' patents. We define PRE_PATENT APPLICATION as a dummy variable equal to 1 if the firm had filed for a patent *before* the incorporation of the company. On the other hand, POST_PATENT APPLICATION is a dummy variable equal to 1 if the firm had filed for a patent *after* incorporation as of December 31st 2013. As seen in Table 3, just over 70% of all the

companies have filed for at least one public patent.

Second, we examine their time to key milestones. In particular we measured the TIME FROM PAPER TO FOUNDING which describes the length of time it took from paper publication to incorporation of the company; and the TIME FROM FOUNDING TO FIRST FUNDING which describes the length of time it took from incorporation of the company to their first funding event. These variables are measured in days.

Third, we also examine their venture capital financing. CrunchBase reports the amount of venture financing received by the firms, and we recorded it as TOTAL FUNDING. We further cross-reference the amounts using other databases where available, such as VentureExpert and Thomson One.

There is substantial heterogeneity among the companies along these measures across the founder types. Table 3 shows the means of each measure as segmented by the founder types. We see that on average, student founded companies are less likely to apply for patents, take less time to incorporate the company after publishing the initial innovation, and take less time to achieve first funding. These patterns resonate with our earlier propositions on the expected behavior of companies as segmented by their strategic profile.

Insert Table 3 about here

While these descriptive results are suggestive, they do not systematically control for a variety of factors. Therefore, the remaining empirical analyses examine correlates of founder type and firm behavior in a more systematic way through multivariate regressions. We include several firm-level and industry-level variables into our analysis. To control for differences across industries, we included industry fixed effects. We further incorporated controls based on the underlying paper of the firm. For the journal quality, we broadly categorize the journals into three tiers for parsimony. Top tier journals (based on impact factor) are classified in tier one, other journals are classified in tier 2, and conference proceedings and published theses are

classified in tier 3. For the paper itself, we control for the average number of citations the paper has received annually as of December 2013 since its publication. While neither measure is perfect, they will help us to capture the underlying quality of the innovation, thereby lending greater robustness to our results.

3.4.4 Results

In Table 4, we first examine the effect of founder type on the patenting behaviors of the companies. We use a linear probability model with errors clustered at the industry code level. The omitted cases are pure student founded companies[6]. The results are striking. For patenting before incorporation, we see that relative to student-founded companies, there is no statistical evidence that faculty-founded companies are more likely to patent either before incorporation. However, we also see that the coefficient on PROFESSOR_RUN is both positive and statistically significant. This suggests that among faculty-founded companies, those that were managed by the faculty founder at an executive level are about 24% more likely to apply for patents before incorporation. This is statistically significant at the 5% level.

Insert Table 4 about here

We see the same pattern repeated for patenting after incorporation. Again, relative to student-founded companies, there is no statistical evidence that faculty-founded companies are more likely to patent after incorporation. However those that were managed by the faculty founder are still more likely to apply for patents after incorporation. Our regressions estimate that among all firms founded by faculty, firms that are also managed by them are 27% more likely to apply for patents. This is statistically significant at the 1% level.

[6] There were 2 startups in the original sample which had both faculty and student founders. Due to the small sample size, for the purposes of this paper, they are excluded from analysis, to more clearly demonstrate the impact of ownership on firm behavior.

These results are collectively interesting. That the patenting behavior between faculty-founded and student-founded firms are statistically indistinguishable, yet exhibits such divergence among the faculty-founded firms, suggests that the strategic choice is indeed driven by the actual *participation* of the faculty in the management of the company and not merely by the founding conditions. We suggest that this is probably consistent with expectations.

We now turn to the timing of key events. We had predicted that Control oriented firms will be slower to hit key milestones. To assess this, we repeated our regressions with TIME FROM PAPER TO FOUNDING and the TIME FROM FOUNDING TO FIRST FUNDING as the dependent variables. Table 5 shows the results for the effect of founder type on the time from paper publication to actual incorporation of the company. The same trends that we saw in the patenting behaviour are repeated here. Incorporating the same controls as we did earlier, our results suggest that on average among Faculty founded companies, those which are also managed by the faculty are founded more than a year later than Student founded companies, although the results are only weakly significant. We again see no statistically significant effect associated with being founded by faculty members. We repeat the analysis for the time from incorporation to first funding. The direction is consistent with our earlier priors, although the results are not statistically significant.

Insert Table 5 about here

Finally, we examine the effect of founder type on the level of venture capital funding obtained by the firms. In Table 6, we see that Faculty founded companies as a whole received more venture capital funding than student founded companies. Our estimates suggest they received on average about 24% more venture capital funding. This is in line with our expectations, given the well-established literature on the signaling effect of human capital on the valuation received by startups (see for example Hsu et al. 2007).

Insert Table 6 about here

Interestingly however, among companies founded by faculty members, those that are also managed by faculty received 21% less funding on average. This is statistically significant at the 1% level. Our present analysis does not allow us to address in detail the mechanisms behind this, but it leaves interesting vestiges for further research in the future.

In summary, our results suggest that faculty management of startups is associated with higher patenting, slower timing for key events, and also attract less venture capital money. We interpret these results as broadly providing support for a model in which faculty managed startups are more likely to pursue a *Control* oriented strategic orientation.

The distinction between pure founding and founding cum management is an especially interesting one. It suggests again that the actual management drives the strategic behavior of the firm. This is not entirely unexpected. Professionals typically manage startups founded but not managed by faculty members, and so we should expect that their behavior will not be as constrained by the TLO, relative to startups which are helmed by faculty members.

3.5 DISCUSSION AND CONCLUSION

Motivated by the substantial differences observed in start-up commercialization strategies despite facing the same exogenous conditions, this paper developed and tested a simple conceptual model highlighting appropriability as an endogenous strategic investment. We focused and examined the key entrepreneurial strategic choice between a *Control* orientation versus an *Execution* orientation. We then presented evidence using a novel dataset of firm-paper pairs to illustrate that for "similar" types of ventures in academic entrepreneurship, there exist significant differences between founder types that are associated with particular strategic orientations.

Our goal in this paper is to illustrate and suggest an important new avenue that was not considered in the original Teece PFI framework, but which recent history suggests has become a

critical component of entrepreneurial strategy. In line with recent work (such as Ceccagnoli 2009), we suggest that the reformulation of appropriability as an endogenous consideration broadly extends literature on the nascent field of entrepreneurial strategy, and provides interesting new insights into the entrepreneurial strategy making process.

A related extension of this paper is to consider the choices of the firm and its effect on the effect on its competitors. It is plausible to hypothesize that firms can leverage the potential endogeneity of the appropriability regime, to gain competitive advantage. For example, if a firm has stronger downstream asset positions, it may consider weakening control on the upstream portion of the value chain where the typical battle for intellectual property resides. As the upstream portion of the value becomes commoditized, the locus of value capture in the innovation chain shifts downwards. Here we can clearly see that the *choice* of a weaker appropriability regime can be economically beneficial to some firms. It may well be in the interest of firms with strong downstream complementary asset positions to proactively weaken the upstream appropriability regime. Scholars have already begun to hypothesize that indeed such a scenario may take place in industries such as the Open Source movement in software (see for example Pisano 2006).

While we emphasize that our results are robust in a purely statistical sense, we are cautious about interpreting our results as a dispositive test of our theory of start-up commercialization strategy. Our empirical measures are imperfect: even though we include a number of control variables, our results may be subject to bias. Moreover, our data is composed of a sample of startups that are all venture funded – as such we readily admit that there could exist selection bias in our empirics. We have also restricted the observations to only firms formed between 2011 to 2012, a comparatively small window of observation. Ideally, we would also have liked to obtain data on the organizational structures of the firms at multiple points in time. As such, in future studies, longitudinal data would be an improvement over our current design.

