Xiameng Hua
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To
NBER Entrepreneurship Research Boot Camp 2021

March 25, 2021

Hi Professor Robinson,

I am a fourth year PhD student in Economics Department at UC San Diego. I learned of the NBER Entrepreneurship Research Boot Camp 2021 from Professor Julie Cullen here at UCSD and from the Workshop on Entrepreneurial Finance and Innovation (WEFI) website. I am applying to the boot camp because I am very interested in entrepreneurship research and am working on related topics.

I have been working on three contract theory projects, including one on staged financing by venture capitalists and another one on repeated lending by banks to small firms. While the empirical literature on entrepreneurship is rich, the theoretical literature is relatively small. The theoretical and empirical training I received in the PhD program at UCSD puts me in a good position to be an applied theorist specializing on entrepreneurship. I am eager to learn and contribute in this field; with the experience of this boot camp, I will gain a better understanding of this literature and a better preparation of my future research.

My advisor Professor Joel Watson (jwatson@ucsd.edu) will send the letter of recommendation to Brett Maranjian (maranjian@nber.org). I look forward to hearing from you, and please do not hesitate contacting me if you have any questions. Thanks for your time and consideration!

Sincerely,

Xiameng Hua

Attachment: Curriculum Vitae, Academic History, Research Statement

Xiameng Hua

x5hua@ucsd.edu, (484)929-3050

Research interests

Relational contracts, game theory, corporate finance, political economics, behavioral economics

Education

UC San Diego — La Jolla, CA
PhD in Economics — Sep 2017 – Present
Advisor: Professor Joel Watson

Lehigh University — Bethlehem, PA
MS in Financial Engineering — Sep 2014 – May 2016
Mentor: Professor Micheal Imerman

Southwestern University of Finance and Economics — Chengdu, China
BS in Mathematics and Economics — Sep 2010 – June 2014
Mentor: Professor Chuan Ding

Working papers

Starting Small in Venture Capital Staged Financing
Coauthor: Professor Snehal Banerjee — Sep 2020 – Present
We model stage financing and optimal contracts in early stage firms. A VC and an entrepreneur together learn about the unknown quality of a project via costly experimentation. The VC optimally chooses the scale of the firm and the compensation to the entrepreneur to learn about the project quality and incentivize the entrepreneur to exert effort. The optimal contract features two stages. Initially, the VC operates the firm at a small scale and defers the entrepreneur's compensation. The VC gradually increases the scale of the firm as both parties become more optimistic about quality. In the second stage, when both parties are sufficiently optimistic, the firm is run at maximum scale, and the entrepreneur receives cash compensation.

Starting Small in Business Lending: Theory and Evidence
Mentor: Professor Allan Timmermann — Jan 2021 – Present
This paper develops a starting-small model of the borrowing-lending game, where the borrower has private information about its riskiness and the bank starts small to learn about it. This paper then empirically examines the five model predictions using the loan level datasets of the 7(a) Program and Paycheck Protection Program from the U.S. Small Business Administration. I show the following results. (1) Repeated borrowers have a lower default rate. (2) Default rates are positively correlated with the distance between borrower and lender. (3) Relative to the one-time borrowers, repeated borrowers face lower interest rates in their first loans but higher interest rates when refinancing the existing loans. (4) In economic downturns, existing loans stall at a low level. (5) First time borrowers obtain larger loan amounts than repeat borrowers.

Starting Small and Renegotiation in Discrete-Time Relationships with a Continuum of Types

Coauthor: Professor Joel Watson June 2019 – Feb 2021

We add to the literature on long-term relationships with variable stakes and incomplete information by analyzing renegotiation-proofness in a discrete-time partnership game between a principal and agent, with a continuum of types. In each period the principal selects the level of a project and the agent then decides whether to cooperate or betray; payoffs in the period scale with the level. The agent's benefit of betraying is privately known. The discrete-time framework allows renegotiation to be put in terms of an internal consistency condition that compares actual equilibria in the continuation of the game from any period, which improves on the prior literature. Our condition assumes the principal has full power to alter the equilibrium selection. Our main result shows that the resulting perfect Bayesian equilibria converge as the period length shrinks to zero, and we provide a closed-form solution. In equilibrium, the relationship starts small and the level gradually rises until it reaches its maximum; cooperation is viable regardless of the type distribution.

