Entrepreneurship as Coordination

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Abstract

This article presents a new lens for studying entrepreneurship, what I call *entrepreneurship as coordination*. In certain situations, people have coordination problems. Buyers and sellers may want to go to a market, but only if the other person also goes. Instead of being stuck in a coordination problem, an entrepreneur is able to coordinate the actions of people within a market. Such coordination raises the gains from trade that buyers and sellers realize and allows the entrepreneur to earn a profit. To highlight the specific role of coordination, I use a simple model from the global games literature. I show how the entrepreneur can improve on coordination by sending a signal to each person in the market. In the limit, the entrepreneur's signal eliminates coordination failures. Finally, I show how my interpretation of entrepreneurship provides new insights by connecting different concepts of coordination used with economics.

Keywords: entrepreneurship, coordination, global games, discovery

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1 Introduction

In this paper I present a new lens for studying entrepreneurship, what I call *entrepreneurship as coordination*. In certain situations, buyers want to go to a market, but only when sellers go, and vice versa. Since each person wants to coordinate his action with another person, this can be modeled as a coordination game. Entrepreneurship as coordination is as *any action that increases the probability of beneficial coordination*. Entrepreneurship, as I show with a simple example below, can increase the likelihood of beneficial coordination. Buyers and sellers are more likely to match their actions to each other on the Pareto-optimal outcome with an entrepreneur than without one. Such coordination does not require a costly effort and is therefore pure profit to the entrepreneur. Additionally, as I show, it is an improvement that could not occur without the outside help of an entrepreneur.

To make this more concrete, imagine it's a cold winter day in Minneapolis, Minnesota. You're in your office, typing away at your latest paper draft. You check the clock; it's 8 P.M. You're late for meeting someone for dinner a few (cold) blocks away. You have two options: get a cab or walk. However, taking a cab is risky. Sometimes you have to wait for 20 minutes in the blistering cold before one comes, which gives a payoff of -1. Sometimes a cab is right outside your door, which gives a payoff of 2. It depends on whether an available cab driver is in the area. If you walk, you know it will take 5 minutes, which gives a payoff of 0.

The cab driver faces a similar dilemma. He can stop driving for the night, which gives a payoff of 0. Otherwise, he can take a risk and swing by the university to see if any professors need last minute rides. If he finds a passenger, he will make some more money, which gives a payoff of 2. If he does not find a passenger, he wasted time and gas, which gives a payoff of -1. In normal form, this game becomes Figure 1. With no communication between the driver and you, a coordination game arises. You want to match the driver's actions and he wants to do match yours.

In the game above, even though both players benefit from trade, there may exist coordination problems. Each player wants to match what the other player is doing, creating two Nash Equilibrium: one where you walk outside and catch a cab and another where you walk and the driver heads home. (Walk, Home) is Pareto-inferior, so it is labeled a coordination "failure". Both players

		Driver	
		Drive	Home
Passenger	Cab	2 2	0 -1
	Walk	-1 0	0 0

Figure 1: Coordination Game

would rather be at the other equilibrium, getting a ride and making money. However, neither the passenger nor the driver has an incentive to change if he does not believe the other person is going as well. This can generate a self-fulfilling bad outcome, which remains even with extremely large gains from being at (Cab, Drive).

As in most simple game theory models, the coordination game is highly stylized. The main assumptions are that communication is impossible between the players and that the decision cannot be reversed. However, this game captures a real world problem. People are trying to coordinate their actions when communication is difficult. It could be friends trying to figure out which bar to go to, firms deciding how much to produce, or whether to go to a market. For whatever reason, communication is extremely costly and beneficial coordination is not perfect. In such models, each firm only wants to increase production if other firms do, so there is an equilibrium where everyone produces little. These models arguably provide a possible explanation of recessions. Thinking about such explanations of recessions, entrepreneurship provides a way out of the recession (or coordination failure) by coordinating firms actions.

In these games, there is a possibility for improvement over the multiple equilibria case. Both players would rather always avoid the bad equilibrium where there is a coordination failure. In the example in Figure 1, the total surplus increases from 0 to 2 when the trade of money for cab-ride happens. With a possible increase in surplus, people have an incentive to exploit it. Someone may help coordinate buyers and sellers, avoiding coordination failures. If an entrepreneur could develop a way to avoid this coordination failure, he has benefited the buyer and seller and can thus find a way to make a profit.

One way to get around the coordination issue is for one player to make a commitment to a specific action. In a conventional buyer/seller market, a seller commits to being at a location by paying a large cost to buy property. That is a way to tell buyers that the seller will be at 123 Main St, everyday from 8 AM to 10 PM. The buyer need not worry about a coordination failure. However, this solution to coordination failures cannot work for cab rides. Passengers and drivers are always moving and are unable to commit. Are passengers and drivers hopeless in the face of such problems? I argue that they are not, but that they require someone to take an entrepreneurial action to help resolve the problem.

In the cab example, entrepreneurship as coordination is any action that increases the probability that both the passenger waits for a cab and the driver tries to pick up a passenger, such as creating an app for the passenger and driver's smartphone. Because of the entrepreneur's action that helps realize the gains from trade and increased both consumer and producer surplus, he can receive an entrepreneurial profit. This type of coordination can be seen in conventional markets or in more recent examples from the "sharing economy," such as Uber, Lyft, and AirBnB. These companies differ from my model in that they do not just coordinate one buyer and seller, but coordinate many buyers with many sellers. Still, these companies are working to coordinate two sides of a market.

