NBER Innovation Policy Fellowship Proposal

Amora Elsaify

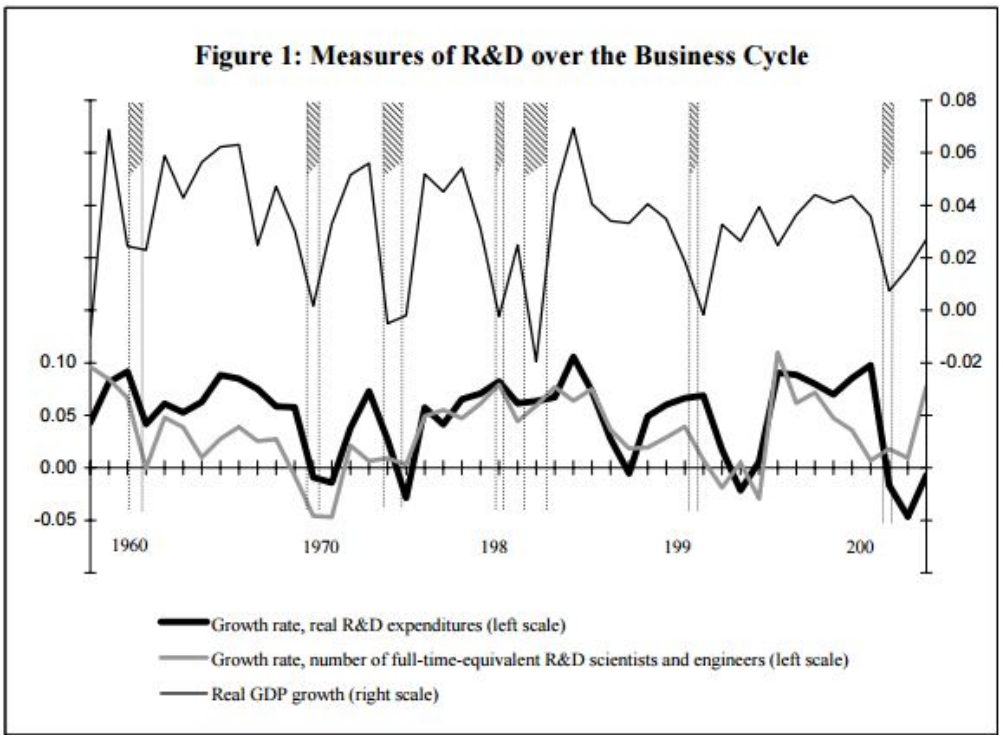
November 30, 2016

1 Introduction

This paper seeks to address the question of how firms will adapt their investment policies to changing credit market conditions. While this is not a new question, the key difference in this study is the goal of analyzing how firms vary the volatility of their investments in response to debt market fluctuations. In this paper, the goal is to explain these facts by describing how the volatility of projects chosen by firms changes as credit market tightness changes. In particular, the key mechanism will be that easier credit market conditions (corresponding to times of lower credit market spreads but higher risk-free rates) will lower the marginal cost of risky projects and incentivize more rm risk-taking. The variability in the outcomes of the projects will be manifested during times of tighter credit markets or poor economic conditions (low aggregate productivity.)

2 Empirical Evidence and Remaining Questions

Empirical evidence for the statement that firms tend to pursue more risky project in expansionary times or times of looser credit market access takes many firms, two of which are presented here. first, there have been several studies documenting the procyclicality of R&D expenditures by firms. R&D is typically viewed as the riskiest form of investment, and thus this evidence indicates that these particularly risky investments are more likely to be taken on in expansions. For example, the following graph (from Barlevy 2006) illustrates the procyclicality of R&D:



We see similar evidence that the fraction of R&D expenses to total investment and that the growth of R&D is procyclical. The second strand of evidence comes in the form of ex-post volatility. To assess this, we consider a sample of 1900 firms from 1990 to 2014, and compute the winsorized cross-sectional volatility in return on invested capital on an annual basis. We see that the contemporaneous business cycle has a weakly negative effect on this volatility, but that lagged credit market tightness (measured here as the BAA-AAA spread) has a significantly negative effect on future return volatility. This provides some evidence that firms are adopting less risky projects during times of tighter credit market conditions, consistent with the R&D evidence. This facts will need to be made clearer over the course of the project. Additionally, skewness and any measures of the expected volatilies of the project at initiation would be helpful to observe.