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Table 1

Panel A Description of variables used

Variable	Definition	Source
Outcome Variables		
PRE_PATENT_APPLICATION	Dummy variable equal to 1 if the firm had filed for a patent *before* the incorporation of the company.	USPTO
POST_PATENT_APPLICATION	Dummy variable equal to 1 if the firm had filed for a patent *after* incorporation as of December 31st 2013.	USPTO
TIME FROM PAPER TO FOUNDING	Length of time it took from paper publication to incorporation of the company in days	CrunchBase ; Incorporation data
TIME FROM FOUNDING TO FUNDING	Length of time it took from incorporation of company to first investment by VC in days	CrunchBase ; Incorporation data
TOTAL FUNDING	Total funding firm has received from VCs as of December 31st 2013.	CrunchBase
Founder Characteristics		
PROFESSOR_EXECUTIVE	Dummy variable, set=1 if firm is founded by at least one active faculty member AND is also managed by the faculty member	CrunchBase ; Company website; Linkedin;
PROFESSOR	Dummy variable, set=1 if firm is founded by at least one active faculty member	CrunchBase ; Company website; Linkedin;
Control Variables		
JOURNAL CITATIONS	Number of citations received by the paper as of December 31st 2013	Google Scholar
JOURNAL QUALITY	Categorical variable describing publication, with 0 = conference proceedings and books; 1 = mid tier academic journal; 2 = top tier academic journal	Google Scholar

Table 2

Panel A Summary statistics of key variables

Variable	Mean	Std. Dev.	Min	Max
PRE_PATENT_APPLICATION	0.54	0.50	0	1
POST_PATENT_APPLICATION	0.32	0.47	0	1
TIME FROM PAPER TO FOUNDING	4.89	2.56	0	8.21
TIME FROM FOUNDING TO FUNDING	5.84	0.73	3.43	6.94
PROFESSOR	0.64	0.48	0	1
PROFESSOR_EXECUTIVE	0.37	0.49	0	1
JOURNAL CITATIONS	133.69	243.74	0	1287

Table 2

Panel B Correlation table

	PRE_PATENT_APPLICATION	POST_PATENT_APPLICATION	TIME FROM PAPER TO FOUNDING	TIME FROM FOUNDING TO FUNDING	PROFESSOR	PROFESSOR_EXECUTIVE	JOURNAL CITATIONS
PRE_PATENT_APPLICATION	1						
POST_PATENT_APPLICATION	-0.13	1					
TIME FROM PAPER TO FOUNDING	-0.13	-0.10	1				
TIME FROM FOUNDING TO FUNDING	0.17	0.15	-0.14	1			
PROFESSOR	0.25	0.03	-0.12	0.13	1		
PROFESSOR_EXECUTIVE	0.25	0.11	-0.01	0.06	0.57	1	
JOURNAL CITATIONS	0.02	-0.10	-0.08	0.18	0.28	0.04	1

Table 3 Means of Patent Application and Time to Incorporation and First Funding, By Founder Type

	Pre Patent Application	Post Patent Application	Time from Paper to Founding	Time from Paper to Funding
STUDENT	0.41	0.27	386.2	776.5
PROFESSOR	0.62	0.35	820.8	1240.3
DIFFERENCE	0.21	0.08	434.6	463.8
T-STAT	1.59	0.62	2.29	2.32

	Pre Patent Application	Post Patent Application	Time from Paper to Founding	Time from Paper to Funding
PROFESSOR	0.50	0.25	641.1	394.7
PROFESSOR_ EXECUTIVE	0.73	0.41	943.9	419.5
DIFFERENCE	0.23	0.16	302.8	25.6
T-STAT	1.43	1.01	1.15	0.29

Table 4 Impact of Founder Type on Patenting

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	PRE PATENT APPLICATION			POST PATENT APPLICATION		
PROFESSOR_ EXECUTIVE	0.227	0.252*	0.238*	0.159	0.316**	0.279**
	(2.49)	(3.71)	(3.10)	(1.24)	(5.28)	(5.32)
PROFESSOR	0.119	-0.0656	-0.104	-0.0357	-0.131	-0.0445
	(1.13)	(-0.49)	(-0.96)	(-0.29)	(-2.53)	(-0.97)
JOURNAL CITATIONS			0.001			0.001
			(-0.43)			(-1.32)
Industry Fixed Effects		YES	YES		YES	YES
Year Effects		YES	YES		YES	YES
Journal Quality			YES			YES
_cons	0.381*	0.339**	0.327***	0.286	0.280*	0.246
	(3.30)	(5.57)	(5.08)	(2.18)	(2.85)	(1.91)
N	58	58	58	58	58	58

Standard errors clustered by industry ; t-statistics in parentheses
*p<0.1, **p<0.05, ***p<0.01

Table 5 Impact of Founder Type on Key Milestones

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	TIME FROM PAPER TO FOUNDING			TIME FROM FUNDING TO FOUNDING		
PROFESSOR_ EXECUTIVE	302.8*	335.5*	381.5*	24.86	121.4	128.3
	(3.02)	(2.09)	(3.58)	(0.46)	(1.42)	(1.40)
PROFESSOR	96.44	-146.5	-211.7	13.49	-109.6	-97.97
	(1.03)	(-1.15)	(-1.73)	(0.28)	(-2.17)	(-1.51)
JOURNAL CITATIONS			0.708**			0.294**
			(3.80)			(3.36)
Industry Fixed Effects		YES	YES		YES	YES
Year Effects		YES	YES		YES	YES
Journal Quality			YES			YES
_cons	544.6**	436.3**	456.1	381.2**	420.3***	349.2**
	(6.28)	(4.18)	(2.31)	(5.90)	(9.05)	(4.87)
N	58	58	58	58	58	58

Standard errors clustered by industry ; t-statistics in parentheses
*p<0.1, **p<0.05, ***p<0.01

Table 6 Impact of Founder Type on Funding Level

	(1)	(2)	(3)
Dependent Variable	NATURAL LOG OF TOTAL FUNDING		
PROFESSOR_	-1.050**	-1.208***	-1.212***
EXECUTIVE	(-3.55)	(-9.78)	(-5.92)
PROFESSOR	1.263**	1.579**	1.247**
	(3.04)	(3.95)	(3.18)
JOURNAL			0.000**
CITATIONS			(0.87)
Industry Fixed Effects		YES	YES
Year Effects		YES	YES
Journal Quality			YES
_cons	14.25***	14.49***	14.76***
	(29.57)	(68.80)	(126.70)
N	58	58	58

Standard errors clustered by industry ; t-statistics in parentheses
*p<0.1, **p<0.05, ***p<0.01

Chapter Four

Institutions, University Spillovers and Firm Innovation
(with Yasheng Huang)

4.1 INTRODUCTION

"As entrepreneurs we are condemned to being either the concubines of state enterprises or the mistresses of multinationals."

-- Wu Kegang, president of Yunnan Hong Wine, a private spirits company in southwest China.[7]

This paper is motivated by the decidedly uneven results of countries (or regions) utilizing universities as strategic economic developmental tool. While Silicon Valley and Boston's Route 128 feature prominently as entrepreneurial regions whose success are at least partly attributable to their proximity to highly productive research universities, the evidence for regions outside of the US and parts of Europe is at best mixed (Lerner, J. 2009). Yet governments continue to invest and promote the clustering of firms around universities (Cooke, 2001; MacKinnon et al., 2002; Storper, 1997) as a part of their regional developmental policy repertoire. Countries especially those in the Far East have increasingly focused on the transfer of new knowledge, skilled labor and other forms of beneficial spillover effects from universities to private industry, enacting a variety of government policies aimed at positioning universities as key drivers of regional and national economic growth (Drucker and Goldstein, 2007).