Let's consider the role of companies like Uber and Lyft more carefully, through the game in Figure 1. As with any company, these companies serve many purposes. They provide communication channels between buyers and sellers for cab rides. They provide private governance through rating systems. They provide easier payment systems. All of these roles help the companies make money from improving the situation for both passengers and drivers. In this paper, I argue that companies like Uber and Lyft also provide a *coordinating* service. Instead of having passengers and drivers stuck in the Pareto-inferior equilibrium with no trade, companies provide a service that coordinates their actions. In Section 3, I provide one possible way, drawn from the global games literature, initiated by Carlsson and Damme (1993) and well elaborated by Morris and Shin (2003), that entrepreneurs are able to coordinate. In my model, the entrepreneur sends a noisy signal to the buyer and seller about how large the gains from going to the market will be. This noisy signal allows people within a market to coordinate effectively on when are the good and bad times to participate in the market by changing people's beliefs.

The main result from that model is that in such a game, as the signal from the entrepreneur gets arbitrarily precise, the probability of a coordination failure goes to zero when the potential gains from trade are large enough. Having this unique equilibrium is better for the players than even a game of perfect information, which still has a coordination failure equilibrium, even if the potential gains from trade are extremely large. For the cab example, it does not matter if your payoff in the top-left is 1 million, if you believe the cab driver will not show up. The coordination failure equilibrium will still exist. However, an outside entrepreneur has the ability to better coordinate people within a market.

Entrepreneurship does not merely provide more *precise* information. There is no "Lemon's Problem" (Akerlof 1970) that the entrepreneur helps solve by telling customers which product is good. In the game above, the players have perfect information and still face problems, not of quality but of coordination. The entrepreneur provides the *correct type* of information that is needed to avoid coordination failures. Entrepreneurship improves each player's payoffs and provides the possibility of a profit for the entrepreneur. This particular type of action is what I call *entrepreneurship as coordination.*

The understanding of entrepreneurship as coordination is closely connected to an exploratory paper by Nicolai J. Foss (2001), who defines "leadership as *the ability to resolve coordination problems by influencing beliefs* (emphasis in original)." I use the term entrepreneurship to emphasize that it is a role that generates profit. Foss (2001, p. 367) discusses three different coordinating role for leaders: (1) coordinating on an equilibrium while outside of equilibrium, (2) coordinating on one equilibrium out of multiple equilibrium, and (3) moving from an inferior to a superior equilibrium. In all of these, the role of coordination is to create a "belief structure that at least approximates common knowledge (p. 359)." My paper is different, however, in following a more standard game theory approach by considering only equilibrium and selecting from those equilibrium. Also, in the main model in Section 3, the coordination occurs by *breaking* common knowledge, which is directly against what Foss is pointing out. Still, my paper should be seen partly as an attempt to connect Foss (2001) to formal coordination games.

Before getting to the model, I contrast entrepreneurship as coordination with other uses of entrepreneurship in the literature, which are many and do not emphasize the role for coordination. After the model, I finish the paper by showing how relating entrepreneurship to coordination also connects two distinct uses of the word "coordination" within economics, as identified by Klein and Orsborn (2009). More fully emphasizing entrepreneurship shows how resolving coordination problems at the micro, game theory level helps bring about coordination at the macro, economy wide level.

2 Related Entrepreneurship Literature

At this point, it may not be immediately clear how entrepreneurship as coordination is distinct from other definitions, or lenses, of entrepreneurship used in the literature. This sections draws out some similarities and differences. My paper is within the tradition that claims that "entrepreneurship is, fundamentally, a *behavior* and not just a process" (Acs et al. 2010, p.1). As shown in the simple model above, entrepreneurship is the action that helps buyers and sellers coordinate. However, within the group that focuses on actions, there are different types of actions discussed. This section goes through some different lenses of entrepreneurship used in the literature and shows how they fail to capture the coordination role as I have defined it. The different lenses I discuss are (1) discovery/alertness, (2) non-wage employment, (3) control of capital, and (4) middlemen. As I show, none of these papers focus on coordination. Therefore, understanding entrepreneurship as coordination provides different insights than previous conceptions of entrepreneurship. At the end of this paper, I discuss some possible insights gained from viewing entrepreneurship through the lens of coordination. Such a lens emphasizes different parts of the workings in a market.

2.1 Entrepreneurship as Discovery

The closest lens to entrepreneurship as coordination comes from the entrepreneurship literature and defines an entrepreneurship as the act of discovering opportunities, as explain by Shane and Venkataraman (2000, p. 220). This lens starts by emphasizing the *opportunities* for improvement. Opportunities are "situations in which new goods, services, raw materials, and organizing methods can be introduced and sold at greater than their cost of production." When an opportunity exists, entrepreneurship exploits it. Shane (2003, p. 4) defines entrepreneurship as "an activity that involves the discovery, evaluation and exploitation of opportunities to introduce new goods and services, ways of organizing, markets, processes, and raw materials through organizing efforts that previously had not existed." For this literature, the entrepreneur brings something new into existence after discovering the opportunity for profit.

