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**GAME THEORY IN VENTURE CAPITAL AND STARTUP  
DEVELOPMENT: HOW ENTREPRENEURS CHALLENGE  
THE ASSUMPTIONS OF GAME THEORY THROUGH  
PERSONAL EXPERIENCE**

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## **Abstract**

Game theory is a statistical branch of study which foresees the market as a competitive landscape for players to interact, strategize and act. There are different statistical game theoretic models depending on the level of information available. This study analyses how game theory dynamics change in markets where information is scarce and asymmetric, such as the venture capital and start-up sector. This study shows a general overview of both, game theory and venture capital, and studies the interconnection between these two concepts. First, venture capital and its main elements are described; the VC market, GP/LP structure, compensation structures, contracts and incentives, valuation methods in the venture capital spectrum and the J-stamina curve. The study later focuses on venture capital from the start-up's (or target company) point of view. Concepts such as startup development, the different stages and factors that lead to success or failure are discussed. The second part of the study is centered on game theory basics and elements; what is game theory, the different elements that compose it, the different type of games and some famous examples such as the prisoner's dilemma. After the general description of both main topics, the interrelation of both and how they interact in funding or exit processes, as well as in the agent-entrepreneur relationships, is also described. The study also includes a case study on an entrepreneurs' experience on developing his own start-up. This study aims to study entrepreneurs' rational thought processes, and how they establish different strategies and tactics depending on the level of information available about other players and the market. After the theoretical and case studies, two main conclusions are reached about the basics of game theory and how these are challenged by entrepreneurs' personal experience.

## **Keywords**

Game theory, venture capital, information asymmetry, players, strategy, rational thought process, preferences.

# **1. INTRODUCTION**

## **1.1 Background and context of the study**

Since the end of World War II, many economies around the world, such as in the US, have roared in comparison to other economies, such as the European one. The US economy has successfully maintained a constant rate of unemployment and inflation, which many scholars attribute to the rise in innovation and reinvention that the venture capital market has allowed for. For these past years, there has been a collective agreement that innovation is key to both macro and microeconomic success, and it is determinant to the future stability and positive growth of an economy (Bartlett, 1999)

Venture capital might not be considered by all as the driver of innovation, but it surely can be defined as the industry that fills a major void or gap. Venture Capital plays an important role in the stage of a company when it starts to commercialize innovation: “We estimate that more than 80% of the money invested by venture capitalists goes into building the infrastructure required to grow the business-in expense investments (manufacturing, marketing and sales) and the balance sheet (providing fixed assets and working capital)” (Zider, 1998). The significance of the venture capital world in the macroeconomic spectrum is high, whether it is the vehicle that allows for innovation or the vehicle that serves as an alternative for traditional funding institutions.

Venture capital is the first key element of the study, and I wanted to study it along game theory dynamics; second element of the study. Game theory is "the study of the ways in which *interacting choices* of *economic agents* produce *outcomes* with respect to the *preferences* (or *utilities*) of those agents, where the outcomes in question might have been intended by none of the agents” (Ross, 2014). The key driver for this study is information availability and asymmetry. As it is commonly known, venture capital is characterized for having higher information asymmetry than other industries where information is more available. Therefore, the different strategies of the players change, as the preferences and potential actions of the rivals are “unknown”.

## **1.2. Main objectives**

My initial objectives were (1) studying the dynamics of game theory in sectors where information is scarce, as well as asymmetric, (2) study how game theory is involved in entrepreneurs' rationale and how it affects the development of a startup, (3) find specific strategies or actions within

venture capital players that differed from other sectors and (4) model game theory strategies in start-up development processes, and find a characteristic strategic and methodical path for start-ups.

Instead, my study led me to the questioning the basics of game theory within venture capital, rather than shedding light on issues of the bigger picture. The case study's results, based on the personal experience of an entrepreneur, challenged two important *concerns or basic assumptions* on which game theory dynamics in the venture capital world, is based on. I will display an overall background of game theory and venture capital (specially focusing on start-up development), the study I inducted and the conclusions I reached, as well as the two concerns mentioned above.

## **2. THEORETICAL BACKGROUND**

### **2.1. Venture Capital Background**

#### **2.1.1 Fundamentals of Venture Capital**

For the purpose of defining the industry in this paper, I will first describe it from a general perspective, focusing on all the players and elements that interact within the market. Later on, I will focus on the target companies'/start-up's perspective and their development, as the study will be related to the personal experience of an entrepreneur on how he developed and founded his business.

Venture capital is characterized by five elements. The first one is its illiquidity in comparison to public markets, while the second one is the asymmetric information that characterizes it. In order to balance this illiquidity, incentives are added to the contracts becoming this way a key element. Additionally, we have the industry's cyclical nature, as there exists specific times to raise funds, to invest or to exit. Finally, venture capital is deeply characterized by "reputation capital", referring to the different connections and networking property possessed by the players. This makes reputation the most important key factor in the venture capital world.

The structure or players within venture capital can be narrowed down to three main categories: 1) general partners (GPs), 2) limited partners (LPs) and 3) target companies. In the real world, other type of investors are often involved, and it is not only about one target company but many simultaneous target companies. However, for simplicity of exposition, only these three categories will be mentioned.

The General Partner(s) (GPs) often refers to the management company for the fund. The General Partners' position can be made up of several professionals in the industry which usually have discretion over fund investments and also possess great expertise in the sector. Fundamentally, the GP establishes the fund objectives and may even invest its own money in the fund. The Limited Partner(s) (LPs) are usually institutional investors with long term investment horizons such as foundations, pension funds, endowments or family trusts. However, this definition can also apply to wealthy individuals who decide to invest high amounts of capital into a specific project. The last category of players are the target companies, entities that receive the investments and funds. These players are often start-ups, mismanaged firms that need a turn-around strategy or firms that no longer want to be public.