In this paper, we attempt to take a fresh look at the economic impact of these policies. We seek to answer first and foremost a simple question: *which firms benefit most from investment in universities?* Our contention is that the mixed results from investment in universities in certain regions, may be explained by the particular institutional landscape of their economy. In particular, we focus on the *ownership type* of the firms. In line with recent literature on ownership type in transitional economies (see for example Huang 2008), we argue that some firms by virtue of their specific ownership arrangements may be more successful (or privileged) than others in accessing spillover benefits from universities.

[7] Quoted by (McGregor and Sun, 2006)

We examine this question in the context of modern China. Since 1995, under the auspices of the Action Scheme for Invigorating Education in the 21st Century, the Chinese government has called for selected universities to lead economic and social development in China, through promoting innovation, technical entrepreneurship and knowledge commercialization. The sweeping reforms encouraged universities to interact with firms by various means, in particular through provision of skilled labor and knowledge transfer; therefore they serve as a rich background to explicate the role of universities in economic development.

At the same time, China's transition towards a market economy has also been marked by the emergence of a myriad of firm ownership types in the domestic economy. In particular, the arrival of foreign invested enterprises (FIE) has received significant attention, both academically and in popular media. On one hand, there is extensive research showing the significant benefits that foreign investment has brought to the Chinese economy, especially in terms of productivity spillovers from FIEs to domestic firms. On the other hand, there is also growing research showing that the picture is more nuanced – the FIEs may have accelerated and/or intensified the emergence of a "pecking order" of firms, where firms higher up on the ladder receive preferential access to resources.

We take advantage of the confluence of these two developments in our study. Based on firm-level data of more than 1400 high tech manufacturing firms in China in 2005, we show that in regions influenced by university investment (and reform), a higher share of foreign ownership is associated with higher firm innovation measured in terms of intangible assets. In terms of economic magnitude, a 10% increase in foreign share is associated with more than 14% increase in the intangible assets within a region-industry cell. In other words, *foreign invested firms in colocation with universities are more innovative than their domestic counterparts*. Assuming that there are spillover effects to be accessed from the universities (and which would boost innovation within the firms), our results suggest that foreign invested firms are taking the lion's share ahead of domestic firms. Most critically, our results also suggest that this effect is most pronounced among small firms, which are arguably the entrepreneurial heart of the economy. Our results are robust to a battery of firm level covariates, and the inclusion of region and industry level fixed effects. Our empirical framework also entails the incorporation of excluded instruments to address potential endogeneity issues, and we demonstrate that our results remain robust.

The results in totality suggest that university-industry relationships are more complex and targeted than popular accounts suggest, and require careful examination of their particular

institutional arrangements. The results suggest that university investment policies – ostensibly to boost the domestic economy and drive domestic entrepreneurship – may be missing their mark due to the muddling effect of the institutional landscape. Our paper complements the literature that studies the institutional complexities shaping China's economic development. For example, Huang (Huang and Corporation, 2008) demonstrated the effects of capital-market distortions on foreign direct investment inflows to China, and argued that under the dualist legal and financial institutions that favor foreign firms and state owned companies, domestic private firms find it difficult to borrow in the domestic credit market because state-owned banks dominate it. In line with this argument, Guariglia and Poncet (Guariglia and Poncet, 2008) provide evidence that financial constraint on domestic private firms act as a 'pull' factor for foreign direct investment. Our study complements this trend of thought on the *hierarchy of firms* in an economic landscape being shaped by complex institutional forces.

4.2 THEORY AND HYPOTHESIS

4.2.1 University Spillovers

One of the central themes in the endogenous growth theory has been the accumulation of knowledge and its spillover into productive capacity (Romer 1990). As a consequence, researchers in industrial and economic geography urban and regional economics have focused on studying how the creation and dissemination of knowledge in universities and other institutions of higher learning act as drivers of economic growth. There has been much research on exploring the role of firm clustering around universities in the creation of national or regional innovation systems (see for example Saxenian, 1996; Acs and Varga, 2005; Audretsch and Feldman, 2004). Other lines of research focus on studying the effect of universities and their effect on the characteristics of the labor market and regional growth (see for example Acs et. al. 1999)

More recently, Delgado, Porter and Stern (Delgado et al., 2010) found through a rigorous survey of US establishments that knowledge clusters are strongly associated with growth in new business formation. In another industrial organization study, Hausman (2010) made use of the Bayh Dohl Act of 1980 as a natural experiment, and found that university research positively influences employment among US counties in close geographical vicinity of universities. The most common finding among similar studies of this nature put focus on knowledge spillovers as a

key innovative advantage conferred on clustered firms (see for example Audretsch, 1995; Ellison et al., 2010; Acs and Varga, 2005; Audretsch and Feldman, 2004; Anselin et. al. 1997).

In general, the specific advantage of geographical proximity in knowledge spillovers has been well explored and defended in literature. University knowledge spillovers may affect the innovative performance of firms in several ways: they may reduce the cost of R&D for firms, thereby improving their innovative performance. (Scherer and Harhoff , 2000); or they may help to improve the quality of products offered by clustered firms, thus allowing them to command higher market prices (Griliches, 1998). A general way to understand this phenomenon is to cast university spillovers as positive externalities which can be accessed by firms (Harris, 2001; Jaffe, 1989). Building on this mechanism, one expects the cost of accessing these externalities to increase with geographic distance; thus firms which are nearer the source should be expected to perform better (Scherer and Harhoff, 2000).

However, research in university spillovers on firms has generally overlooked institutional frameworks in their studies. This is an important layer of unexplored complexity, because firm outcomes are not only determined by industry conditions and firm-specific resources, but are also a reflection of the particular institutional framework in which they are entrenched (Scott, 2007; Oliver, 1991, 1997; Hall and Soskice, 2001). Many studies, and thus policymakers, fail to account for the fact that universities are embedded in a variety of institutional arrangements, some of which may be more or less effectively aligned to transform universities into an economic engine of growth (Hall and Soskice, 2001). In particular, we call attention to the relative scant description of university-firm spillover effects as influenced by the ownership type of the firms.

There is increasing research recognizing ownership type as one of the key features in the institutional landscape. Scholars have demonstrated that ownership type impacts firm productivity (see for example Djankov and Hoekman, 2000; Li et. al. 2009), choice of market entry strategies (see for example Tan, 2002) and internationalization efforts (Li et al., 2010). Our contention here is that the ownership type of the firm may similarly impact university-firm spillover effects; as a consequence firms may not benefit equally from investment in universities.

Part of the reasons why extent literature has not explored this aspect is that most existing research has been performed on developed and market driven economies, which do not typically exhibit large variation in their institutional landscapes in terms of firm ownership. Transitional economies on the other hand are continuously experiencing changes in their institutional makeup, shaped by growing economies and rapid policy changes. As a result, we argue that transitional

economies such as China provide an ideal setting to explain the interaction of institutional arrangements with potential spillovers from university investments.

4.2.2 Institutional Transformation in China

One of the key consequences of China's transition towards a market economy has been the emergence of a myriad of firm ownership types. Ownership type is in turn one of the most important institutional arrangements because it embodies one way the Chinese state can effectively exercise control, even to the firm level, and possibly affect their performance and strategy. (Boisot and Child, 1996; Nee, 1992; Peng and Heath, 1996; Tan, 2002; Tan, Li, & Xia, 2007).