Entrepreneurship as discovery relates to entrepreneurship as coordination. Both start with an opportunity for improvement. But the discovery lens does not capture fully the coordination that occurs in markets. While it is certainly true that an entrepreneur must discover how to bring about coordination, the key step is the coordination, not the discovery. In the coordination game in Figure 2, both players know there is a coordination problem. Discovery is not necessary. Instead, the problem requires an outsider to work to coordinate them. This different lens causes the discovery literature to not look at the coordination role. Taking the ride-sharing example, entrepreneurship as discovery focuses on the discovery that people want to buy and sell rides. The focus is not on the coordinating role of bringing these people together.

Much of the discovery literature also focuses on ownership of resources. Shane and Venkataraman (2000, p. 220) explain that "entrepreneurship involves joint production, where several different resources have to be brought together to create the new product or service." This further separates the discovery definition from coordination. One could conceive of the coordination role that I am highlighting as a new service. However, in my examples, the entrepreneur need not take control of any resources. Entrepreneurship as coordination separates the coordination role from resource ownership. In this way, coordination is closer to the type of discovery discussed in Kirzner (1973, p. 16), who says "*pure* entrepreneurship is exercised only in the *absence* of an initially owned asset (emphasis in original)." Instead of "discovery," Kirzner uses the term "alertness" and leaves open the possibility of resource ownership (p. 35). Although, the division between Kirzner's "alertness" and Shane and Venkataraman's "discovery" should not be overblown. They are closely connected and Kirzner's work influences more and more of the entrepreneurship literature that Shane and Venkataraman advanced (Klein and Bylund 2014, p. 264).

An area where entrepreneurship as coordination is in agreement with Kirzner is by emphasizing how an entrepreneur generates gains from trade that were not being realized before. For Kirzner (1973, p. 14), entrepreneurs discover opportunities to buy low and sell high. However, my model is novel in its emphasis on the role of the entrepreneur as coordinator. In the model above, the entrepreneur can improve on the outcomes of a perfect information game. Therefore, it is not just that the entrepreneur has "better" information about the possible gains from trade. Instead, the entrepreneur sends the proper signal that induces coordination that was absent in the perfect information case. Due to the frictions of imperfect information in the model, the entrepreneur can utilize this to generate better outcomes than in the frictionless perfect information game, which can lead to coordination failures. In Kirzner's model, people in the market do not realize that goods are being sold at different prices[1]. It is incumbent on the entrepreneur to discover the problem, at which point the correction of prices follows.

A further distinction between discovery and coordination exists. Shane (2003, p. 22) separates what he calls "Schumpeterian" opportunities from "Kirznerian" opportunities. "Schumpeterian" opportunities "are contingent on the introduction of *new* information that results in the creation of entrepreneurial opportunities that had not existed prior (emphasis added)." "Kirznerian" opportunities "emerge from the errors and omissions made by prior market participants." Using the coordination framework, the opportunity is not quite either. The coordination opportunity existed prior to the entrepreneurial act, but was not the result of previous errors. The coordination opportunity comes from the complementary nature of the two players' actions. There need not be any errors. Because of these differences, there are important aspects of entrepreneurship as coordination, which are not captured in the entrepreneurship as discovery literature and are worthy of study.

1. The same good at two different prices could be considered "disequilibrium." In that sense, the entrepreneur takes a market from disequilibrium to equilibrium. The entrepreneur reallocates resources to equilibrate a market. This is the view of T.W. Schultz (1975). See Klein and Cook (2006) for an overview of T.W. Schultz on entrepreneurship.

2.2 Non-wage Employment

Within economics, in particular, most papers use entrepreneurship to refer to non-wage employment, generally small business ownership. As Hurst and Pugsley (2011, p. 73) say, "researchers and policy makers often either explicitly or implicitly equate small business owners with 'entrepreneurs.' " This is how many recent papers, such as Hurst and Lusardi (2004), Cagetti and De Nardi (2006, 2009), and Hall and Woodward (2010), use the term entrepreneurship. Other applied work focuses specifically on start-ups, such as in Decker et al. (2014), but the concept is closely related. Entrepreneurship is a title/job/position and not a type of action.

There are two standard reasons used for why certain people choose non-wage employment. For much of the literature, people choose non-wage employment if they have a high enough shock to their entrepreneurial ability (Cagetti and De Nardi 2006, 2009). Another justification for entrepreneurship as non-wage employment comes from differences in risk-aversion. Because of uncertainty about the future, people with low risk-aversion will tend to take on risk, relative to more risk-averse people, by getting income through forms other than guaranteed wages. This idea goes back to classic authors, such as Cantillon (1959), Say (1971), and Knight (1921). Recent empirical work has also shown a connection between low risk-aversion and non-wage employment. For example, Cramer et al. (2002) construct a survey of attitudes about risk and employment history. From that, they argue that the evidence suggests that risk aversion discourages people from non-wage employment. Cramer et al. (2002) and Caliendo, Fossen, and Kritikos (2010) similarly look at survival rates for non-wage employment and find that people with medium levels of risk aversion survive in non-wage employment longer.