The dynamic of this structure is that GPs need LPs for funding purposes, LPs need GPs because they need the expertise and the resources to monitor companies, and target companies need

the funding, because typically they can't access financing with traditional resources. For instance, a timeline for a venture capital project could go as following. The fund begins its capital raise process, where LPs commit capital and make a commitment to give in money that the GPs have a right to ask for. Later on, there is a period between the raise of funds and the vintage year, where the fund closes and makes its first investment. Then, the fund will likely live for ten years, where it will end through an exit. It is relevant to note that during the fund-raising period, there exists follow-ons, which are additional amounts of committed capital that occur until a hard close.

In terms of the different incentives, these are reflected within the compensation structure or "the carry", which refers to the split of profits. In private equity, the common compensation structure is 2+20%, but in venture capital it usually is 2.5+20% (more management fees are included as venture capital is riskier and requires more time). These compensation structures are important because they reflect the different players' interests and relationships. Another way to capture this, is through partnership agreements, mainly used to align interests between the GPs and the LPs. For instance, different kind of agreements in venture capital securities are set to establish said interests and preferences in ownership. The different agreements can be redeemable preferred stock (RPS), redeemable preferred stock (RPS) and "cheap common", convertible preferred stock (CPS) and participating convertible preferred stock (PCPS).

Valuation within venture capital is relevant, as it allows for information in an environment characterised by the lack of such. Valuation helps evaluate new investments, report performance to managers, evaluate possible exits or also assist with regulation purposes. Some possible valuation methods are present value, adjusted present value (net present value of equity and debt), comparable through multiples, the venture capital method or options valuation.

As the name says, a common valuation method in venture capital is the venture capital method. This method attempts to value a start-up once positive cash flow is generated. The calculated value is then discounted at a high discount rate which represents a very subjective risk (between 40%-75% is common). Then, the investor calculates the present ownership to be negotiated based on their dollar investment as a perfect of this present value. This method has a big pro, as it helps a venture capital investor fight dilution of their equity position. This is why sometimes "ratchets", are included within clauses. These specific clauses state that in the event of future financing, an investor's equity share will increase proportionally with the new financing.

However, it should also be acknowledged that there exists several challenges to venture capital valuation. First, the volatility of cash flows in a start-up is usually large and venture capital firms don't usually have accurate comparables. The most important challenge of all is the nature of the venture capital market itself, by which venture capital companies typically have negative cash flows for many years. This can be measured through the J-stamina curve. "In practice, it means that VC funds have generally terrible financials for the first several years of existence. Some investors call this "the valley of tears," and for good reason. If VC financial performance is measured as the difference between capital outflows (initial and follow-on investments) and capital inflows (cash and/or stock proceeds from a liquidation event), it makes sense that a snapshot of a fund in the midst of its investment period will look, at best, lackluster. This is a well-known phenomenon known as the J Curve" (Rowley, 2019).

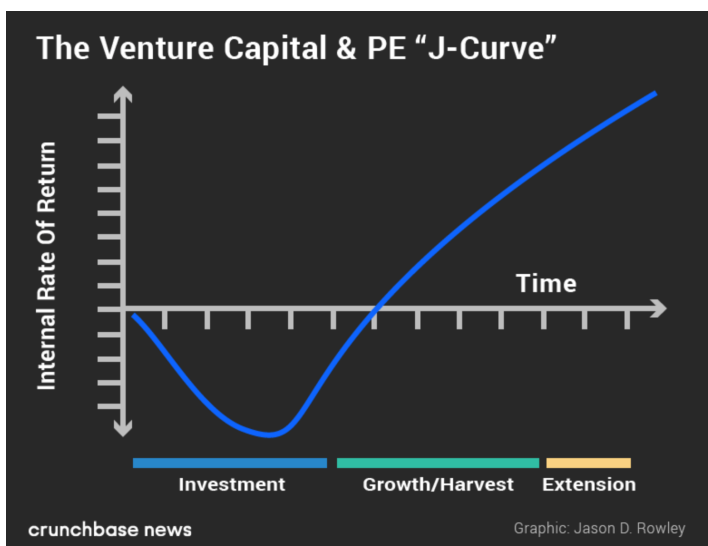


Figure 1, Rowley (2019)

### 2.1.2. Start-up development within the venture capital sector

From the venture capital frame described above, start-ups can be considered as the players under the name of "target companies". Start-ups are born from a human desire, need or idea that fits within the economic, political and social environment the entrepreneur is in. An important remark when studying the founding of a start-up is that "action" is more relevant than the "idea". An entrepreneur cannot think a business into life, the entrepreneur needs to turn the idea into a tangible structure and change it accordingly to the needs of the environment (Gartner & Carter, 2004).

Normally, start-up development can be summarized to three main stages; early-stage, venture-funded (growth) stage and late stage. These stages are not clearly delineated but it is more of a continuum spectrum in which the entrepreneur moves along, as the idea develops into a tangible



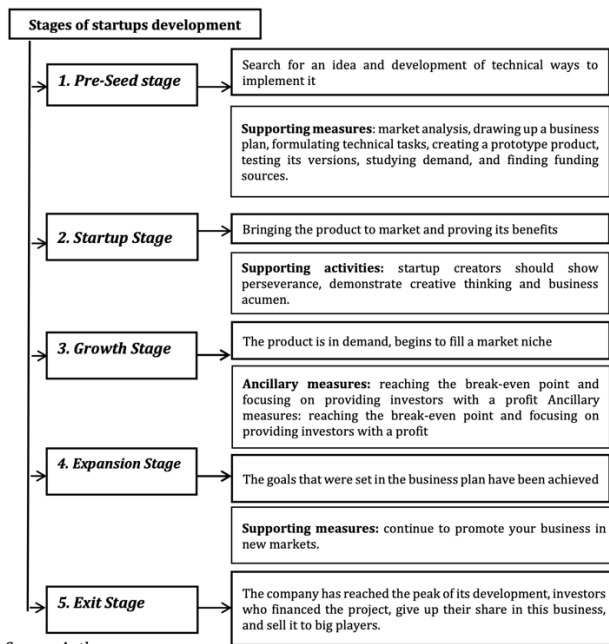
solution to an existing problem. It should also be considered that this is a generalization and not all start-ups follow the same development process. However, in order to give a general overview, it is the path that the majority of start-ups end up taking.