Teaching & research experiences

Teaching assistant, UC San Diego Sep 2017 – Present

Principles of Microeconomics, Intermediate Microeconomics, Game Theory, Operations Research, Financial Markets, Financial Risk Management

Graduate student researcher, UC San Diego April 2020 – Dec 2020

Supervisor: Professor Renee Bowen

Help with working papers "Agenda-Setter Power Dynamics: Learning in Multi-issue Bargaining" and "Trade Policy and the Status Quo Effect "

Teaching assistant, Lehigh University Jan 2016 – April 2017

Financial Optimization, Derivatives & Management of Risk, Applied Engineering Statistics

Research assistant, Lehigh University Oct 2014 – May 2015

Supervisor: Professor Andrew Ward

Help with graduate program admission office in the College of Business and Economics

Presemtations

Starting-small Revisited: Multiple Types and Renegotiation April 2020

Alumni Seminar Series, the 95th Anniversary Celebration of Southwestern University of Finance and Economics

Implied Probabilities of Transmission Line Outages from Financial Transmission Rights Aug, 2016

The "Modeling and Optimization: Theory and Applications" (MOPTA) Conference, Lehigh University

Training and certificates

Chartered Financial Analyst (CFA) Program. June 2017
Passed all three levels of the CFA Program and may be awarded the charter upon completion of the required work experience.

Teacher Education Program June 2016
Level I and Level II Certificates, College of Education, Lehigh University

Sichuan Women's Federation June 2013
Female College Students Employment and Entrepreneurship Training

Miscellaneous information

Language Mandarin (Native), English (Fluent)
Software MATLAB, Stata, LaTeX, BloombergAPI, ThomsonONE
Volunteering The 12th Fortune Global Forum (2013), The 6th Annual Conference of China Management(2011)

UCSD Graduate Courses by Subject

Term	Subject	Course	Course Title	Units	Grade	Repeat
FA17	ECON	200A	Microeconomics A	4.00	A+	
WI18	ECON	200B	Microeconomics B	4.00	A	
SP18	ECON	200C	Microeconomics C	4.00	A-	
WI20	ECON	201	Advanced Economic Theory	4.00	A	
FA20	ECON	202A	Workshop in Economic Theory	4.00	S	
SP21	ECON	202C	Workshop in Economic Theory	4.00		
SP20	ECON	202C	Workshop in Economic Theory	4.00	S	
FA19	ECON	204	Contract Theory	4.00	S	
FA18	ECON	204	Contract Theory	4.00	A+	
FA17	ECON	205	Mathematics for Economists	4.00	A	
WI19	ECON	208	Games and Information	4.00	A	
FA17	ECON	210A	Macroeconomics A	4.00	B	
WI18	ECON	210B	Macroeconomics B	4.00	A+	
SP18	ECON	210C	Macroeconomics C	4.00	A-	
FA17	ECON	220A	Econometrics A	4.00	A+	
WI18	ECON	220B	Econometrics B	4.00	A	
SP18	ECON	220C	Econometrics C	4.00	A+	
FA18	ECON	220D	Econometrics D	4.00	A	
WI19	ECON	220E	Econometrics E	4.00	A-	
SP19	ECON	220F	Econometrics F	4.00	A	
FA18	ECON	250	Labor Economics	4.00	A	
FA19	ECON	263	Modeling Behavioral Economics	4.00	A-	
SP19	ECON	263	Modeling Behavioral Economics	4.00	A	
SP19	ECON	272	Finance:T&T Intrtmprl Asset Pr	4.00	A+	
WI18	ECON	280	Computation	2.00	A	
WI20	ECON	281	Special Topics in Economics	4.00	A+	
WI19	ECON	281	Special Topics in Economics	4.00	A	
SP20	ECON	285	Pre-Candidacy Presentation	2.00	S	
FA19	ECON	285	Pre-Candidacy Presentation	2.00	S	
SP21	ECON	286	Grad Resrch Presntation Worksh	3.00		
FA20	ECON	286	Grad Resrch Presntation Worksh	3.00	S	
SP20	ECON	286	Grad Resrch Presntation Worksh	3.00	S	
SP20	ECON	296	Original Research Paper	3.00	S	
FA19	ECON	296	Original Research Paper	2.00	S	
FA20	ECON	297	Independent Study	1.00	S	
WI20	ECON	297	Independent Study	4.00	S	
WI21	ECON	500B	Teaching Methods in Economics	4.00		
FA19	MGT	225	Behavioral Economics	4.00	A	
FA20	MGT	285	Financial Economics	4.00	A-	
WI21	MGT	287	Empirical Finance	4.00	A	
SP21	MGT	289	Topics/Financial Economics Res	4.00		
SP21	MGT	299	Individual Directed Study	1.00		
WI21	MGT	299	Individual Directed Study	4.00	S	
SP21	MGT	491	Investments	4.00		

Cumulative Summary

Grade Option	UC-Crdts Attm	Crdts Pssd	UC-GPA Crdts	UC-Grade Points	UC-GPA
Letter	102.00	102.00	102.00	398.00	3.901
S/U	36.00	36.00	0.00	0.00	0.000
TOTAL	138.00	138.00	102.00	398.00	3.901

Research Statement

Xiameng Hua (x5hua@ucsd.edu)

My primary research interests are to model long-term relationships and contracts in entrepreneurship and to use the theory to explain empirical regularities and reconcile discrepancies between existing theory and evidence. I am eager to attend this boot camp for three reasons. First, the boot camp will give me the opportunity to learn more about cutting edge research and the recent issues in the area. Second, this boot camp will allow me to learn from and network with leading faculty and PhD peers in the field. Third, I hope to develop my research ideas further by discussing them with participants and getting their feedback and suggestions.