All of these papers understand entrepreneurship in a way different from entrepreneurship as coordination. For the non-wage employment literature, entrepreneurship has nothing to do with coordination, but ability or risk aversion is the defining characteristic. It may be that those that coordinate people also have a some skill or low-risk aversion. However, the coordination and ability/risk are conceptually distinct. In fact, in the model above, coordination plays a role even in a world with arbitrarily small risk and no need ability parameter. For the ride-sharing example, the non-wage lens would focus on the companies that create apps. Again, it is not coordination.

Therefore, a new concept of entrepreneurship beyond non-wage employment is needed in order to understand the problems of coordination in this paper.

2.3 Control of Capital

Closely related to the non-wage employment definition of entrepreneurship is a strand of the literature which defines entrepreneurship as the control of capital. Under the division of labor, certain people specialize in making decisions about how to best use capital and so gain control of the capital. Under such a theory, the entrepreneur is the name given to the person who specializes in such decision-making Casson (1982, 2005) or as Klein (2008) calls it: judgment.

Specialized decision makers may also come about because entrepreneurs need to deal with distinct problems. For March and Olsen (1976), entrepreneurship is characterized by an ambiguous environment and the need to deal with this. Recent work uses this definition (Minniti 2005). For such a lens of entrepreneurship, the main role of the entrepreneur is to decide between different investments in projects. This lens also focuses the entrepreneur as the head of a firm, which decides between different investments, making it similar to the non-wage employment literature. For the ride-sharing example, this lens might focus on the decision of the owners of capital to devote that capital to housing servers for their app and not for a different use. Again, while this literature has advanced economists understanding of entrepreneurship, it does not emphasize coordination and it therefore does not emphasize the situations in this paper.

2.4 Middlemen

There is another literature that studies the work on "middlemen," which is related to coordination, but again distinct. In some classic papers, such as Alchian (1969, 1977) and Hirshleifer (1973), information is costly. People do not always know what the supply and demand will be in a time period. They might not even know if a market will exist. However, certain people, called middlemen, can specialize in collection such information. These people collect information, thereby lowering search costs for other people in an economy. This helps both buyers and sellers in a market, making it close to entrepreneurship as coordination. An alternative conception of middlemen comes from

Rubinstein and Wolinksy (1987). For them, people are randomly matched and middlemen help speed up matches by working between buyers and seller.

However, the model in Figure 3 is different. For Alchian, Hirshleifer, and Rubinstein and Wolinksy, search is the problem. Middlemen are the people help facilitate trade in a world with search frictions. For the ride-sharing example, a focus on middlemen looks at the app creator who searches to find out where passengers and drivers are. This search helps a market function, but it does not coordinate a market in the way described in this paper. For this paper, the problems do not come from costly information that middlemen help discover. Even with costless and perfect information, coordination problems can exist. Therefore, coordination might still be an issue, even without the information costs that give rise to middlemen.

3 Coordinating Entrepreneurship

In this section, I provide one simple model of how entrepreneurship can eliminate coordination failures. The model below isolates the coordination aspect of entrepreneurship by only changing the coordination abilities of the two players and not changing the payoffs. Entrepreneurship changes the structure of the game that buyers and sellers are playing.

To better capture this idea of *entrepreneurship as coordination*, consider a model close to the original game above of one buyer and one seller deciding whether to Go to the market or Not, as in Figure 1. Trade between the Buyer and Seller only occurs when they both go to the market. Not going to the market is normalized to zero for each player. It costs the buyers and sellers to make the trip. For simplicity, I normalize that cost to one. However, unlike the original example, now there is uncertainty about the possible gains from trade. The benefits that the buyer and seller receive is related to some feature of the market at a given time, θ. I call this the parameter for the *gains from trade*. Considering the ride-share example in the introduction, the buyer is the passenger and the seller is the driver. The parameter θ is a reduced form way to capture the benefits of trade, such as price, time spent waiting, quality of the conversation, etc. The payoffs are given in Figure 2. This is a slightly more general version of Figure 1, but the coordination problems remain when there are positive gains from trade, i.e. $\theta \geq 0$.

		Seller	
		Go	Not
Buyer	Go	θ θ	0 -1
	Not	-1 0	0 0

Figure 2: Market Coordination Game

Both players know that the gains from trade come from a normal distribution with mean y and standard deviation τ. This is public information. The parameter τ captures the fundamental uncertainty about what the gains from trade will ultimately be. For the ride-sharing example, a longer wait time for the passenger and driver means a lower gains from trade. If both players happen to be on the same street, then the gains will be large. If the other person is in another town, the gains will be small (or negative). The parameter y captures the expected gains from trade. If $y < 0$, then the expected gains from trade are negative. Therefore, neither player will want to go to the market. The only equilibrium is when both players stay home.

The more interesting case is when the expected gains from trade are positive, as when $y \geq 0$. In that situation, there are possible gains from going to the market, but only if the other player also goes to the market. If the other player is not going to the market, it is better to also not go to the market. If $y \geq 0$, coordination is important for the buyer and seller. There are two equilibria, one where both players go to the market and one where both stay home. This is what makes the game a coordination game and similar to Figure 1. Each player is trying to coordinate with the action of the other player.