Researchers have generally agreed that there are four types of Chinese enterprises based on how property rights are assigned within the firm: (1) state-owned enterprises (SOEs), (2) collectively owned enterprises (COEs), (3) privately owned enterprises (POEs), and (4) foreign-invested enterprises (FIE). Different ownership types represent different levels of state control, and most critically, different positions in the hierarchy of firms.(Huang et al., 2004; Tan et al., 2007). Overall, these studies have argued that a pecking order of firms exists, sorted by their ownership, within China's institutional landscape. The relative positions on this pecking order can lead to different levels of access to key firm resources, such as manpower, state-grants and networks. Walder, Li and Treiman (Walder et al., 2000) also found evidence of career mobility and choices being shaped by socialist state practices, which emphasizes the relative prestige of firms. The latter observation is particularly salient to my study, given that manpower development is a key thrust of Chinese university reformation.

In particular, a slew of studies have emerged suggesting that foreign-invested enterprises (FIE) in China enjoy substantial benefits, over and beyond that for domestic companies. Huang (Huang, 2005) using the data from World Business Environment Survey (WBES) on over 10,000 firms across eighty one countries, finds evidence that foreign firms enjoy significant regulatory advantages over domestic firms. The findings on regulatory advantages of foreign firms hold with a variety of alternative measures of regulations and with or without firm- and country-level attributes and industry and country controls. There is also evidence that foreign firms' regulatory advantages are especially substantial vis-a-vis the politically weak domestic firms. In another article by the same author, Huang (Huang, 2003) argues that there is a dualist legal regime in

China in that different bodies of laws and regulations apply to foreign-invested enterprises (FIEs) from those that apply to domestic firms, and suggest that the legal and regulatory treatments of FIEs are superior to those that pertain to domestic firms.

There are a myriad of reasons for why foreign invested firms are favored by governments in developing country. To the extent that FIEs are more productive, pro-foreign policies and enforcement of regulations can be justified by motives to enhance long-term growth. (In our empirical implementation, it should be noted, we control for many of the variables denoting firm-level efficiencies.) Another possibility is that foreign firms are in fact more politically powerful than commonly assumed. Their power does not come from voting booths but from capital mobility. Due to relatively more credible threats of relocation, FIEs enjoy greater bargaining power and perhaps more political influence than domestic firms. FIEs may be more able to bargain for a favorable operating environment when they enter the host economy. Domestic firms simply do not have such advantages.

Against this landscape, our hypothesis is that in university clusters, FIEs will gain access to spillover benefits ahead of the disadvantaged domestic firms, as they are ranked more highly in the hierarchy of firms. And hence as a consequence, they will be relatively more innovative. Thus, we derive our main test hypothesis:

> *Hypothesis: All else equal, Foreign Invested Companies are more innovative than domestic companies in university cluster regions.*

4.3 EMPIRICAL METHOD AND SETTING

4.3.1 Setting: University Reforms in China

A major policy avenue for the post-Mao leadership has involved using education and science as a thrust for China's modernization (Guo and Ngok, 2008). Besides implementing economic reform and an 'open-door' policy, post-Mao leaders have recognized education as an essential contributor to China's modernization, economic growth and social development (Wei et al., 1999). To this end, an 'economic ideology of education' was developed, where education and economic development were viewed as inseparable and interactive. Moreover, following China's integration into the world economy, the Chinese leadership has realized that to achieve

sustainable growth, the country must focus on developing its own high-tech knowledge economy. As a consequence, the Chinese government has made educational development, technological modernization and knowledge innovation a key economic and social focus. (Ministry of Education, 2007). Naturally, establishing world-class universities has thus become a strategic objective pursued by both Chinese universities and the government since the mid-1990s. In autumn of 1992, at the CCP's 14th National Congress, then General Secretary Jiang Zemin proclaimed that 'it is essential for China to shift the economic construction to the track of depending on advancement of science and technology and the improvement of the quality of laborers.'(Guo and Ngok, 2008)

In February 1993, the Chinese authorities issued the 'Programme for Education Reform and Development in China', where the energies and powers of central and local governments were directed to 100 key universities and a core of key academic disciplines and specialties, in an effort to promote greater educational quality, research and management. Two years later, the CCP and the State Council (the cabinet of China) jointly promulgated the 'Decision to Speed up the Advancement of Science and Technology' and committed to carrying out a strategy of 'revitalizing China through developing science and education'.(Guo and Ngok, 2008) To realize these ambitions, the State Council launched the '211 Project' in 1995 (Zhou and Leydesdorff, 2006).

The 211 Project has been the most ambitious enterprise in higher education undertaken by the Chinese government since 1949 – it selected a group of universities to become standard bearers of tertiary education and to achieve international standards in key disciplines. Disbursement amounts were evenly distributed across the participating universities (Zhou and Leydesdorff, 2006). As part of the 9th Five-Year Plan, the central government endorsed 112 universities to be developed under the 211 Project, and identified 602 projects, hosted within these institutions, to be key fields of study. Between 1996 and 2000, more than US$2.2 billion was appropriated for Project 211; by the end of 2000, the selected universities held 96% of China's major laboratories, and utilized 70% of nationally-available research funding (GUO and NGOK, 2008). The full list of Project 211 Universities is appended in *Appendix A*.

By most popular accounts, these schemes have been successful. The scale of Chinese higher education has expanded steadily since the late 1990s: the national gross enrollment ratio in was 9.1% in 1997 and increased to 9.8%, 10.5% and 11% respectively in following years (Ministry of Education China, 2008). In 1999, higher education institutions matriculated 1.53

million students, a 42% increase from 1.08 million in 1998; by 2000, the intake of higher education institutions reached 2.2 million, almost double the number from two years earlier. In 2001, a total of 2,682,800 first-year students enrolled in 1225 regular tertiary institutions (Ministry of Education, 2007, 2008).

These large-scale policy shifts and planning are testament to China's ambition of becoming a serious player in higher education. The stimulus poured into her educational infrastructure and manpower development is a strategic move to keep abreast with global competition from other knowledge-based economies, and with her own rising international stature on political and socioeconomic fronts.

4.3.2 Empirical Strategy and Data

Isolating the effects of university research and innovation on local industry is a methodologically challenging task, because the historical co-development of universities with local economies results in the deep intertwining of both university and industrial activities. In this study, we propose exploiting the Project 211 Chinese university reformation as a national boost or shock to university-industry interactions to identify the university-industry clusters of interest as the national measures affected only select universities. Furthermore, the statistics reveal that these selected universities dominate the academic scene in terms of research funding and graduation rates as highlighted earlier. Together with the even disbursement of research funding across the universities, this gives us further confidence that the clusters are well defined.

While previous studies - see for example Liu and White, 2001 - have tried to illustrate the important role of university innovation on economic growth in China, due to the lack of reliable data, they are largely based on anecdotal case studies and surveys. Our study will attempt to overcome this limitation by utilizing a unique dataset - the Chinese Industry Census (CIC) compiled by the National Bureau of Statistics (NBS).

The CIC is the most detailed and reliable dataset on firm activities in China. It is an annual census of all industrial firms, regardless of ownership type, with sales value above 5 million yuan. Besides its comprehensiveness and coverage of all ownership types, the benefit of using this data is that it allows us to sidestep survey data provided to Western-based researchers for prior studies, for which sampling procedures and innate biases were either undisclosed or unknown. For each registered company, the database records a detailed array of company

characteristics ranging from company address to research expenditure). It contains information about each company's identity, address, industry classification, incorporation year, total employment, annual payments of wage and fringe benefits. It also documents the authority level each company answers to (regional, provincial, town-level, etc.), its registration type (SOE, private, foreign-affiliated, or joint cooperative, and finer classifications in each of these categories), its three main products in order of relative importance and the production capacities for each of them.

Another significant advantage of the CIC is that it contains detailed product breakdowns. The Chinese standard of industrial classification (CSIC), modified in 1988, was adapted from the International Standard of Industrial Classification (ISIC); the CSIC in the CIC dataset is at the four-digit level of precision, thus offering detail to the level of product groupings (reporting commodities such as leather shoes, as opposed to just shoes). Such fine industry classification allows us to control for technological variances and other dynamics at the near-product level, and thus facilitates comparisons of firms within each industry. The panel structure further helps to eliminate any time-invariant industry-specific effects.