The early-stage phase is the time to carefully plan how to turn an idea into something valuable for the addressable market. It is the stage to define the mission, vision, business plan, long-term goals and strategy. It is also the most difficult time to raise funds, even though it is incredibly necessary for the healthy development of the venture. This stage is also the time to establish a consolidate team, demonstrate the value of the product and to essentially make the venture be known and recognized in the market.

The venture-funded stage normally begins after the venture has received its first Series A round of financing. This phase is important, as this funding demonstrates that an investor considers the prototype to be an scalable product capable of hitting positive financial milestones. This round of financing essentially allows a start-up to further develop and research the possibilities of the prototypical product, find the correct infrastructure and start expanding the business.

Finally, in the late stage “it all stops being about potential and starts being about performance”. In this stage, the start-up starts being on the eyes of investors and it needs to keep up with sales, performance and the milestones established during the previous processes. During this process, the funding sources become easier to attract as the entrepreneur no longer relies on pitching and potential possibilities, but on the start-ups’ financial performance. This can be a double-edged sword, as here is where the true intentions of the entrepreneur are revealed; performance metrics can help boost the venture and build trust, or these can dismantle the product pitch performed in previous stages. As will be mentioned later, adverse selection and moral hazard are two main risks described in game theory, that are likely to happen during these development stages of the venture (Silicon Valley Bank, 2024).

These three stages are adapted and changed depending on the author, but they all end up referring to the same path and development process. Figure 2 shows a detailed breakdown of the different stages:



Source: Authors.

Figure 2, Kasych & Amelyaniuk (2020)

Even though this figure shows five phases instead of three, it refers to the same general development process for start-ups.

As it is widely known, start-up development does not usually reach the latter stages and many ideas and prototypical products are left behind and forgotten in its initial stages. That is why many researchers and scholars have researched which factors promote start-up success and development. Many papers have shown that there are no specific entrepreneurial traits that lead to success but that it mainly depends on how well the idea helps fix a problem for clients and the environment. Interestingly enough, a country can be more entrepreneurial than other, having higher success rates for start-ups. This might be because of the economical state of a country or the cultural perception on entrepreneurship across countries; for example, in some African countries entrepreneurship is culturally seen as selfish, while in the US it is seen as a tool for research and innovation (Neck et al., 2019).

In the paper “The Nature of Startup Development: Concepts, Theories, Trends, Conditions”, the authors conclude that for a start-up to be successful it needs to be supported by the following criteria: “increase investment by the state, support social orientation of innovative projects, to develop entrepreneurial culture, strengthen the intellectual property regime” (Kasych & Amelyaniuk, 2020). It also states the importance of governmental help, highlighting that a country must: “promote the effective functioning of startups, create mechanisms to increase the effectiveness of their activities and to recognize the importance of innovative technologies for the successful development of enterprises”.

## 2.2 Game theory

### 2.2.1 Introduction

Let's imagine a game of chess, where two players (Sam and John) are competing against each other. Both might have some tactics and moves planned, depending on how the game develops. However, neither of them came to the competition with a clear strategy on how they intend to beat their opponent. The moves Sam makes will depend on the ones that John makes and vice versa. The players will observe and adapt to their opponent's strategy, influencing each other and modifying the strategies as the game develops. This chess game is deeply similar to the dynamics of game theory in general. But game theory is not just present in mathematical situations or chess games, it is present in the most mundane aspects of life and has been present historically before it was even studied. For instance, game theory is present in behavioral interactions at the most basic level, such as real estate negotiations or the most innocent jigsaws for children, such as the one I am about to tell.

When I was in high school, there was a very popular jigsaw among students. It described the story of three prisoners who were given the possibility to be freed by one of the officers. The officer told them that each would be assigned with a color hat, either black or red. There could be infinite red hats but there could only be one possible black hat. The three of them had to stand in front of each other and look at each other, once they had their hats assigned. The three of them were assigned red hats and the game began. The officer asked the first prisoner, "what's the color of your hat?" to what he responded, "I don't know". Then, the officer asked the second prisoner, "what's the color of your hat?", to what he responded, "I don't know". Finally, the officer asked the third prisoner, "what's the color of your hat?" to what he responded, "Red". How did he know?

The first natural responses to this jigsaw were always along the lines of tricking the game or seeing the color in the jail's window reflection. But it had nothing to do with that and had everything to do with game theory and rational behavior. The third prisoner thought that if he had the black hat, the other two prisoners would not have doubted about the color of their hat, as there could only be one black hat. Therefore, he knew that he did not have a black hat. His desired outcome was a consequence of the other prisoners' behaviors, who unconsciously allowed him to know the color of his hat.

Historically, there were signs of game theory in many aspects, thousands of years before the term "game theory" was even invented. Such examples can be seen in ancient military strategies and historic battles. For instance, in the battle of the Spanish conqueror Cortez against the Aztecs, Cortez removed any possibility of retrieving from the battle, forcing his soldiers to stand up and fight against

the Aztecs. He, in fact burnt all of his ships to show the Aztecs the positivism and confidence they had on the battle. The Aztecs saw this and decided to retreat, because what opponent would destroy their only option of surrendering, if they didn't have a good reason to believe they'd win? This allowed Cortez to have one of the easiest victories in history, and not because of their skills, but because he took advantage of rational reasoning processes and played with human psychology to his advantage. (Ross, 2014).

Today, game theory is a whole science and mathematical conjecture, but early authors like Cournot or Morgenstern (during 1928 before his work on game theory with Van Neumann was developed), already began to outline the glimpses of game theory dynamics. For instance, in the 1920s, Morgenstern already discussed about “the recursion problem in a situation of strategic interdependence without well-defined payoffs” (Dimand & Dimand, 1996). What seems to be most interesting from looking at early authors and their works, is that the way in which subjects responded to theoretic games back then, is deeply like the outcomes predicted by game theory currently. All of this evidence proves that game theory has served as a mathematical tool to hedge uncertainty and risk from interdependent situations, that people have unconsciously faced and solved for thousands of years, across all history (Dimand & Dimand, 1996).