The outcome where both players do not go to the market is called a coordination failure, if there were positive gains from trade to realize. The coordination failure between the buyer and seller does not come from any asymmetric information. In that sense, the problem is not the same as in models like Akerlof (1970). Both players have the same information, although incomplete, about the expected gains from trade. Yet, there are still failures within this market, where a failure implies that there is the possibility of some improvement. The global games framework (Carlsson and Damme 1993; Morris and Shin 2003) allows for one interpretation of a way out of the failure toward better coordination.

Suppose a third person exists, called an entrepreneur. The entrepreneur observes the actual state of the world θ. He can tell this information to buyers and sellers, but only with some noise. Alternatively, the entrepreneur could observe a noisy-signal and send a signal with additional noise to the buyer and seller. The limit results, which I focus on below, hold as the combined noise goes to zero. The entrepreneur can take two actions: send a noisy signal about θ to the other players or do not send a signal. For the ride-share example, the entrepreneur has information about the time it would take the driver to get to the passenger and he can send this information to the players. If he chooses to send a signal and help buyers and sellers coordinate, the entrepreneur takes a percentage of the realized gains from trade, $u_{entrepreneur} = \pi \cdot 2\theta$, where $\pi \in (0, 1)$. This is his *entrepreneurial profit*. To isolate the coordination role of the signal, instead of the strategic play of the entrepreneur, the entrepreneur always wants to send the signal.

The buyer receives a signal, $x_b = \theta + \epsilon_b$, where ϵ_b is independently normally distributed with mean 0 and standard deviation σ. The seller receives a similar signal $x_s = \theta + \epsilon_s$. Each player calculates his action based off of his expected gains from going to the market. Without the entrepreneur, the players consider the expected gains from trade, y. With the entrepreneur, the players use their private signal to calculate their expected gains from trade, $\overline{\theta}_B$ and $\overline{\theta}_S$. If such a signal can increase the realized gains from trade, the entrepreneur will strictly profit from sending the signal and will therefore want to do it. The game is described in Figure 3. The act of the entrepreneur changes the structure of the game. Instead of being stuck in Subgame B, the entrepreneur creates a new Subgame A for the players that benefits the buyer and seller. For simplicity, I leave out the entrepreneur's payoffs from the matrices of the two subgames for simplicity.

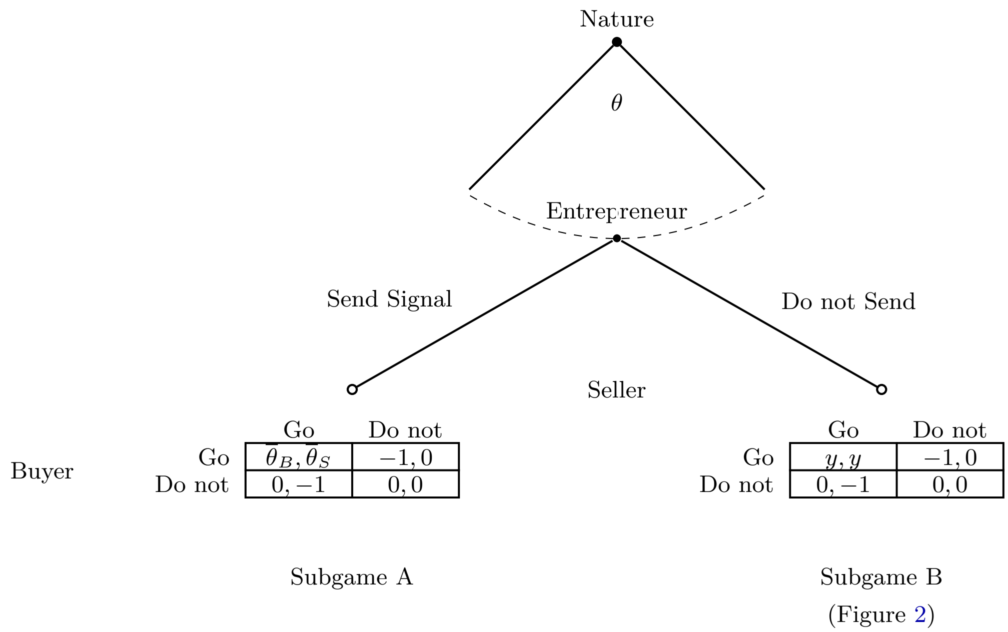

Figure 3: Full Coordination Game

To see how the entrepreneur increases the realized gains from trade, we need to determine the outcome of such a game. First consider each player's (ignoring the entrepreneur) optimal strategy. Each player i will rationally use both his private information about the gains from trade, x_i, and the public information, y. Combining all available information, each player i has an expected gains from trade,

$$\overline{\theta_i} = \frac{\sigma^2 y + \tau^2 x_i}{\sigma^2 + \tau^2}. \tag{1}$$

The signal from the entrepreneur gives the buyer and seller more information than without the entrepreneur, but still less than the perfect information case. Still, as shown below, the players are better off than in the common knowledge case, despite having less information about the game. The entrepreneur helps alleviate the coordination problems.