3 Existing Literature

There are several strands of literature that are relevant to this project. The first is the literature on the adoption of R&D projects and their procyclicality, which stands in contrast to the traditional Schumpeterian view that recessions increase incentives to invest in R&D. Several papers study this, including Barlevy (2006), Ouyang (2008), and Fabrizio and Tsolmon (2014). The second relevant area of the literature studies how investment policies vary with business cycles, but these papers primarily study the level of investment (as in standard RBC models) or the cross-sectional dispersion of investment levels (e.g. Bachmann and Bayer 2014). Lastly, several recent papers, such as Navarro (2014) have made predictions on how investment volatility and business cycles will be related, but, in most of these papers, this is not the central focus of study.

4 Outline of Model

There are several important modeling issues associated with this task. In particular, generating the time variation in credit market conditions endogenously and coming up with a plausible distribution for the selection of projects over time are tasks that deserve careful attention. For the time being, the following outline of a very simple model can illustrate some of the core ideas.

Consider a setting featuring both households and firms, where debt is priced by risk-averse households. Households are endowed with a certain amount of capital, and lend this capital each period to finance their consumption. firms, meanwhile, begin with an initial level of equity but thereafter finance their entire investment through one-period debt. In a given period, they issue precisely the amount which they will invest in that period. Each period, firms have access to a measure K of one-period projects. All projects have the same expected return, but they differ in their standard deviation (which can be materialized as either greater exposure to aggregate productivity, idiosyncratic variation, or some combination of the two.) In this setting time-varying risk-aversion can generate different credit market conditions. In particular, all else equal, times of high risk aversion will feature low risk-free rates and larger increases in borrowing costs for an increase in default risk, which, if the latter is sufficiently significant, will incentivize less risky project selection. Note that this will also have implications for the magnitudes of investment: in particular, fewer projects will be financed during these times, which is consistent with empirical evidence.

There are a number of useful and important extensions to this setting. first, having one-period projects and debt leads to relatively primitive time-series dynamics for investment volatility, so a more sophisticated maturity structure will likely need to be considered. The time-variation in credit market conditions would also ideally be endogenous, either with a more complete household sector and consumption dynamics or potentially through another mechanism. It would also be interesting to consider cross-sectional dynamics in both credit market conditions and project availability, as well as potentially exploring the role of cash holdings in allowing firms to smooth their investment policy (i.e. by breaking the link between financing and investment in a particular period.)

5 Goals

This project will seek to capture several elements of the data. The first is the time-series dynamics of investment volatility. While existing data sources show this for realized TFP volatility and adoption of R&D and most attempts to explain the dynamics focus on that perspective, this project will attempt to explain it by describing the process of taking on risky projects and the conditions under which firms do so. Ideally, it will be possible to obtain data on this and test this feature directly. In so doing, this project should also answer another interesting question, namely how firms change their investment policies (in particular their adoption of risky projects) in response to credit market conditions. An interesting result that could potentially come out of this is a decomposition of credit spreads into financial risk (coming from rm leverage) and operational risk (the inherent riskiness of the project). Finally, the project should hopefully give some insight on how these measures and responses are likely to vary across the cross-section of firms.