Available data on firm registration type will also be helpful for sorting out the pattern of economic outcomes among firms with different ownership types, in particular when comparing domestic and foreign firms.

For my analysis, we will restrict my scope to firms in high technology sectors only (as defined by China's National Bureau of Statistics). The reasons for this are twofold. First, the overarching aim of China's sweeping university reforms was ostensibly to drive economic output towards high technology industry sectors which have higher value-add. As such, limiting our focus to these sectors is in closer alignment with the rationale for university reform. Second, focusing on high technology sectors helps us circumvent homogeneity traps in our assumptions about the economy, given that lower technology sectors tend to be very different in terms of capital utilization and technologies. The full list of industry sectors defined as high tech industries is listed in Appendix B.

Finally, the CIC dataset allows us to include a set of firm-level control variables in my regressions, which include the firm's total current assets, total assets, employment, and age. To ensure that results are not driven by extreme outliers (stemming from measurement errors), we have 'winsorized' observations in my final sample, for which the dependent and independent

variables are larger than the 99th percentile or smaller than the 1st percentile. The 'winsorized' sample contains more than 1400 firm -year observations.[8]

Apart from utilizing the CIC dataset, geographical information on universities covered by nationalized university reform schemes was also collected. Analysis was conducted at the County-level[9] - each County is typically assigned a band of unique 4-digit postal codes, and the division is based largely on the size of the area. However in certain densely-built metropolitan areas, a few closely clustered (and smaller) counties can share the same band of postal codes. In such cases, we have treated all counties that share the same band as a single contiguous county[10]. This procedure has allowed us to define 43 unique regions in my sample.

[8] The procedure of winsorizing data to enhance data quality has become a common practice in empirical studies using firm-level data from developing countries. Importantly, the results of regressions using the non-winsorized sample are qualitatively the same.

[9] The Constitution of the People's Republic of China provides for three levels: the province, county, and township. However, two more levels have been inserted in actual implementation: the prefecture, under provinces; and the village, under townships. The People's Republic of China administers 33 province-level regions, 333 prefecture-level regions, 2,862 county-level regions, 41,636 township-level regions and even more village-level regions.

[10] For example, Haidian District and Chaoyang District in Beijing City shared the same band of postal codes. These are clustered into a single region in my classification.

4.3.4 Variables

The key explanatory variable of our study is the degree of the firm's *Foreign ownership*. As mentioned, the CIC has detailed information about the firm's ownership structure i.e. the percentage of shares owned by foreign firms, domestic private firms, and the government. Using these information, we construct the variable *Foreign ownership* as the natural logarithm of percentage of shares owned by foreign individuals, foreign institutional investors, foreign firms, and foreign banks in 2005.[11]

We are interested in the impact of foreign ownership on firm's innovative performance. As such, our main performance measure is *Intangible Assets*. Intangible assets are assets that do not have a physical or financial embodiment. They are sometimes referred to as "intellectual assets", "knowledge assets" or "intellectual capital". In the Chinese accounting system, this is typically focused on R&D, key personnel or software. The official classification in China groups intangibles into three types: computerized information (such as software and databases); innovative property (such as scientific and nonscientific R&D, copyrights, designs, trademarks); and economic competencies (including brand equity, firm-specific human capital, networks joining people and institutions, organizational know-how that increase enterprise efficiency, and aspects of advertising and marketing). There is increasing attention paid on intangible assets as key determinants of firm innovation and innovative productivity. Previously unmeasured intangible capital has been calculated to account for 18% of the growth in multifactor productivity (MFP) in the United States between the mid 1990s and early 2000s. Given its importance, we argue that the level of intangible assets is a good measure for the level of innovation by the firms.

We also control for other variables that may possibly affect both firm innovative performance and foreign ownership as a way to address the omitted variable bias. These include firm characteristics, as well as industry and region level dummies. The variables related to firm characteristics are *Total assets* (measured by the logarithm of total assets in book value), *Worker* (measured by the logarithm of total employment and logarithm of total output), *Age* (measured by the logarithm of years of establishment up to 2005), and *State ownership* (measured by the

[11] 1 is added to the percentage shares before the natural logarithm is applied to ensure that firms with zero foreign shares are not dropped from the analytical sample.

logarithm of the percentage of shares owned by the government)[12]. As mentioned, our model also incorporates industry sector and region-level fixed effects. These fixed effects will allow us to strip out any effects from exogenous economy-wide shocks.

Our final data set consists of more than 1400 firm-year observations across 43 regions. Table 1 summarizes the key variables and their definitions.

Insert Table 1 about here

4.3.4 Econometric Estimation

Our core econometric estimation examines the impact of foreign ownership on firm's innovative performance.

$$Y_{fir} = \propto + \beta * Z_{fir} + X_{fir} + \eta_{fir} \qquad (1)$$

Where *f, i, and r* index firm, industry, and region respectively; Y_{fir} is the measure of firm innovation; Z^F_{fir} is the measure of foreign ownership; X_{fir} is a set of control variables; and ε_{fir} is the error term. The standard errors are clustered at the region level, to take into account correlation between observations within the same region, in line with econometric corrections advocated by Bertrand, Duflo and Mullinathan (Bertrand et al., 2004).

Nevertheless there remain understandably endogeneity-related issues with regards to our estimations. Addition of the set of firm-level control variables can help to address observable heterogeneity among the firms, but we remain aware that the residual error might still be

[12] We add a 1 to these variables before taking the natural logarithm to ensure observations are not dropped for having zero values for these variables.

correlated with the measure of foreign ownership, introducing bias into our results. Furthermore, there is potential reverse causality, in that it is possible that foreign investors self select more innovative firms to invest in.

As such, our empirical strategy in dealing with these concerns is to develop and incorporate excluded instrumental variables. In line with recent literature on empirical industrial organization (Berry et al., 1995; Nevo, 2000; Li et. al. 2009; Novak and Stern, 2009), the identifying assumption is that with the inclusion of industry and region level fixed effects, the only source of omitted variables are at the industry-region or individual firm levels. Given this assumption, we adapt Li et. al. (2009) original conception by using foreign ownership of firms in other regions or in other industries as valid instrumental variables in our estimations. The basic justification behind their use is similar to Li et. al. (2009): The foreign ownership of firms in any two regions (or industries) will be correlated due to the common pool of invested capital; it will however be uncorrelated with region or industry specific levels of foreign ownership due to the independence assumption.

Formally, our instruments are the *average degree of foreign ownership among firms belonging to the same industry but located in other regions*, and the *average degree of foreign ownership among firms belonging to other industries but located in the same region as the two instruments for the degree of foreign ownership in the concerned firm.* Similar to Li et. al. (2009) original conception of the excluded instruments, we argue that these instruments can help us recover a consistent estimate of β as they should be correlated with the foreign ownership share of each firm, but independent of η. [13]

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[13] The intuition behind these instruments' relevance and correlation to the potentially endogenous variable is similar to Li et. al. (2009). Consider the instrument the *average degree of foreign ownership among firms belonging to the same region but belonging to different industries.* Since we are working with a single year of data, there is a fixed amount of foreign capital inflow to any one region. Furthermore, by including region dummies in our estimations, the absolute degrees of foreign ownership are controlled across different regions. In other words, the instrumental variable and the endogenous variable are deviations from the region averages and they should move in opposite direction from each other. Put simply, given the total amount of foreign capital inflow, the instrumental variable is expected to be negatively correlated with the potentially endogenous explanatory variable.