A strategy tells each player what to do based on his private signal, or equivalently on his expected gains from trade. As Morris and Shin (2003) show, a natural strategy to consider is that the player i goes to the market if and only if his expected gains from trade, $\overline{\theta_i}$, are above some cutoff point, k_i:

$$s_i = \begin{cases} \text{Go} & \text{if } \overline{\theta_i} > k_i \\ \text{Not} & \text{if } \overline{\theta_i} \leq k_i \end{cases} \tag{2}$$

Such a strategy means that if the player believes the gains from trade are "high enough," i.e. above k_i, he will go to the market. Otherwise, he will not go. If a player receives a high signal, he believes the other player also received a high signal. Each player will want to go to the market. As Proposition 1 shows, a cutoff strategy is the *unique* optimal strategy for each player. More than that, the cutoff for each player will be exactly when he expects the gains from trade to be as great as the possible loss if the other does not show up. This result is Proposition 1, which comes almost directly from Morris and Shin (2003, p. 77-81)

Proposition 1. *For a precise enough signal from the entrepreneur, the unique strategy that survives iterated deletion of strictly interim-dominated strategies is a cutoff strategy. The unique cutoff goes to $k_i = 1$ as the noise of the entrepreneur's signal goes to zero.*

Proof. See Appendix. ∎

This result is intuitive. Each player will only go to the market if he expects the gains from trade to outweigh the possible cost of going to the market alone. Otherwise, he will stay at home. With both players following cutoff strategies, the entrepreneurs signal eliminates the multiple equilibria. Since each player follows a strategy with a unique cutoff, there is a unique equilibrium for the game as a whole. The Buyer and Seller follow their cutoff and the entrepreneur sends a signal to each. Yet, this does not yet show that the entrepreneur's signal improves the situation. If the signal eliminated the better equilibria, the players would be worse off with a unique equilibrium than with multiple equilibria. The signal is beneficial if it eliminates the coordination failure. The entrepreneur sometimes can do this, but not always, as Proposition 2 shows.

Proposition 2. *As the entrepreneur's signal becomes arbitrarily precise, the unique outcome has both players going to the market if the actual gains from trade, θ, are greater than 1 and not going* *for $\theta < 1$.*

Proof. See Appendix. ■

As the entrepreneur is able to send a more precise signal, his information more accurately reflects the actual gains from trade. For any given gains from trade, each player's signal becomes arbitrarily close to the actual gains. Therefore, the action is pinned down by the state of the world. The buyer and seller both go to the market if the gains from trade are greater than the costs of the other not going. They stay home when there are negative. This outcome is better or worse than without the entrepreneur, depending on the actual gains from trade.

If the actual gains from trade, θ, are small, say ϵ, then without the entrepreneur two outcomes are possible. Both players could stay home and earn 0 or go to the market and both realize ϵ gains from trade. If ϵ is less than one, then with a precise entrepreneur the players will stay at home. The buyer and seller will not realize the gains from trade that were possible. If the players happen to land on the Pareto-superior equilibrium, the players are better off without the entrepreneur.

However, the players are only worse off when $\theta < 1$. Suppose the actual gains from trade are really large. Without the entrepreneur, there are two equilibrium. The buyer and seller may stay home, even if the expected gains from trade, y, or the actual gains from trade, θ, are huge. The coordination problem persists no matter how large y becomes. However, with an entrepreneur the problem disappears for large actual gains from trade. The entrepreneur's signal convinces both players to go to the market whenever the gains from trade exceed one. Players are no longer stuck in the coordination failure.

As the probability that the actual gains from trades is below one decreases, as when the expected gains, y, increases (or if $y \geq 1$ as the uncertainty τ decrease) the benefits of entrepreneurship increases. The fact that the entrepreneur is an *outsider* is key for this result. A signal from the buyer to the seller in this model could not bring about an equivalent result. To see this, it is important to recognize why the coordination failure is an equilibrium. If the Buyer believes that the Seller believes, etc, that no one will go to the market, then no one ends up going to the market. The Buyer and Seller are left in self-fulling failure. The independence of the noise signals breaks the self-fulling failures that occur without an entrepreneur. Conditional on the actual gains from trade,

θ, the private signals are independent of each other. The Buyer does not know what signal the Seller received conditional on the state of the world. Enough uncertainty about the higher-order beliefs can creep in to break the self-fulling failure. Independence cannot come from either the Buyer or Seller sending a signal to the other. Therefore, any such signal from buyers to sellers does not generate a unique equilibrium. Entrepreneurship from outside is required.

Again, notice that the entrepreneur does not give the people more precise information than in the common-knowledge. Yet in the common-knowledge world, there are possibilities for coordination failures. However, with an entrepreneur who sends a private signal, the probability of a coordination failure goes to zero as the noise in the private signal also goes to zero. In the limit, the probability of a failure is zero, if $\theta \geq 1$.

The above examples focus on situations where the noise is arbitrarily precise. This is only to make the example clear, since given a state of the world, the realized outcome is uniquely pinned down. With precise signals, each player's signal is so close to the true state of the world that his action is pinned down. In situations where the entrepreneur's signal is not arbitrarily precise, outcomes depend on both the state of the world and the realized signals from the entrepreneur. The entrepreneur still improves outcomes, but in a probabilistic manner, and results similar to Propositions 1 and 2 go through. Since the definition I gave does not distinguish probabilistic coordination improvements from certainty improvements, I focus on the example with small noise for simplicity.