However, it was not until 1944 when the term “game theory” was properly defined by John von Neumann and Morgenstern. The epitome of their work was their book “The Theory of Games and Economic Behaviour”, where they observed that the current models designed for economics were poor, and that in fact economics was much like a game where players interacted between each other interdependently. During the 50s “game theory” was further developed by authors like John Nash, “who established various mathematical principles of game theory, examining the rivalries between competitors with different interests” (Davis & Brams, 2018). From the 1950s to the present, game theory has developed into a vast array of statistical and mathematical formulas and concepts with infinite possibilities. Now game theory has infinite definitions depending on the author quoted, but a straightforward and clear definition of game theory could be “the study of the ways in which *interacting choices of economic agents* produce *outcomes* with respect to the *preferences (or utilities)* of those agents, where the outcomes in question might have been intended by none of the agents” (Ross, 2014).

### 2.2.2. Basic elements and assumptions

In game theory, it is important to note its most basic elements and assumptions. Economic agents often refer as those entities with preferences that have different utilities. The term “utility”

refers to “an abstract ranking of the subjective welfare that an agent gets from an event” (Ross, 2014). It is ultimately a measure of subjective psychological fulfilment from an economic agent in relation to an event. In game theory, there are two main assumptions; the first one by which all economic agents will normally act in accordance to maximising their psychological fulfilment and the second one by which all agents are assumed to act with rationality (Ross, 2014).

Now, “all situations in which at least one agent can only act to maximise her utility through anticipating the responses to her actions by one or more agents is called a game”. Inside of this definition, all the agents within a game are called players. “In a game, each player faces a choice among two or more possible strategies, which is a program of play that tells her what actions to take in response to every possible strategy other players might use” (Ross, 2014).

Now, apart from the players and the utilities of each player, a key aspect in game theory (which will be incredibly important in the development of this thesis) is information availability. In a game, it is deeply relevant to know what information there is available, what each player knows, and what each player knows about the beliefs and information that the rest of the players hold.

### 2.2.3. Types of games: Extensive vs normal games

A game is a way of representing key elements interlinked together; who the players are, the information available to them, each player’s utilities and what each player knows. There exist many ways of representing games, but it can be narrowed to “extensive form representation” or “normal-form (or strategic form) representation” (MIT, 2012).

#### 2.2.3.1. Extensive form representation

The extensive form representation is such in which “the above information is explicitly described using game trees or information sets” (MIT, 2012). For instance, in an extensive form representation the game contains all the information, including who moves when, what information is available to each player, what each move leads to. Extensive form representation games also fall under the category of perfect information games, where all the information is available. Games of perfect information are the simplest of games, as these allow for backward induction. A player in such a game will choose their next action based on the different options, counter-options and outcomes that each possible way offers. The player can evaluate which option brings the highest utility and choose the action that starts the chain process leading to the desired outcome. (MIT, 2012)

A game tree is a representation made up of nodes that must follow certain conditions. There must be “an initial node for which there is not incoming edge, for every node there is exactly one incoming edge and for every two nodes, there is a unique path that connects these two nodes”. If the representation holds the belief that the player can get to X node from different paths that are not the initial node, it could not be considered a tree. There are no such things as loops in these representations, but “trees”, in the sense that the game has a starting point from which the different possibilities and outcomes (modelled through nodes) branch out, until it reaches a payoff or outcome (MIT, 2012).

Another definition worth noting is that those nodes which have no consequent nodes after them are called “terminal nodes”, while the other kind of nodes are called “non-terminal nodes” (MIT, 2012). In order to facilitate the explanation on the different conditions and the definitions laid out, here are some examples:

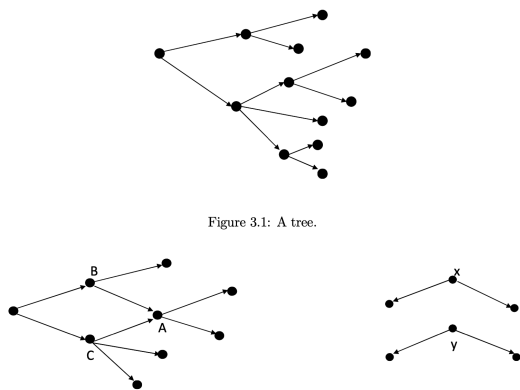


Figure 3.1: A tree.

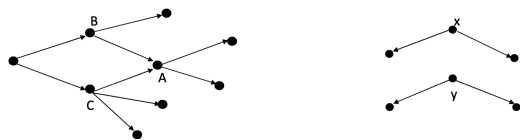


Figure 3.2: Two graphs that are not a tree

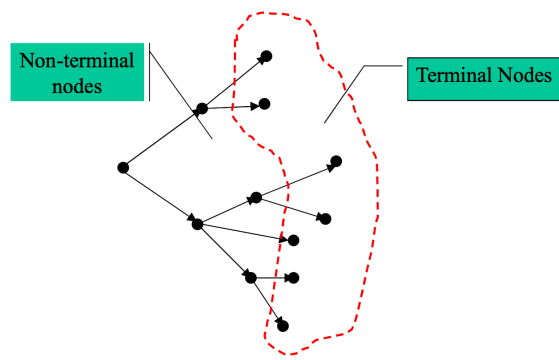


Figure 3.3: Terminal and non-terminal nodes.

Figure 3&4, MIT (2012)

Now a game within a game tree extensive form representation will have the following elements: the players, the outcomes and payoffs and the decision nodes. Also, the different lines represent the “actions” that each player will take (MIT, 2012)

The players will be described as  $i = \{1, 2, \dots, N\}$ . The outcomes and payoffs will be modelled as “the set of terminal nodes ( $Z$ )”. This makes sense, as a terminal node is, by definition, the last node of the tree, which is ultimately an outcome or payoff. The mapping of this will be:  $U_i: Z \rightarrow R$ . Here the  $u_i$  refers to the function of personal utility for each player (as described by Von-Neumann and Morgenstern) to the different outcome or payoff that the player ends up deciding. Finally, the decision nodes refer to the mapping of the decision that each player must make at all the different steps (nodes) of the decision process. At a non-terminal node, the player must make a choice until they end up in

their assigned terminal node. Therefore, this part of the game describes all the available options the player has at each non-terminal node (MIT, 2012)

On the other hand, information sets “belongs to a particular player and contains decisions nodes satisfying the following criterion: the player gets to play or make a move at every node in that information set and when a node belonging to the information set is reached, the player does not know which node in the information set has been reached”. Besides, each decision node is in exactly one information set and at each decision node in an information set, the player must have the same set of feasible actions and ultimately choose the same action (MIT, 2012)

### 2.2.3.2 Normal form representation

On the other hand, the normal form representation is such in which “the above information (who the players are, the information available to them, each player’s utilities and what each player knows) is summarized by use of strategies” (MIT, 2012).