On the other hand, the other instrument *the average degree of foreign ownership among firms belonging to the same industry but in different regions*, should be expected to be positively correlated with the endogenous variable. Our analysis is conducted for only university clusters i.e. we are not including regions which do not have a university under the 211 scheme. Assuming that the impact of the university reformation is even throughout the universities –

As such, the first stage regression is estimated:

$$Z_{fir} = \delta + \gamma \cdot Z_{-i,r} + \vartheta \cdot Z_{i,-r} + X'_{fir} + \varepsilon_{fir} \qquad (2)$$

Where $Z_{-i,r}$ is the average degree of foreign ownership among firms belonging to other industries (*-i*) but located in the same region (*r*); and $Z_{i,-r}$ is the average degree of foreign ownership among firms belonging to the same industry (*i*) but located in other regions (*-r*).

Summary statistics and correlation matrix on all variables are listed in *Table 2, Panel A and B* respectively.

Insert Table 2 about here

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4 Empirical Results

Table 3 reports the OLS estimation results of equation (1).

Insert Table 3 about here

In Column (1), we see that *Foreign ownership* has a positive and statistically significant estimated coefficient, which we interpret that higher levels of firm innovation is associated with larger degrees of foreign ownership. A firm with an additional 10% foreign share on average, outperforms an otherwise equivalent firm by 13.9% in terms of intangible assets. We then include the firm level controls and different levels of fixed effects in stepwise fashion through

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which is stated in the policy – then it is reasonable to assume that the level of foreign investment interest should be uniform throughout our regions of study.

Columns 2-5. Our estimations suggest that the positive impact of foreign ownership on firm innovation remains robust to the inclusion of these controls.

We also examine briefly the associated effects with our control variables. Firms that are more capital-intensive should be more innovative, as reflected by the positive and significant coefficient of *Total assets*. Surprisingly though, higher employment is also associated with higher innovation, as reflected by the negative and significant coefficient of *Worker*. We will explore this size aspect in further analysis. We do not see any significant effects associated with firm *Age*, which is not unexpected, given that these firms are generally new, and we are only exploring a small but specific subset of firms (high technology companies). Firms with a higher degree of state control are also interestingly, less innovative.

While Table 3 reports the OLS results, we now present estimations incorporating our proposed instruments. Table 4 reports the estimation results. Panel B reports the first stage results of the two-step GMM estimation. We see that both instrumental variables are statistically correlated with the endogenous variable. We also report the results of test statistics such as the Kleibergen-Paap Wald statistic and the Cragg-Donald F-test, which both help to confirm that our instrument variables are relevant and not weak.

Insert Table 4 about here

Panel A of Table 4 reports the second stage results of the two-step GMM estimation. In Column 1, we exclude the firm characteristics while in Column 2, they are included. We find that *Foreign ownership* continues to exert a positive and statistically significant impact on the levels of firm innovation. The estimated coefficients range from 5.92 to 6.01, which are about 2.5 times larger than the corresponding OLS estimates. In terms of economic significance, an additional 10% of foreign share is on average associated with a 35% increase in intangible assets.

In summary for our baseline results, we found statistical support for our test hypothesis. In university reform regions, higher foreign investment is associated with higher innovation. The

results are robust even after our potentially endogenous explanatory variable *Foreign ownership* is instrumented. We now turn to further robustness checks on the impact of foreign ownership on firm innovation.

4.4.1 Robustness Checks

We first want to alleviate concerns that the results may be driven by particular outliers in our data. Similar to other studies of this nature (see for example Li. et. al. 2009), we examine two other estimation specifications: quantile regression (without instrumenting *Foreign ownership*), and the two-step GMM estimations using a sub-sample excluding the top and bottom percentiles. The estimation results are reported in Table 5. Again, clearly foreign ownership still casts a positive and statistically significant impact on firm innovation, ruling out the concern of the outliers.

Insert Table 5 about here

There could also remain concerns that our results are biased due to some sample selection issues. Although our data should technically be representative of the entire population of firms in China, nonetheless we conduct further analysis to alleviate these concerns. To do this, we repeated our two-step GMM estimation using different subsamples of firms. These results are shown in Table 6.

Insert Table 6 about here

First, we divide the sample into large-firm and small-firm samples. In Table 5, we repeat our baseline analysis on the sample with firms having output above the median (large firms) in the corresponding year in column (1), and another one with firms having output below the median (small firms) in column (2). We find a positive and significant coefficient on the explanatory variable for only the small firm sample, but more critically the foreign-ownership boost appears to be significantly more pronounced among the small firms (coefficient = 10.28) than the large

firms (coefficient = 2.48). These findings imply that the foreign firm effect appears to be even more pronounced against the smaller domestic private firms.

In columns (3) and (4), we use firm employment as the criteria to define the large-firm and small-firm samples. The results are qualitatively very similar to that in columns (1) and (2). Again, we find a foreign boost only among the small firms. Collectively this issue suggests that this effect is driven primarily by smaller firms, which we like to propose is a serious issue for policy makers. We will discuss this issue further in the Discussion section.

For another robustness check, I restricted the sample to regions outside of Beijing. Beijing holds a disproportionately large share of reformed universities; thus exclusion of Beijing can test my claims of the effects of university reformation spillovers. We see in Column (5) that the effect still holds although I lose some statistical significance. Finally in Column (6), we exclude State owned firms altogether from our analysis, and our findings continue to hold.

The third set of robustness checks entails administering a "placebo" test. A plausible challenge is that foreign investors are simply selecting into the more innovative companies existent in any region, independent of any potential spillovers from universities. One way to potentially get at this is to examine the relationship between firms in non-university treated regions and foreign ownership. If indeed this challenge holds true, then we should expect to see a similar relationship as we did in university collocated regions i.e. foreign ownership should continue to be associated with higher levels of innovation. Hence we repeat our estimations with data of firms from non-university treated regions. Table 7 reports the results.

Insert Table 7 about here

Interestingly, the relationship between foreign ownership and firm innovation is not significant in non-university collocated regions. Assuming that spillovers are localized to regions collocated with universities, we interpret this finding in support of our original supposition, that foreign invested firms are gaining access to university spillovers ahead of domestic firms.

4.5 DISCUSSION

In totality, our results suggest that in university-influenced regions, foreign firms in China are more innovative than domestic firms. Indeed and perhaps more troubling, the discrepancy appears to be strongest among small firms, which are largely composed of the domestic entrepreneurial and private firms. The results are robust to a broad range of specifications, as well as numerous robustness checks.

These results are somewhat surprising and potentially controversial. The complexity of spillover effects uncovered here challenges the standard view that university spillover effects are unidirectional and always beneficial. They speak, in particular, to the growing literature on the institutional landscape of China. As China has advanced considerably in its transition towards a capitalist or market driven economy, its economy has become dotted with companies of various ownership structures, reflecting a complex institutional landscape. As this paper and other research have shown, the ownership structure of firms constitutes a key determinant of their eventual outcome and performance (see for example Tan et al., 2007).

One plausible mechanism for the underperformance of domestic firms is that their low ranking in the firm hierarchy is a deterrent to university graduates just entering the job market, at least compared to higher ranked foreign invested enterprises. Interviews with recent graduates from a 211 university in Beijing appear to support this line of thought as well:

> *"It is important to find a top job after graduation... it will give you (more) opportunities in the future. MNCs are more prestigious ... (working with them) will look good on my CV." (Interview with Ms. Liu, an engineer with a FIE in the communication equipment sector)*

> *"My parents preferred me joining either an MNC or ideally the government. We call these jobs are 'Iron Ricebowls'. " (Interview with Mr. Wang, project manager with a MNC in the IT sector)*

We draw caution towards over-extrapolating this interview evidence. Further research needs to be done to define the precise mechanisms underpinning the performance gap between foreign and domestic enterprises. Nevertheless, the quotes provide a glimpse into an interesting

phenomenon, which plays a central role in China's economic transformation, and aligns well with the quantitative results that are the central focus of this paper.