Consider the case of ride-sharing apps, such as Uber or Lyft. Drivers decide between driving or not. Passengers decide between walking or waiting for a cab. The drivers and passengers have a coordination problem. In a world without communication, there are bad equilibria. Without the app, there is some distribution over times until the driver finds another passenger and similarly for the passenger. Now the app sends a signal to each. It is not perfect. Passengers do not know exactly which car I will have or the time the car arrives. However, as the signal gets better, the likelihood of a coordination failure goes to zero. Incorporating an understanding of entrepreneurship as coordination provides a fuller understanding of where the gains are coming from.

While I focus on a market example in this paper, the coordination lens for studying entrepreneurship could be applied to non-market situations. Thinking about non-market settings, this lens is similar to Boettke and Coyne (2009). In their paper, the main discussion is about social and cultural change. Following Schelling (1960, p. 54-8), they discuss people picking a time and place to meet in New York City. In Schelling's model, any actions where both players are present at the same time and location is an equilibrium. However, there are certain "focal points" where people could coordinate, such as Grand Central Station at noon. For Boettke and Coyne, social and cultural entrepreneurship involves changing people's focal point. For applied work, Storr, Haeffele-Balch, and Grube (2015, p. 49) argue the social entrepreneurs were able to solve coordination problems by creating focal points after natural disasters, such as Hurricane Katrina. While my model does not explicitly include focal points, it is possible to interpret the entrepreneur's signal as creating a focal point on a specific action. Instead of leaving such actions as focal points, my model results in only one equilibrium in pure strategies, generically. A further distinction is that, entrepreneurship as coordination distinguishes between good and bad equilibria. Entrepreneurship helps people avoid coordination failures. For "focal points," it is not necessarily that meeting at places that are not Grand Central Station is bad. Instead, they just are unlikely equilibria. Still, this paper is closely connected to Boettke and Coyne.

4 Understanding Coordination

Studying the connection between entrepreneurship and coordination not only helps make sense of entrepreneurship: what it is, how it helps a market operate, and where we will see it. Focusing on coordination also helps make sense of how coordination happens within markets. Thinking about the Full Coordination game in Figure 3 gives a different understanding of the nature of these markets that require coordination, compared to only looking at the standard coordination game in Subgame B. Entrepreneurial profit creates an incentive for people to find improvements over coordination failures. Instead of being stuck with coordination failures of Subgame B, the buyers and sellers avoid problems with the help of the entrepreneur. If observers are only looking at such situations through the lens of Subgame B, the world would seem hopelessly prone to coordination failures. Any time people's actions are complements, coordination can be a problem. Recognizing the role of the entrepreneur opens our eyes to the full scope of coordination that occurs in a market and how such problems are avoided everyday.

Looking at the world with a model of entrepreneurship as coordination makes sense of phenomena that would be missed through other lenses. For an example, consider advertisement. Through the framework presented in this paper, advertising can be seen as a signal that is sent to help avoid coordination failures. This simple act keeps markets operating, instead of buyers and sellers just staying at home. Focusing on the entrepreneur allows the observer to recognize the role played by such information sent through advertisements. If economists look at the "bigger" game that is being played, certain alleged problems might disappear. Even the coordination games in macroeconomics, such as Cooper and John (1988), can be seen as part of a larger game of a market process. Looking at the entrepreneur's role does not dismiss the empirical regularity of recessions. However, thinking about the coordination role of entrepreneurship implies a different way of understanding how economies get out of recessions. It is not simply a jump from one equilibrium to another, but the result of decisions of people within a larger model. People take actions that move an economy from coordination failures to coordination successes.

The lens presented above also adds to our understanding of coordination by relating different definitions of coordination that have been used in economics. Klein and Orsborn (2009) distinguish two types: *concatenate* coordination and *mutual* coordination. Concatenate coordination deals with such phenomena as a business owner coordinating factors of the production together or the price system coordinating the actions of buyers and sellers. This is how the term coordination was originally used within economics. For example, as Klein and Orsborn show, John Bates Clark used coordination in this way:

> These are, respectively, the earnings of labor, the earnings of capital and the gains from a certain coordinating process that is performed by the employers of labor and users of capital. This purely coordinating work we shall call the entrepreneur's function, and the rewards for it we shall call profits. The function in itself includes no working and no owning of capital: it consists entirely in the establishing and maintaining of efficient relations between the agents of production. (Clark 1908, p.3)

Over the past few decades, coordination has come to mean something else. *Mutual* coordination deals with coordination in game theory sense, where each players' payoff depends on whether she coordinates with the other player on a specific action. Games such as Figure 1 or the Battle of the Sexes are examples. New Keynesian macroeconomics uses this framework when describing macroeconomic coordination failures, such as in Cooper and John (1988) or more recent models like Angeletos and La'O (2013) and Benhabib, Wang, and Wen (2015). Mutual coordination does not necessarily deal with specific business owners coordinating inputs, but a specific type of strategic interaction between players in a formal game.