In the normal form, the key elements will be: the players, the set of all available strategies to player  $i$ , and therefore the utility function for each player; represented as  $u_i: S_1, \dots, S_n \rightarrow R$ . Here it should be noted that a player’s utility does not depend solely on the action the player takes, but also the actions that the rest of the players take. Furthermore, a key assumption is that every player will try to maximize their utility function given their beliefs and wants (MIT, 2012).

One common way of representing normal form games is through pay-off matrixes:

		Player II	
		<i>Confess</i>	<i>Refuse</i>
Player I	<i>Confess</i>	2,2	4,0
	<i>Refuse</i>	0,4	3,3

Figure 5, Ross (2014)

The difference between extensive and normal representation lies on the information they provide and deal with. Extensive form games usually contain information, while strategic form games do not. While perfect information games make use of trees and information sets, imperfect information games are more complicated. Usually, these types of games are not only reduced to matrixes, but they also have a heavy statistical overload. For instance, a “Bayesian game” is an asymmetric strategic decision-making model that allows “to analyze a situation in which each player is imperfectly informed” (Osborne, 2000).

The key concept about a Bayesian game is that, because all information is not available, each player has private information sets, that include the player’s preferences, believed information about the state of the environment that the rest of the players might not know. Within this type of game, a probability distribution of each player’s private information is developed to hedge uncertainty. As the game progresses and players oversee each other's actions and rational thought processes, they update their beliefs and set of private information accordingly. The solution for these types of games often include concepts such as the Bayesian Nash equilibrium (Osborne, 2000)

2.2.4 Nash equilibrium and Bayesian Nash equilibrium

The Nash equilibrium in game theory, concept developed by the Nobel Winner John Nash, is often referred by many authors as “the solution to a game”, as it is a status of equilibrium. Even though it is not always a solution, the Nash equilibrium is by definition “the optimal solution in a non-cooperative game in which each player lacks any incentive to change his/her initial strategy” (CFI Team, n.d.). If a game reaches the Nash equilibrium, this means that a player does not gain anything from deviating from their initial strategy, assuming that the rest of the players also keep their strategy straight.

To envision this, let's imagine two companies; Company A and Company B. Imagine both companies want to launch two complementary products. If they both launch their products, they will each attract 100 new customers. If only one company decides to launch the product, that company will attract 200 customers, while the other company would attract 0. If both companies decide not to launch their products, then none of the companies will attract any new customers (CFI Team, n.d.). Their payoff matrix would be as follows:

		Company B	
		Product	No product
Company A	Product	(100;100)	(200;0)
	No product	(0;200)	(0;0)

Figure 6, CFI Team, n.d

Here, we can see that as both companies wanted to launch their products, the situation of Nash equilibrium is where both companies launch the product and obtain 100 new customers each. Even though they would get better individual payoffs if only one company launched the product, it is assumed that both players will maintain their initial strategies despite of this information.



Another example to envision the Nash equilibrium is the prisoners' dilemma. This dilemma is famous in game theory, as it shows the difference in outcomes between individual decision making and group-based decision making (cooperation versus non-cooperation). The prisoners' dilemma presents two prisoners who have been convicted of a crime. The police does not have enough proof to convict them, so the police gives each one of them the option of testifying or remaining silent. If both of them stay silent, they would only be convicted of 1 year prison each. If one of them testifies against the other, and the other one remains silent the testifier would be free and the one who remained silent would get 5 years in prison. Finally, if they both testify against each other, they would get three years each in prison (Potters & Velasquez, 2022). The payoff table would be as follows:

		Prisoner 2	
		Silent	Testifies against
Prisoner 1	Silent	(1;1)	(5;0)
	Testifies against	(0;5)	(3;3)

	Total Nº Years
<b>Silent-Silent</b>	2
<b>Silent-Testifies against</b>	5
<b>Testifies against-Testifies against</b>	6

Figure 7, Potters & Velasquez, 2022

In the context of the Prisoners' dilemma, the Nash equilibrium and optimal decision would happen if both prisoners remained silent, resulting in the minimum jail sentence for each (1 year). However, if one prisoner defects the other, they gain a better individual outcome than if they cooperate.

This is what gives rise to a dilemma: the most favorable outcome for both is given if they collaborate and remain silent. Nevertheless, it is highly likely that each prisoner will be driven by personal interests for the best *individual* outcome, opting to betray the other prisoner. This decision shows how in some games, decisions driven by self-interest and by undermining collective benefit, can lead to the "bad Nash equilibrium" in which both players testify against each other, obtaining both the best individual outcome.

This can also be linked to information asymmetry. If by any chance both prisoners received all the information on the different outcomes depending on the chosen actions, the most likely thing to happen is that their different personal utilities would evolve into a unique group utility. Both players would decide to collaborate, as they possess all the information available in the game.

However, if the information was unidirectional and only one prisoner knew all the information, the most likely thing to happen is that one prisoner would remain silent hoping for collaboration, while the other one (who holds the information) would defect hoping to get the minimum sentence. This would leave one prisoner with the best outcome and the other prisoner with the worst outcome. When this is laid out, it seems that the prisoners' dilemma is only a dilemma because both players lack from knowing all the information needed in order to make the most optimal decision for both.

However, perfect information scenarios don't always lead to collaboration. As seen before in the product launch example, with limited information available the most likely thing to happen is that both companies launched their own products. Nevertheless, if this situation was informationally symmetric, the companies would not collaborate (as seen in the prisoners' dilemma example) but compete. Both companies would hurry to be the first company to launch a product, so they could obtain the most favorable individual outcome, which essentially was to attract 200 customers.