Amora Elsaify

November 2016

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Research Fields

Macro-finance, Empirical Asset Pricing, Dynamic Corporate Finance,
Applications of Nonparametric Statistics and Machine Learning to Finance

Education

The Wharton School, University of Pennsylvania

Ph.D. Finance	Expected May 2017
M.A. Mathematics	Expected May 2017
M.S. Statistics	Expected May 2017
B.S. Economics	December 2012

Job Market Paper

The Innovation Premium

Firms that engage in innovative product development, as measured by the fraction of their investment that goes to Research and Development (R&D) activities, earn higher risk-adjusted equity returns. A portfolio that goes long the most innovative and shorts the least innovative firms earns a risk-adjusted return in excess of 7% per annum. R&D-intensive firms also tend to charge higher price markups. Combining insights from industrial organization with a production-based asset pricing framework, I propose a model in which heterogeneous firms produce vertically differentiated goods and market them to heterogeneous consumers. Firms are subject to aggregate demand and supply shocks, which are both priced by investors, and thus the return premium of innovative firms is explained by their differential exposures to these shocks. In addition to explaining this return spread, the model makes predictions on firm investments, future profit markups, and firm size that are consistent with the data.

Awards and Research Grants

2016: Rodney White Center for Financial Research Grant, Jacobs Levy Equity Management Center for Quantitative Financial Research Grant, Macro-Finance Society Travel Grant
2015: American Finance Association Student Travel Grant, MIT FARFE Invited Student
Earlier: University of Pennsylvania Dean's Fellowship for Distinguished Merit (Ph.D.), Penn Undergraduate Researh Mentoring Grant, Joseph Wharton Scholar, Benjamin Franklin Scholar, National Merit Scholarship

Teaching Experience

Fixed Income Securities (Lead TA): 2014
Corporate Finance (Lead TA): 2014, 2016
Behavioral Finance (Lead TA): 2015, 2016
Global Monetary and Financial Stability Policy: 2015, 2016

Professional Experience

AQR Capital Management, Research Analyst, Global Asset Allocation (2013)
Mizuho Corporate and Investment Bank, Summer Intern, Corporate Finance (2011)

Computer

Python, Matlab, R, SQL, Stata, Visual Basic

Working Papers

Why Do Firms Issue Callable Bonds? (joint with Nikolai Roussanov)
Winner of 2015-16 Rodney White Center for Financial Research Grant

Corporations in the US have significantly increased their usage of callable bonds in the past 10-15 years. Whereas callable debt was issued in the past for interest rate hedging motives, the vast majority of callable bonds issued today have call options that will enver be "in the money". This feature implies that previous explanations for the issuance of callable debt no longer rationalize the current pattern. We present evidence on the types of firms issuing these bonds and their usage of the proceeds, which motivates a new theory for why firms desire these eternally "out of the money" call options. This theory captures the motives of firms in matching the maturities of investment and financing and endogenously generates firm-specific refinancing risk. We then embed this theory into a production-based model and show that callable bonds can expand access to capital markets and increase investment.

Firm Volatility and the Composition of Investment

This paper studies the question of when firms invest in Research and Development (R&D) activities and physical capital. It begins by documenting novel empirical evidence on how the composition of investment changes with firm profitability conditions, in contrast to the focus on aggregate or industry-level cyclicality in the existing literature. It then shows that this new evidence is not as consistent with existing explanations for the timing of investment, and proposes a new mechanism to explain this through the relation between types of investment and future equity volatility. New evidence on this relation is documented. In particular, I show that R&D is significantly associated with future idiosyncratic volatility while investment in physical capital is positively associated with future systematic volatility. I then propose a simple model to illustrate how the relation between investment and volatility can explain the investment timing patterns.

A Machine Learning Analysis of Equity Return Predictability

This paper analyzes the predictive power of traditional equity return factors by utilizing machine learning models. These models offer the advantages of allowing for nonlinearities in relationships between the quantity of risk and the effect on excess returns as well as allowing for interactions between factors. Sampling of predictors is also employed in order to potentially quantify the effects of weaker predictors. In addition to evaluating the individual predictive power of various factors, this paper also quantifies the impacts of these departures from the linear framework.