Consider the relationship between a venture capitalist and an entrepreneur. When their interests are not perfectly aligned, financial contracts are written to provide incentives. Such principal-agent games are well-studied in the relational contract literature, but details of the institutional setting have important implications to the results of the model. To study financial contracts, I begin with the "starting-small" model in contract theory, which was first proposed in Watson (1999, 2002). In this model with hidden information, the relationship dynamics are characterized by variable stakes that gradually increase over time as private information reveals.

Current Research

In the completed paper Hua and Watson (2021), we study an extension of starting-small game and renegotiation procedure of Watson (1999). In this discrete-time game, a principal interacts with an agent with private information and a continuum of types. In each period the principal selects the level of a project and the agent then chooses whether to cooperate or betray. We characterize the model's perfect Bayesian equilibria and we propose a renegotiation condition, which we call *alteration-proofness*, that narrows the set of equilibrium outcomes. Alteration-proofness is a notion of internal consistency that assumes the principal has full power to coordinate the players on an altered equilibrium. Although there are multiple alteration-proof equilibria, our main result establishes that these equilibria converge as the period length shrinks to zero, meaning that the model has a unique prediction in the limit. The limit outcome is characterized by a differential initial-value problem. We provide an example for which the solution is easily found in closed form, along with analysis of comparative statics.

In financing of early stage firms, the intuition of "starting-small" model also applies. The staged financing modeled in the classic paper Bergemann and Hege (1998) is an example. My current research also involves starting-small models in venture capital-entrepreneur game. In the working paper Banerjee and Hua (2021), we study the game where a venture capitalist and an entrepreneur are dedicated to work jointly on a project of unknown quality. The entrepreneur is privately informed about her own cost of effort. The VC engages in costly investment to learn about both the project's quality and the entrepreneur's type, and can choose the scale of the project and short-term revenue sharing contracts in each period.

We assume that the good project always has positive return while the bad project has zero return with positive probability. In this experimentation problem, if the venture capitalist is able to incentivize the entrepreneur, the project type is discovered once it fails. The venture capitalist's

strategy is to offer the entrepreneur an incentive compatible contract and invest until the project fails. The incentivizing contract in our game has two stages. In the early periods of the venture, the scale of the firm increases gradually, and the venture capitalist gets all revenue generated. If the project generates positive returns consistently for enough periods, the VC's belief that the project is good is sufficiently high, and the contract enters the second stage. In these later periods, the firm is run at the highest scale, and the entrepreneur's stake initially jumps and then gradually decreases. At the later periods of the venture firm, the stakes of the firm is set at its highest level, whereas the share of entrepreneur first jumps high and then gradually decreases.

The paper provides a natural explanation for why early stage firms start small and gradually increase in scale. We derive predictions about how the firm's scale is related to the entrepreneur's compensation contract and terms of financing. Finally, the model addresses some limitations of existing models of stage financing (e.g., Bergemann and Hege (1998)). For instance, in our model, firms that are refinanced are likely to be more successful. As this paper is still work in progress, we will look into the security design and comparative statics of this contract, as well as additional empirical predictions of this model.

Future Research

While the empirical literature on entrepreneur research is rich, on the theoretical side there is room to develop a relational-contract-theory foundation. My ultimate goal is to apply formal models of bargaining, negotiation, renegotiation, contracting and relation dynamics to specific financial environments in order to develop richer empirical predictions. After the baseline analysis, I also plan to work on variants of these models, such as the settings with imperfect monitoring, lack of commitment power, multi-dimensional levels, and menus.

In my working paper Hua (2021), I study the bank-firm relationships by building the starting-small model in business lending environment and testing the model predictions with the U.S. Small Business Administration (SBA) loan level data from the 7 (a) program and paycheck protection program (PPP). When the lender is unsure of the borrower's riskiness, they could build their relationships through starting-small loans, where the lender monitors and learns about the borrower's private information.

So far, this project has three main findings regarding the impact of repeated loans. First, the starting-small model predicts that the repeated borrowers have lower credit risks, which is consistent with the SBA 7 (a) data. Second, repeat borrowers on average receives loans with lower interest rates, but such correlation is caused by selection effect and the treatment effect of repetition is increase in interest rates, according to synthetic control and difference-in-difference methods. This evidence supports the theoretical prediction that the bank has more bargaining power and can extract surplus from the borrowers. Third, I provide an extension of the baseline model that tackles the impact of productivity shock. During the economic downturn, the existing borrowers renegotiate the loans to a lower level and get a smaller loan amount than new borrowers. From the data of the Covid-19 relief package, the Paycheck Protection Program provides larger loan amount to new borrowers than to existing 7 (a) borrowers.