The Nash equilibrium is a feasible concept for games of perfect information or at least where most of the information is present. However, for games of imperfect information a Bayesian Nash equilibrium is used instead. This is extremely common in auctions where there is no information about the players available. The Bayesian Nash equilibrium is "the strategy profile that maximizes the expected payoff for each player given their sets of belief and given the strategies played by other players" (Osborne, 2000). In summary, Bayesian Nash equilibrium is reached if "there is not strategy that strategy that a player could play that would yield a higher payoff, given all the strategies played by the other players" (Osborne, 2000)

A Bayesian game can be described as the difference in the player's maximized payoffs given their set of beliefs about a state of nature. "A player's beliefs about the state of nature are formed by conditioning the prior probabilities" (Osborne, 2000)

### **3. GAME THEORY AND ITS ROLE WITHIN VENTURE CAPITAL AND START-UP DEVELOPMENT**

#### **3.1 Introduction**

In previous sections, I have given an overview of the venture capital industry as a whole, described the basics of start-up development and generally explained game theory dynamics and elements.

The fascinating thing about game theory is that an entrepreneur does not need to know about it, in order to act accordingly to it. Entrepreneurs carefully think about different factors such as competition, obtaining their most fulfilling outcome or act according to their preferences, and they don't necessarily know about game theory. Now, it is interesting to put these concepts together and understand how game theory acts within players who are trying to develop a start-up.

During the development of a start-up, many key milestones (such as the funding or exits) require a decision making guided by considerations such as the competing players, the operating market, the strategic positioning, the desired outcome and the individual preferences. Here, the entrepreneur must consider all of these and develop a strategy that will position their new venture in the market successfully. Here is where entrepreneurship and game theory intertwine to scale an idea into a tangible product, into a new venture and, hopefully, into a profitable long-lasting business.

#### **3.2 Funding, principal-agent relationships and game theory**

It is relevant to remark that interactions in the venture capital world can be zero-sum (non-cooperative) or non-zero-sum (cooperative) interactions. Zero-sum interactions involve direct competition with fixed total benefits as, the gain of one player directly corresponding to the loss of another. On the other hand, in cooperative interactions, players will try to achieve their desired payoffs, while also adding value from the interaction with other players. In an investor-entrepreneur relationship, it is easy to fall into zero-sum interactions, even though cooperative interactions tend to be more beneficial for both parties, as it entails value creation (Almanza, 2021)

For example, let's say that two similar start-up firms want to pitch to the same VC company to obtain funding. The firms will have no intention of cooperating between each other, but they will try to exploit their possibilities to get their desired payoffs before the other startup does. If one start-up anticipates and poses a lower valuation, the other will react similarly.

Another interesting topic that relates start-up funding and game theory is the start-up's choice of funding. Let's investigate how decision-making processes and behaviors develop in the case of a growing company. In order to seek investment, the most typical sources in the venture capital world are either traditional funding sources, angel investors or venture capitalists. As discussed previously, traditional funding sources are expensive and scarce for companies of this nature, so the possibilities are reduced to angel investors and venture capitalists (Fairchild, 2011).

One would assume that a start-up will be more likely to choose venture capitalists as investors, as they have the expertise and are more sophisticated than angel investors. However, as demonstrated by Richard Fairchild in "An entrepreneur's choice of venture capitalist or angel-financing: A behavioral game-theoretic approach", start-ups are more likely to rely on angel investors rather than venture capitalists. This ultimately means that the decision that maximizes payoff for the entrepreneur is to have experts (venture capitalists) working alongside them, but they still choose a less beneficial option by working with angel investors. Researchers in this paper saw that this was mainly caused by the fact that angel investors focus on building relationships based on trust, creating a "warm-glow" feeling in the entrepreneur, that drives them to choose an angel investor over a venture capitalist, despite the fact that this will not lead to their maximized and desired payoff.

This draws an extremely important remark, as two of the main assumptions laid in game theory ["(1) all economic agents will normally act in accordance to maximizing their fulfillment, (2) all agents are assumed to act with rationality" (Ross, 2014)] are tore down by this research paper.

"The players will always choose that strategy that gives them their maximized payoff or result" (Ross, 2014). However, this seems not to be the case. I draw two explanations to this; the first one is that usually game theory models fail to include the fact that players within a game are human, emotional beings driven not only by rationale but also by feelings. Secondly, players might be more likely to rely on feelings rather than rationale when there is no information available. Going back to the previous example, the entrepreneur probably does not know which investor is best because there might not be enough information available about their past performance and client satisfaction. Therefore, the player (in this case the entrepreneur), might be guided by their feelings and sense of trust towards the investor, rather than the rationale that venture capitalists are more sophisticated than angel investors.

### **3.3. Moral hazard and adverse selection**

Another inefficiency to be exploited in the entrepreneur-investor relationship is the fact that normally the entrepreneur has more information than the investor does about the product. As it is widely known, only a few ventures are successful in the venture capital world. In fact, only five out of ten start-ups “succeed”, meaning that the chance to fail is a fifty percent. Here, the start-up is the entity who fully knows whether what is being offered is valuable or not and its shortcomings. But the start-up is also the one pitching the product, so it can always select the most convenient information, even if it is not the most realistic one. Therefore, this one-sided flow of information makes it challenging for investors to differentiate between low-quality products and high-quality products, taking game theory to the start-up’s advantage. This is what is called adverse selection, phenomenon in a game where one player (start-up) has relevant information that the other player does not (investor). In order to tackle this, investors hedge adverse selection’s risk through due diligence processes, high hurdle rates or staged financing (Mishra & Zachary, 2014)