Making Matrices Better: Geometry and Topology of Singular Value and Polar Decomposition (joint with Dennis DeTurck, Herman Gluck, *et al.*) *Currently submitting to Notices of the American Mathematical Society*

Our goal here is to see the space of matrices of a given size from a geometric and topological perspective, with emphasis on the families of various ranks and how they fit together. We pay special attention to the nearest orthogonal neighbor and nearest singular neighbor of a given matrix, both of which play central roles in matrix decompositions, and then against this backdrop visualize the polar and singular value decompositions and examine some of their applications.

References

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João F. Gomes
Howard Butcher III Professor of Finance

8 November 2016

Dear colleague,

I am writing to recommend Amora Elsaify for an Assistant Professor (or equivalent) position in your department. Amora is a finance student in our Doctoral Program who is on the job market this year. Although his thesis is on empirical asset pricing, Amora's research interests are somewhat broader and include a paper on corporate bond issuance with my colleague (and his main advisor) Nick Roussanov.

We have a very large graduating class at Wharton. I rank Tetiana Davydiuk, Mete Kilic and Ram Yamrthy as our three strongest candidates this year and all finance departments, *including the very best*, should look at them. Although I think highly of Amora, he is perhaps just marginally below those three.

Although Nick is Amora's main advisor, I followed his progress through our doctoral program very closely. He did well in my advanced topics class and presented regularly in my various reading groups. His second year paper work showed both promise and ambition and later evolved into a fully developed collaboration with Nick. Initially, the paper examined the recent rise in the usage of callable debt, and presented evidence on the types of firms issuing these bonds and their usage of the proceeds. The current draft includes a novel theory based on refinancing risk and maturity management to explain how and why firms use these securities and their impact on corporate investment. The paper is nearly finished and my understanding is that this paper it should be submitted to an journal after the job market.

Amora's job market paper, entitled "Innovation Premium", is another good illustration of his abilities and interests. It contains a mixture of empirical asset pricing and some theoretical and quantitative work. As is well known that the cross section of asset returns exhibits several interesting patterns. Broadly speaking, authors have either focused on identifying new "anomalies", or "alphas", with respect to some well-established risk factor models or, tried to produce plausible risk based explanations for existing risk factors.[1] A number of more ambitious papers have tried to do both and this is Amora's work fits.

The main fact in the paper is the strong spread in future equity returns between firms that engage in high (relative) R&D spending and those that do not.[2] I have to say that his finding was very puzzling to me.

[1] And some of course have also chosen to abandon the risk-return paradigm, at least partially.
[2] Several firms do not report R&D expenditures at all. Amora shows that the results are unchanged whether these firms are treated as no R&D firms or simply excluded from the sample.

Several authors have investigated this relationship in the past 15 years or so and the results have always been more or less the same. Regardless of how you organized the data, the most you could find were somewhat modest spreads between high and low R&D firms. Moreover these were often sensitive to portfolio construction and (often) existed only when using equal weighted returns.

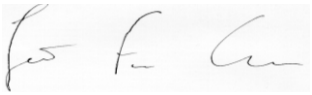
Here, by contrast there is a very robust and sizable link between firms that engage in R&D and their future equity returns. Amora has a few more years of data than were available to others, but the main reason for his findings has to do with how he constructs R&D portfolios. The measure is simple: define R& intensity by the ratio of R&D expenses to the sum of capital expenditures plus R&D expenses. By contrast previous authors chose instead to look at things like R&D to sales to R&D to assets. Surprisingly, although all of these seem equally plausible, Amora's measure is the only one that really produces large and robust results.

Beyond this core finding is supplemented with another Amora finds something else that appears quite interesting: high R&D firms seem to earn higher markups (operating margins) on their sales. This leads him to construct a nice model linking innovation, in the form of R&D investments, to brand quality and markups. Because high quality goods are luxuries their demand tends to be more cyclical and this leads naturally to higher risk premia. The model is not a full quantitative exercise but is both clever and very creative. Coming from someone who did not spend that much time studying models, this was especially impressive.