While it is important to recognize the differences between the two types of coordination, it is also important to understand their connection. Viewing entrepreneurship as coordination allows for such a connection. In this way, the full coordination game in Figure 3 includes *mutual* coordination failures. However, the actions of the entrepreneur helps to avoid these problems. Such actions bring about *concatenate* coordination among buyers and sellers. When seeing this relationship, the two definitions of coordination are no longer separate, but related through the actions on an entrepreneur within a market. The lure of entrepreneurial profits create incentives to coordinate markets, such as discussed in Hayek (1933, p. 129-31). Such interpretations, along with aided understanding of coordination problems within market economies, allow for additional insights beyond what previous conceptions of entrepreneurship provide.

5 Conclusion

This paper puts forward a new lens for studying entrepreneurship, which I call entrepreneurship as coordination. According to this lens, entrepreneurship improves the coordination abilities of people, increasing the gains from trade in a market. To demonstrate one way in which an entrepreneur can improve the coordination ability of a buyer and seller, I construct a model of a global game. The main result of this paper is that when an entrepreneur's signal to buyers and sellers becomes precise, his actions improve coordination. In the limit, entrepreneurs eliminate all coordination failures when the possible gains from trade are large. I then show how this lens connects different uses of the term coordination used within economics.

Appendix

Proposition 1. *For a precise enough signal from the entrepreneur, the unique strategy that survives iterated deletion of strictly interim-dominated strategies is a cutoff strategy. The unique cutoff goes to $k_i = 1$ as the noise of the entrepreneur's signal goes to zero.*

Proof. Because of the normality of the noise (and walked through clearly in Morris and Shin (2003, 79)), each player has posterior beliefs about θ that are normally distributed with mean

$$\overline{\theta}_i = \frac{\sigma^2 y + \tau^2 x_i}{\sigma^2 + \tau^2}. \tag{3}$$

and standard deviation

$$\sqrt{\frac{\sigma^2 \tau^2}{\sigma^2 + \tau^2}}. \tag{4}$$

Because of the independence of the noise term, player i believes x_j is distributed normally with mean $\overline{\theta}_i$ and standard deviation

$$\sqrt{\frac{2\sigma^2 \tau^2 + \sigma^4}{\sigma^2 + \tau^2}}. \tag{5}$$

Let $\Phi(\cdot)$ be the cumulative normal distribution. Suppose player i believes the other player, j, is following a switching strategy at k. Player i assigns a certain probability that the other player has received a signal large enough that j's expected gains from trade is above his cutoff, and so j goes to the market. The probability that i attaches to j going to the market is strictly decreasing in cutoff k. A higher cutoff means the other player is less likely to go to the market. The probability is given by

$$\Pr(j \text{ goes}) = \Phi\left(\frac{\overline{\theta}_i - k - \frac{\sigma^2}{\tau^2}(k - y)}{\sqrt{\frac{2\sigma^2\tau^2 + \sigma^4}{\sigma^2 + \tau^2}}}\right). \tag{6}$$

The optimal switching point is when the expected payoff for going to the market equal to not going to the market, which is normalized to zero. Then the optimal switching strategy for i is

$\overline{\theta}_i = \theta_i^*$ which solves

$$\Pr(j \text{ goes}) \operatorname{E}[\theta|x_i] + \Pr(j \text{ does not go})(-1) = 0 \tag{7}$$

$$\Pr(j \text{ goes})(\operatorname{E}[\theta|x_i] + 1) = 1. \tag{8}$$

Since the left hand side of Equation (8) is strictly increasing in $\overline{\theta}_i$, there is a unique optimal cutoff for any cutoff of the other player. When the expected gains from trade, $\overline{\theta}_i$, are above this optimal switching point, player i both has higher expected gains from trade and assigns a higher probability that the player j, received a signal above $j's$ cutoff, k. The optimal cutoff point is to go whenever the expected payoff to going equals the payoff of staying home.

Combining equations (6) and (8), the optimal cutoff for player i, θ^*, given j's cutoff k solves

$$\Phi\left(\frac{\theta^* - k - \frac{\sigma^2}{\tau^2}(k-y)}{\sqrt{\frac{2\sigma^2\tau^2+\sigma^4}{\sigma^2+\tau^2}}}\right)(\theta^*+1) = 1. \tag{9}$$

Given any level of precision for the public signal, for sufficiently small private noise, σ, the numerator in the CDF becomes approximately $\theta^* - k$. Each player's beliefs about the gains from trade is approximately what his signal from the entrepreneur is.

Suppose $k = 1$. Then $\theta^* = 1$. Then each player's optimal cutoff is 1 if the other player is following a cutoff of 1. Since the game is symmetric, each player following a cutoff at 1 is the unique equilibrium. ■

Proposition 2. *As the entrepreneur's signal becomes arbitrarily precise, the unique outcome has both players going to the market if the actual gains from trade, θ, are greater than 1 and not going for $\theta < 1$.*

Proof. Take any actual gains from trade, θ. As the signal from the entrepreneur becomes arbitrarily precise, the probability that $|x_i - \theta| > \epsilon$, for any $\epsilon > 0$, goes to zero for both players. The signal that each player receives is arbitrarily close to the actual gains from trade. Since Proposition 1 showed that a cutoff strategy at 1 is optimal as the noise goes to zero, the probability that $x_i \geq 1$ goes to 1 for any $\theta > 1$.. If $\theta < 1$, the probability that either player will go to the market goes to

0, since the probability that $x_i \geq 1$ goes to 0.

$\blacksquare$

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