As a venture capital project develops, more information is unveiled to the investor. However, at the beginning one party might take more risks that impose added costs to the other party when the other party has no control over the initial party’s actions and information. This poses the perfect scenario for moral hazard, determining the dynamics of principal-agent relationship. In order to obtain initial funding, moral hazard can be effective to the entrepreneur as the investor has limited information to their disposition. However, as the project develops and more information is available to both parties, the investor begins to form an idea on the idea’s legitimacy and the other players’ intention. Funding in venture capital is a dynamic process; it has multiple rounds of financing and check-ups. Therefore, the strategic interactions between the investors and the founders will likely evolve over time. Moral hazard is a key aspect in these strategic interactions, where both parties will realize the likelihood of opportunistic behavior from the other party, which will ultimately affect future potential rounds of financing. This is important because it will be key for determining when to keep on developing a project or giving a project up (Bergemann & Hege, 1998)

To assess these issues from early on, there are many ways in which investors can indirectly subtract information from the start up. One way is through the different closures in contracts, specially within equity stakes, as the interests and intentions the start-up has, shows the trust that they have in their own project, showcasing the information the investors do not have. An example of this is vesting schedules, which dictate the evolution of ownership over time. If an entrepreneur decides to leave the venture prematurely, unvested equity could be forfeited. This action encourages commitment and interest alignment for both players, reducing the risk of opportunistic behavior. Another way is

through the implementation of convertible securities to potentially convert the stock into equity in a future. This hedges moral hazard as VCs will not be fully committed to the project until the entrepreneur achieves certain milestones. This way, if an entrepreneur refuses to accept these closures, this gives the investor the idea that the startup might be hiding information on the shortcomings of the product. (Bergemann & Hege, 1998)

### **3.4. Exits**

As it is widely known, the main exits strategies in the venture capital world are either through sales or through a public offering. The rationale and decision making behind on why entrepreneurs and venture capitalists choose the first or the latter, has been scarcely studied but it can be directly tied to game theory dynamics.

The main ways to exit in venture capital are mergers, buybacks, IPOS and liquidation. The most profitable companies usually choose IPO as an exit strategy while the low profitability companies usually use sales as an exit strategy. The unprofitable companies usually opt for liquidation processes (Bayar & J. Chemanur, 2006).

Over the last few years, the desire to be acquired rather than to do a public offering has risen, showing the costs and risks of undergoing a public offering strategy are much higher than an acquisition strategy. Given the fact that many small companies who go public are acquired three years later, it has become interesting to understand why companies would choose public offering strategies rather than selling the firm. Some research indicates that the main reason behind is the fact that IPOs allow for higher valuations (Bayar & J. Chemanur, 2006)

The main motivations for an exit are often related to either a desire to satisfy personal liquidity needs, to raise new equity to grow the project or both. These motivations and final decisions made on the exit strategy usually fall under two personas: the entrepreneur and the venture capitalist. There can be three feasible situations; the choice falls only under the entrepreneur, under the venture capitalist or they both cooperate and find an exit strategy that benefit both. However, this is where game theory comes in; the venture capitalist and the entrepreneur will potentially have different interests, leading to a process that can reach an equilibrium for both, or one player will end more benefited than the other. This is why many firms decide to go for IPOs and get acquired a few years later, rather than directly selling the company from early on; the final decision making depends on the different interests of the parties, the decision power of the parties and the information possessed by each party. According to the paper "IPO or acquisitions? A Theory of the Choice of Exit Strategy

by Entrepreneur and Venture Capitalists” by Onur Bayar and Thomas Chemmaur there are five important factors that drive the firm’s equilibrium choice between IPOs or acquisitions: 1) The probability of success in product market competition (smaller companies will have higher barriers of entry than established firms), 2) the information asymmetry about this probability of success, 3) synergy probability, 4) valuation benefits, 5) entrepreneurs will seek an exit that gives them financial and control benefits while the venture capitalist will solely focus on financial benefits.

As discussed previously, moral hazard and adverse selection are two of the main challenging factors in venture capital, fueled by the asymmetric information nature. This dynamic interplay of strategies extends across the entire venture capital life cycle, influencing each stage in the circular process. Therefore, the impact of moral hazard and adverse selection practices also reaches the last phase of exits, within the venture capital landscape (Yuan, 2021).

## **4. TRADE & WORKING CAPITAL'S JOURNEY ON START-UP DEVELOPMENT: HOW GAME THEORY CAME INTO PLAY**

### **4.1 Introduction**

Given the previous introduction to game theory, venture capital and specifically the process of start-up development, I have decided to analyze how all the theory might look like in a real life-example. How the prospective market, competition, funding opportunities, and strategies of cooperation/non-cooperation are affected by the information available, the different options at hand and, therefore, the rational thinking process taken by the entrepreneur.

To do so, I have decided to interview Baihas Baghdadi, founder and CEO of Trade & Working Capital Financial Services (TWC). This way, I could truly understand his rational process during the development of the venture and what strategic considerations he took into consideration when deciding the steps of the development process.

### **4.2 Trade&Working Capital Financial Services Overview**

#### **4.2.1. What's Trade&Working Capital Financial Services?**

Trade&Working Capital Financial Services (TWC) is a non-bank financial institution specialized in working capital solutions to complement banking product offerings. It was founded in 2019 by Baihas Baghdadi in Madrid, with the main purpose of being a second alternative to financial solutions for companies, complementing the traditional financial institutions like banks. TWC is a solid partner for companies, capable of offering flexible solutions in short time frames in an agile manner (Trade Working Capital Financial Services, 2024)

#### **4.2.2 TWC's services and products**

The main services TWC offers are related to optimizing their clients' current assets and improving their balance sheets by supporting their business expansion in a healthy and balanced way. They do so by reducing the burden of the accounts receivables of the balance sheet, accessing to immediate liquidity through the discount of their receivables, covering the insolvency risk of their debtors, improving their financial ratios and optimizing the treasury cash management. (Trade Working Capital Financial Services, 2024)

Their current products are divided into two branches: current assets for customers and current assets for suppliers. For customers, the main goal is to help clients achieve their current goals as fast as possible in the right way, encouraging their growth. To do so, TWC offers flexible solutions to



accelerate the corporate's cash conversion cycle, converting the accounts receivables in cash in a flexible and agile way. TWC helps its clients increase their turnover without having to worry about terms of payment and gives them access to reliable and cheaper funding, to support the company's growth without putting the company's liquidity at risk. (Trade Working Capital Financial Services, 2024)