To summarize, Amora is a very well trained empiricist that asks (and doggedly pursues) interesting questions and has the skills and motivation to write a lot of papers in the next few years. I think he will be fit well in nearly all finance departments. I recommend him strongly.

Please do not hesitate to contact me if you have any further questions.

Sincerely



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Nikolai Roussanov
Associate Professor of Finance

November 7, 2016

Dear committee,

I am writing to recommend Amr (Amora) Elsaify, a fifth-year PhD student in Finance at the Wharton School, who will be on the finance PhD job market this year. I have known Amora since he was an undergraduate student at the Wharton School, he worked closely with me as a TA and an RA over the years and I have come to rely on his help quite a bit.

Amora's main research area is asset pricing, including both empirical and quantitative theoretical modeling. His job market paper, "The Innovation Premium," explores asset pricing implications of firms' investing in research and development (R&D) activities. He begins with the observation that firms with high R&D intensity (relative to investment in capital expenditures) tend to earn higher average stock returns than less "innovative" firms, controlling for the standard factor risk exposures. These of course tend to be smaller, growing firms (albeit the empirical pattern is present among the large firms as well), but they also tend to be firms that earn higher profit margins. This latter fact motivates Amora's quantitative theory, which aims to explain the puzzling asset pricing facts. The key assumption is that higher quality goods command higher markups in imperfectly competitive markets, but also require greater investment in technology to maintain the competitive advantage in quality. The higher quality (and more profitable, on average) products also tend to be luxury goods, in the sense that when consumers become richer they purchase them in greater quantity. Real life examples abound (e.g. Apple vs. generally less expensive Android smartphones and tablets, luxury cars, etc.), and Amora provides some more systematic empirical evidence. This evidence suggests that the profits of innovative firms are particularly sensitive to aggregate demand shocks. This is in contrast to firms that produce lower quality products with small profit margins, which are primarily driven by productivity shocks. To the extent that both kinds of shocks command positive prices of risk, the differences in product quality can give rise to an "innovation premium" that is not explained away by the CAPM, and which Amora calibrates to match the average excess returns on R&D-sorted portfolios.

In addition to a novel economic story that seems to match the data well, Amora's job market paper provides a new perspective on the long-standing debate on value – and ``quality'' – investing. Innovative firms tend to exhibit characteristics of "growth" rather than "value" and they do not necessarily appear "profitable" by standard accounting measures, which makes their

high average returns particularly puzzling (e.g. from the standpoint of Fama-French 3- or 5-factor models). Yet they exhibit some features of "quality," as investments in intangibles such as R&D may give such firms a competitive advantage and higher average profit margins. However, Amora's work suggests that, far from being protective "moats" that are undervalued by investors, such monopoly profits are exposed to a source of aggregate risk that earns compensation in the equity markets.

In addition to his own dissertation, Amora is also working with me on a project aimed at understanding the recent trend in the corporate issuance of callable bonds that have a make-whole provision, which have accounted for the bulk of corporate debt issuance since the early 2000-s. Having documented this trend empirically, we are in the process of developing a quantitative model for understanding the tradeoffs involved in issuing callable debt, such as flexibility in refinancing the issue in order to take advantage of favorable credit conditions and thus staving off rollover risk, bankruptcy costs, and pricing implications. Amora has been the driver of the project, not only doing all the empirical work and quantitative modeling thus far, but coming up with key ideas and writing up the early draft of the paper.

Amora possesses a rare combination of skills: excellent mathematical training and eagerness to learn new quantitative tools, fluency with large datasets, and unusually (for a PhD student coming to the program straight out of college) extensive institutional knowledge of financial markets. Above all, he is creative and hard-working. In addition to being a great researcher, Amora is also an excellent teacher, able to communicate complex material to students in review sessions and office hours, with glowing reviews. I came to rely on his help as the head TA for my Fixed Income Securities and Behavioral Finance courses that I taught over the last six years quite a bit.