As alluded to earlier, perhaps the most troubling part of the results is that the statistics appear to suggest that the innovative performance discrepancy between domestic and foreign-invested firms is most apparent among small firms. The danger is that the small firms are invariably also the domestic entrepreneurial private firms. If the innovative performance discrepancy is persistent, these domestic private firms might be crowded out from the economy, thereby throwing into question the intended policy intentions of creating university-driven clusters. Existing research has already documented similar crowding-out phenomenon in other developing nations (see for example Kosova, 2009). We believe this is the first documentation of a similar effect in China.

Sociologists and political economists have studied the multifaceted processes underlying the economic shifts of urban China. In doing so, Huang (2008) argued that China's transformation has been far more nuanced than generally perceived, and economic development has been accompanied by vastly different welfare implications than previously expected. Our findings resonate with this line of thought. They add to the varieties of capitalism literature (Hall et al., 2001) by illuminating the complex relationships between academic institutions and the economy. Spillover effects from universities on industry are neither unidirectional nor uniform in application; therefore the institutional arrangements of each country should dictate policies for innovation and economic development that are individualized and targeted.

Broadly speaking, our findings also call attention to the unique institutional frameworks that have emerged from China's economic reform. North (North, 1990) described institutions as 'the rules of the game in a society or, more formally, [they] are the humanly devised constraints that shape human interaction.' As a result, institutions shape how economic agents produce, exchange and interact with each other; furthermore the contexts in which resources and opportunities come together can affect the behavior and performance of individual actors.

China's institutional transition presents a singular and natural laboratory to 'tackle the harder and more interesting issues of how institutions matter, under what circumstances, to what extent, and in what ways' (Powell et al., 1996). Among the post-Communist era transition economies, China has been at the forefront of introducing market-based institutions; however these reforms are set against an almost unprecedented level of institutional upheaval, thereby

giving rise to an almost unique institutional landscape. The welfare effects cannot be understated. We argue that the role of universities, as a core pillar of China's economic growth, has to be understood in the context of her institutional landscape because the latter influences the direction of any observed spillover effect.

Our results also cohere with recent literature on the effect of foreign ownership on firm productivity, which has largely suggested that the effect has been a positive one in China (see for e.g. Li et. al. 2009). Nevertheless, our concerns are at the policy implications level. As emphasized earlier, if foreign firms are indeed benefitting disproportionately from university spillovers (vis a vis *small* domestic firms), and the original intentions of the policies are to at least in part drive local economic growth and entrepreneurship, then it calls into question the efficiency of public investments in universities when the benefits of such investments are seemingly offset by the localized institutional arrangements.

While we emphasize that our results are robust in a purely statistical sense, we are cautious about interpreting our results as a dispositive test of our theory of FIEs benefitting disproportionately from university investment. Our empirical measures are imperfect: even though we include a number of control variables, our results may still be subject to bias. Our empirics also do not allow us to develop further claims on the actual mechanisms. Further study will have to be conducted, possibly with patent or publication data which will allow us to understand any potential knowledge spillover at a finer grain level. We have also restricted the observations to only observations in 2005, a comparatively small window of observation. Ideally, we would also have liked to obtain data on the firms at multiple points in time. As such, in future studies, longitudinal data would be an improvement over our current design

Our study contributes to several threads of literature. First, we bring new clarification to the effect of university spillovers on the development of the local economy. Second, we bring institutional variance to the study of spillovers, by demonstrating that firms' successful assimilation of spillover benefits depends on ownership type. Our examination of this relationship further reveals a key issue surrounding firm performance in China's transitional economy. During its decades of rapid growth, China has thrived by allowing once-suppressed private entrepreneurs to prosper, often at the expense of old, inefficient state-run sectors of the economy. Now, our research suggests that it is foreign companies who may have gained the competitive advantage.

4.7 APPENDIX A

List of 112 Institutions of Higher Learning under the 'Project 211' Scheme

1. Anhui University
2. Beijing Foreign Studies University
3. Beijing Forestry University
4. Beijing Institute of Technology
5. Beijing Jiaotong University
6. Beijing Normal University
7. Beijing University of Aeronautics and Astronautics
8. Beijing University of Chemical Technology
9. Beijing University of Chinese Medicine
10. Beijing University of Posts and Telecommunications
11. Beijing University of Technology
12. Central Conservatory of Music
13. Central South University
14. Central University of Finance and Economics
15. Chang'an University
16. China Agricultural University
17. China Pharmaceutical University
18. China University of Geosciences
19. China University of Mining and Technology
20. China University of Petroleum
21. China University of Political Science and Law
22. Chongqing University
23. Communication University of China
24. Dalian Maritime University
25. Dalian University of Technology
26. Donghua University
27. East China Normal University
28. East China University of Science and Technology
29. Fourth Military Medical University
30. Fudan University
31. Fuzhou University

32. Guangxi University
33. Guangzhou University of Traditional Chinese Medicine
34. Guizhou University
35. Hainan University
36. Harbin Engineering University
37. Harbin Institute of Technology
38. Hebei University of Technology
39. Hefei University of Technology
40. Hohai University
41. Huazhong Agricultural University
42. Huazhong Normal University
43. Huazhong University of Science and Technology
44. Hunan Normal University
45. Hunan University
46. Inner Mongolia University
47. Jiangnan University
48. Jiangxi Agricultural University
49. Jiangxi Normal University
50. Jilin University
51. Jinan University
52. Lanzhou University
53. Liaoning University
54. Minzu University of China
55. Nanchang University
56. Nanjing Agricultural University
57. Nanjing Normal University
58. Nanjing University
59. Nanjing University of Aeronautics and Astronautics
60. Nanjing University of Science and Technology
61. Nankai University
62. National University of Defense Technology
63. North China Electric PoIr University
64. Northeast Agricultural University
65. Northeast Forestry University

66. Northeast Normal University
67. Northeastern University
68. NorthIst A&F University
69. NorthIst University
70. NorthIstern Polytechnical University
71. Ocean University of China
72. Peking Union Medical College
73. Peking University
74. Renmin University of China
75. Second Military Medical University
76. Shandong University
77. Shanghai International Studies University
78. Shanghai Jiao Tong University
79. Shanghai University
80. Shanghai University of Finance and Economics
81. Sichuan Agricultural University
82. Sichuan University
83. South China Normal University
84. South China University of Technology
85. Southeast University
86. Southwest University
87. Southwest Jiaotong University
88. Southwestern University of Finance and Economics
89. Sun Yat-sen University
90. Soochow University
91. Taiyuan University of Technology
92. Tianjin Medical University
93. Tianjin University
94. Tongji University
95. Tsinghua University
96. University of Electronic Science and Technology of China
97. University of International Business and Economics
98. University of Science and Technology Beijing
99. University of Science and Technology of China

100. Wuhan University
101. Wuhan University of Technology
102. Xiamen University
103. Xi'an Jiaotong University
104. Xidian University
105. Xinjiang University
106. Xinjiang Medical University
107. Xizang University
108. Yanbian University
109. Yunnan University
110. Zhejiang University
111. Zhengzhou University
112. Zhongnan University of Economics and Law