I plan to develop a richer model of repeated lending to address some of the simplifying assumptions in the current setting, including those about outside options, imperfect monitoring, and renegotiation. For example, the consideration of endogenous outside options could weaken the principal's bargaining power, and such models would enable the characterization of the pool of borrowers and credit market. The imperfect monitoring component adds another dimension of level, which could be complimentary or substitute of the time-varying stakes and shed lights on security design issues in these contracts.

References

Banerjee, Snehal, and Xiameng Hua. 2021. "Starting Small in Venture Capital Staged Financing." *Working Paper* (March).

Bergemann, Dirk, and Ulrich Hege. 1998. "Venture capital financing, moral hazard, and learning." *Journal of Banking & Finance* 22 (6-8): 703–735.

Hua, Xiameng. 2021. "Starting Small in Business Lending: Theory and Evidence." *Working Paper* (March).

Hua, Xiameng, and Joel Watson. 2021. "Starting Small and Renegotiation in Discrete-Time Relationships with a Continuum of Types." *Working Paper* (January).

Watson, Joel. 1999. "Starting Small and Renegotiation." *Journal of Economic Theory* 85 (1): 52–90.

———. 2002. "Starting Small and Commitment." *Games and Economic Behavior* 38 (1): 176–199.

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March 24, 2021

Confidential Letter on Xiameng Hua
for NBER Entrepreneurship Research Boot Camp 2021

NBER Bootcamp Organizers:

I highly recommend Xiameng Hua and I hope you will accept her for this summer's NBER Entrepreneurship Research Boot Camp.

Xiameng is one of the best graduate students in her cohort at UC San Diego. She is keenly interested in the economics of entrepreneurship, with excellent skills and knowledge in both microeconomic theory and empirical methods. After easily completing all of the required coursework and qualifying exams in our program, Xiameng set out to conduct research on dynamic financial arrangements, such as staged financing for entrepreneurs. She and I coauthored a theoretical paper on "starting small" in discrete-time relationships; our modeling exercise is abstract and not geared toward any specific finance application, but it was a useful initial theoretical exercise that Xiameng can build from. Xiameng advanced to candidacy last year and is now in the early stages of work on dissertation projects

Xiameng's application to the NBER Bootcamp contains a description of our paper. Instead of providing a redundant summary here, let me comment on Xiameng's contribution. Although the project follows from some work that I did previously, Xiameng has been a full partner in the research. My earlier work focused on a continuous-time setting and the case of two types of players. The discrete-time setting that Xiameng and I study requires quite a different line of analysis and a reformulation of concepts and definitions. Xiameng took the lead in developing the new definitions and conducted all of the analysis early on. I provided regular input and guidance and also did a lot of the work in laying out the paper and polishing the text. I was also responsible for a key element in the proof of the main result, but I ended up presenting this mathematical result in a separate paper of my own, so the coauthored paper represents Xiameng's contribution at least as much as my own.

Xiameng and Snehal Banerjee (my colleague at the Rady School of Management) are working on a project that tries to understand the dynamics of stage financing and optimal contracting in early stage firms. They are considering a setting in which a venture capitalist (VC) and an entrepreneur learn about the unknown quality of a project. Learning requires costly experimentation by both parties, with the VC providing capital in each round and the entrepreneur providing costly effort. The VC faces uncertainty about the entrepreneur's cost of effort in addition to the project quality. Their preliminary results show that, in equilibrium, the

VC starts small and gradually increases the scale of the firm by increasing investment over time as both parties become more optimistic about the quality of the project. Here is a statement from Professor Banerjee regarding the development of the project:

"Xiameng has been the driving force behind this project. We started working on it after I learned about her joint work with Joel Watson, and suggested to her that 'starting small' appears to be a feature of staged financing in venture capital. She has taken the lead in terms of learning (and teaching me) about the related literature, and in terms of developing and solving the model that we are working on. She is very entrepreneurial and creative in coming up with new research ideas, and is technically adept and extremely hard working. She will benefit tremendously from participating in the Entrepreneurship Research Boot Camp. Given the opportunity to further explore her interests and interact with other experts in the area, she has the potential to make significant contributions to applied theory in entrepreneurship and venture capital."

Xiameng is very bright and industrious. She is a mature thinker with good ideas. She would benefit a great deal from the NBER Entrepreneurship Research Bootcamp. She is quite capable of making important contributions to the field of entrepreneurial economics and I firmly believe that her participation in the program will greatly increase the likelihood that she will do so. I hope that you will admit her to the Bootcamp.

Sincerely,



Joel Watson
Professor