We have a large and very strong group of Wharton Ph.D. students on the finance job market this year. Among this group, Amora is among three or so students who should be interviewed by all schools (others include Mete Kilic and Tetyana Devidyuk).

Please let me know if you have any questions about Amora's application.

Best regards,

Nick Roussanov

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November 2, 2016

Letter of recommendation for **Amora Elsaify**

To whom it may concern:

I am writing in support of Amora Elsaify who is applying for a position at your institution. Amora is a student in the Finance Department at Wharton, and he is expected to graduate next year. Amora is interested in empirical asset pricing, corporate finance, and macro-finance. He has strong empirical skills. His job market paper makes significant empirical and theoretical contributions. Moreover, he has several on-going research projects and working papers. One of these, joint with Professor Nikolai Roussanov, seems particularly promising. Overall, I believe he is on track for a productive research career, and I recommend you give a favorable look at his file.

In his job market paper "The Innovation Premium" Amora documents that R&D-Intensive firms earn significant excess returns beyond the returns due to their exposure to common risk factors. He shows that the return spread of high minus low R&D-intensive firms is a priced factor in the cross section. After documenting that R&D intensity is linked to higher product mark-ups, he develops a model that captures this link. The model can rationalize the documented empirical regularities. This paper extends the literature through a thorough empirical investigation of the important relation between R&D investment and stock returns and by presenting a novel explanation for the documented facts.

Amora defines R&D intensity as the share of R&D investment in a firm's total investment. He is able to construct a time series from Compustat going back to 1962. Firms with high R&D investment are typically relatively smaller and less leveraged, and they have higher revenue growth. Amora shows that after controlling for the three Fama-French factors, the decile portfolio with highest R&D intensity outperforms by more than half a percent per month the decile portfolio with the lowest R&D intensity. The high R&D portfolios load positively on SMB and negatively on HML, in line with the reported basic properties of these firms. Fama-MacBeth regressions are then used with the three (or five) Fama-French factors augmented by a high minus low R&D-intensity factor. This novel factor is shown to have a positive price of risk, and to drive out HML. While other studies have shown high returns for R&D intensive firms, Amora's focus on the share of R&D in total investment and his exhaustive return analysis leads to a more conclusive and more complete characterization of this important property.

To explain the documented facts, Amora first shows that firms with higher R&D investment also charge higher mark-ups, suggesting that firms are willing to incur the investment expense in order to boost their competitive position. He also shows that an increase in luxury good sales in a given year is associated with higher returns for firms with R&D-intensive investment. Both of these facts motivate his focus on an explanation emphasizing the link between R&D investment and product mark-ups.

The model combines firms that choose goods prices and investment subject to productivity shocks with consumers that have differential tastes for high quality goods. An exogenous shock shifts the cross-sectional distribution of consumer tastes, and affects the average willingness to pay for higher quality goods. Firms are specializing at a given quality level and are affected differentially. The demand for higher quality goods ends up being more sensitive to the shock. The quality of a firm's product is determined by its share of investment in intangible capital (R&D). The model features a stochastic discount factor driven by the productivity and demand shocks. With the two shock processes disciplined by other studies, the model is shown to produce higher expected returns for R&D intensive firms and positive CAPM alphas. This model makes a nice contribution to the quantitative theoretical literature on cross-sectional return properties by augmenting a standard production setting with a product demand driven by consumer preferences for quality.

Amora has several other on-going research projects and working papers. For instance "Why Do Firms Issue Callable Bonds?" (joint with Nikolai Roussanov), where they examine the popularity and properties of callable corporate debt, and present a model to explain some of features of the data. I have seen Amora present an early version, and I think this work has a lot of potential.

Overall, Amora has a nice job market paper that showcases his abilities in empirical asset pricing and for quantitative modelling. He is also a very clear and poised presenter, which suggests he will be a good teacher. He is a promising candidate; I strongly recommend you consider his application.

Please do not hesitate to contact me if you have any questions.

Sincerely,



Urban J. Jermann
Safra Professor of International
Finance and Capital Markets