4.8 APPENDIX B

2710: Medicines and Chemical Reagents
2720: Pharmaceutical Preparations
2730: Chinese Medicines and Pharmaceuticals
2740: Veterinary Medicines
2750: Biological Products
3615: Electrical Engineering Equipment
3617: Electronics Equipment
3619: Other Special Electromechanical Equipment
3651: Surgical Apparatus and Instruments
3652: Medical Apparatus and Equipment
3653: Diagnostic Products
3654: Medical Materials and Utilities
3771: Aircraft
3779: Other Aircraft and Spacecraft
3786: Aircraft Repairs
4027: Electronic Equipment Parts
4112: Communication Switching Equipment
4113: Communication Terminal Equipment
4119: Other Communication Equipment
4121: Radar
4122: Radar Parts
4130: Broadcast and Television Equipment
4141: Computers
4151: Vacuum Tubes
4153: Semi-conductor Devices
4155: Integrated Circuits
4160: Electronic Components
4190: Other Electronic Equipment
4212: Electrical Instruments and Meters
4230: Electronic Measuring Instruments

4242: Measuring Instruments

4.9 TABLES AND FIGURES

Table 1 Panel A Description of variables used

All variables sourced from the Chinese Industrial Census 2005 unless otherwise stated

Variable	Definition
Outcome Variable	
Intangible Assets	Natural log of (1 + intangible assets owned by firm)
Explanatory Variable	
Foreign ownership	Natural log of (1 + % of shares owned by foreign individuals, institutional investors, firms and foreign banks)
Control Variables	
Total assets	Natural log of (1+total assets)
Worker	Natural log of (1 + total employment)
Age	Natural log of (1+years of establishment up to the end of 2005)
Total output	Natural log of (1+ total output in current dollars)
State ownership	Natural log of (1 + % of shares owned by the government)
Instrumental variables	
Average degree of foreign ownership among firms belonging to the same industry but in different regions (IV1)	The average of *Foreign ownership* of firms of same industry but in different regions
Average degree of foreign ownership among firms belonging to the same region but of different industries (IV2)	The average of *Foreign ownership* of firms in same region but of different industries

Table 2

Panel A: Summary Table

Variable	Obs	Mean	Std Dev	Min	Max
Intangible assets	1407	3.62	4.13	0	13.24
Total assets	1407	10.32	1.56	4.32	16.21
Total output	1407	9.87	2.04	0	15.74
Worker	1407	4.76	1.19	0	9.92
Age	1407	2.05	0.99	0	6.00
State ownership	1407	0.11	0.24	0	0.69
Foreign ownership	1407	0.03	0.12	0	0.69
IV1	1407	0.02	0.01	0	0.07
IV2	1407	0.02	0.03	0	0.41

Table 2

Panel B Correlation Table

	Intangible assets	*Firm assets*	*Firm output*	*Firm size*	*Firm age*	*State ownership*	*Foreign ownership*	*IV 1*	*IV2*
Intangible assets	1								
Total assets	0.5765	1							
Total output	0.3456	0.5647	1						
Worker	0.4323	0.6939	0.655	1					
Age	0.0773	0.2213	-0.0722	0.1512	1				
State ownership	-0.0689	0.016	-0.3264	-0.0574	0.326	1			
Foreign ownership	0.0791	0.0361	0.0597	0.0222	-0.0009	0.0127	1		
IV1	-0.0266	-0.0797	-0.0251	0.0144	-0.0538	0.0249	0.0326	1	
IV2	-0.1069	-0.0443	-0.0952	-0.0355	0.0484	0.0207	0.06	-0.0007	1

Table 3 OLS Estimations

Dependent variable is natural log of *Intangible Assets*

	(1)	(2)	(3)	(4)	(5)
Foreign ownership	2.484***	3.080***	2.210**	2.001**	2.104***
	(0.918)	(0.943)	(0.881)	(0.784)	(0.777)
Total assets				1.209***	1.229***
				(0.0911)	(0.100)
Total output				-0.0471	-0.115
				(0.0568)	(0.0703)
Worker				0.268**	0.310**
				(0.128)	(0.129)
Age				-0.190	-0.117
				(0.104)	(0.102)
State ownership					-1.299***
					(0.430)
Constant	3.548***	3.532***	5.027***	-9.042***	-8.751***
	(0.251)	(0.0260)	(0.531)	(0.855)	(0.878)
Region FE	No	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes	Yes
N	1407	1407	1407	1407	1407
R-squared	0.005	0.100	0.225	0.417	0.421

Notes:. Standard errors, clustered at the region level, are reported in parentheses;

***, **, and * denote 1%, 5%, and 10% significance levels, respectively

Table 4 Panel A: 2-Step GMM Estimations

Dependent variable is natural log of *Intangible Assets*

	(1)	(2)
Foreign ownership	6.010** (2.938)	5.922** (2.841)
Total assets		1.278*** (0.105)
Total output		-0.173** (0.0736)
Worker		0.331*** (0.116)
Age		-0.108 (0.104)
State ownership		-1.705*** (0.479)
Region FE	Yes	Yes
Industry FE	Yes	Yes
N	1407	1407
R-squared	0.101	0.341

Notes: Standard errors, clustered at the region level, are reported in parentheses.

***, **, and * denote 1%, 5%, and 10% significance levels, respectively

Table 4 Panel B: First stage regressions corresponding to Panel A

Dependent variable is natural log of *Foreign ownership*

	(1)	(2)
Average degree of foreign ownership among firms belonging to same industry but located in other regions	0.501*	0.431*
	(0.172)	(0.167)
Average degree of foreign ownership among firms belonging to other industries but located in the same region	-5.348***	-5.053***
	(1.698)	(1.606)
Cragg-Donald F-statistic	45.49	40.33
Kleibergen-Paap Wald rk F statistic	8.79	8.22
N	1407	1407

Notes: Standard errors, clustered at the region level, are reported in parentheses.

***, **, and * denote 1%, 5%, and 10% significance levels, respectively

Table 5 Outliers Analysis

Dependent variable is natural log of *Intangible Assets*

	(1)	(2)
Estimation specification	Quantile	GMM
Sample	Whole	Without top and bottom 1%
Foreign ownership	1.847*	8.464**
	(1.014)	(3.937)
Total assets	1.334***	1.258***
	(0.116)	(0.106)
Total output	-0.180**	-0.177**
	(0.0857)	(0.0703)
Worker	0.394**	0.299**
	(0.155)	(0.119)
Age	-0.0975	-0.108
	(0.129)	(0.107)
State ownership	-1.489***	-1.765***
	(0.550)	(0.467)
Industry FE	Yes	Yes
Region FE	Yes	Yes
N	1407	1407

Notes:

Standard errors, clustered at the region level, are reported in parentheses.

***, **, and * denote 1%, 5%, and 10% significance levels, respectively

First stage regressions are not reported here for parsimony and are available on request

Table 6 Sub-sample Analysis

Dependent variable is natural log of *Intangible Assets*

All estimations are 2-Step GMM

Sample	(1) Large Firms (Output)	(2) Small Firms (Output)	(3) Large Firms (Workers)	(4) Small Firms (Workers)	(5) Exclude Beijing	(6) Exclude State
Foreign ownership	2.448	10.282***	1.170	11.227***	9.364*	7.615*
	(7.911)	(3.149)	(11.141)	(2.317)	(4.579)	(3.655)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
N	652	755	635	772	1112	1211

Notes:

Standard errors, clustered at the region level, are reported in parentheses.

***, **, and * denote 1%, 5%, and 10% significance levels, respectively

First stage regressions are not reported here for parsimony and are available on request

Table 7 Analysis with non-university collocated regions

Dependent variable is natural log of *Intangible Assets*

	(1)	(2)
Estimation specification	OLS	GMM
Foreign ownership	0.518	0.956
	(0.596)	(1.533)
Firm controls	Yes	Yes
Industry FE	Yes	Yes
Region FE	Yes	Yes
N	8431	8431

Notes:

Standard errors, clustered at the region level, are reported in parentheses.

***, **, and * denote 1%, 5%, and 10% significance levels, respectively

First stage regressions are not reported here for parsimony and are available on request