In relation to suppliers, TWC helps its clients improve their negotiation power with suppliers. TWC helps corporations buy and plan their treasury, expanding their payment terms without harming the financial needs of the suppliers. This way the suppliers of TWC's clients can convert their invoices into cash at any time, without hurting their leverage and without the need of using banking institutions. (Trade Working Capital Financial Services, 2024)

#### 4.2.3. TWC's milestones

Since its foundations, TWC has focused on offering flexible and personalized financial solutions, positioning as a complementary alternative to banking institutions. In fact, the company has recently opened a second office in New York, United States. TWC has also committed to integrate and improve new technologies and innovative processes, to improve the efficiency and efficacy of their financing solutions. (Trade Working Capital Financial Services, 2024)

### **4.3 Overview of the industry**

Trade&Working Capital Financial Services operates within the financial services industry, specially focusing on non-bank financial activities related to trade finance and working capital solutions. This industry is relevant for companies that need to manage their cash-flows, finance their inventory and make sure they have enough funding for their daily activities without the constant need for financial institutions' help (Trade Working Capital Financial Services, 2024).

The main solutions offered within the trade finance and working capital sector include financial products such as lines of credit, factoring or invoice financing. This industry has shifted a lot during the past few years due to the consolidation of big financial institutions, and the increasing evolving technology. This has disrupted the industry in a way in which clients demand for quicker and more effective solutions. Besides, as there has been more financial consolidation among banks, this has reduced the number of players in the industry allowing for a big gap in the market (Lown et al., 2004). Over the recent years, this gap has been filled with institutions that have served as substitutes or complements to traditional financial institutions, such as TWC.

Also, since the pandemic, this industry has suffered from high interest rates and stubborn inflation which has increased the intrinsic cost of traditional lending. Even though, these current events have affected most institutions, it has opened a great opportunity for those companies who serve as an alternative which can offer cheaper credit options than banks (JP Morgan, 2024). As stated by TWC, “we are witnessing a revolution in the banking industry that comes two centuries after the industrial revolution, with disruptive ripple effects. The impressive new technology is allowing for real time processing and access to information, but it is having its direct negative impact due to the huge losses of jobs in banking. During these turbulent days in the banking sector, corporate clients are struggling to keep their business cash flow cycle alive with the subsequent slowdown impact on the economy” (Trade Working Capital Financial Services, 2024).

TWC competes with bigger institutions due to the nature of the lending industry in Spain and also due to its competitive advantages. In the US, the existence of companies that serve as alternative financing are highly common whereas in South Europe there still exists a big gap in the market, as there are only a few companies tapping this need of alternative sources of financing. When I interviewed Baihas, he explicitly explained that when he started his start-up, he saw a gap and a need in the market that few companies were addressing in Spain. He believed it was a great niche market to operate in, as it hadn't been developed enough in Spain even though it is a traditional service (Trade Working Capital Financial Services, 2024).

However, TWC does not only stand out among the competition due to the nature of the Spanish lending industry but also due to its main competitive advantage: flexibility and speed of action. Clients truly value the effectiveness and quickness of a lending institution, as they seek instant cash availability. Specially within the working capital and receivables specialization, clients who go to companies like TWC looking for financing, are truly seeking a quick solution to obtain cash and keep on growing their business while possibly relieving the current debt they possess. TWC's entry to the market contributed to a trend of specialization in the financial services industry, also reshaping the way in which Spanish businesses manage their working capital, short-term debt and their operations' financing. All of these financing firms heavily rely on their ability to trade fluidly and be efficient in their capital use, factors that make TWC stand out among the competition. (Trade Working Capital Financial Services, 2024)

#### **4.4 Methodology of study**

To carry out this study, I decided to interview Baihas Baghdadi, founder and CEO of TWC. Baihas is a great example, as he has built up a start-up from scratch and has had to go through a rational thought process and decision making that is interesting to analyze to see the different preferences and ways of acting of players in a market. TWC has enormously developed through the years but it is still a privately-owned, small-sized, family company. I considered that interviewing a founder of a company this size was key, as it is a great representation of the Spanish market, where most companies are small-middle sized. Interviewing a founder of a bigger company, apart from being extremely difficult, would not have been as insightful for this study focused on the development of a start-up and venture capital dynamics.

In order to study the relationship between Baihas' experience and game theory, I chose a set of questions divided into three different sections: competition&strategy, funding decisions, strategies of competitive vs cooperative games. For the interview to be dynamic, I decided to reduce the number of questions to seven, so Baihas could go in depth and deeply explain each one of the points. The questions proposed were the following:

##### **Competition&Strategy**

- Before founding TWC, how was the existent competitive market for TWC analyzed and decided upon?
- How much information asymmetry is there in your sector and how has that affected your decision making?

##### **Funding decisions**

- When seeking funding, did TWC pursue financing from angel investors, VCs, or other resources? What factors affected this decision?
- Why do you think your clients prefer to come to you in search of financing rather than traditional funding resources, when your interest rates are usually higher?

##### **Strategies of competitive vs cooperative games**

- During the development of TWC, did TWC adapt its strategy to strategic movements from the competition? How does TWC cope with the competition's changes in tactics and strategies?

- Has TWC ever thought about collaborating with other players in the market, instead of directly compete with them?

To better listen and fully grasp all the insights given by Baihas, the interview was recorded and later transcribed for the purpose of this thesis.

#### **4.5 Results from the study**

In this section, I will draw the insights given by Baihas and reach some main conclusions. All the information mentioned below will exclusively be taken from Baihas' interview.

Before directly referring to the questions, Baihas gave me a quick overview of the company, stating that he was specialized within the working capital and receivables needs. He also highlighted and heavily emphasized that TWC was not devised to be an alternative to traditional funding resources, but a “complementary service” to traditional sources of financing. Now, I will provide the answers to the different questions made:

*Competition&Strategy: Before founding TWC, how was the existent competitive market for TWC analysed and decided upon?*

Baihas had a successful career path as a Global Head of Trade & Working Capital at Barclays, so he had the expertise and knowledge to build TWC. However, the first thing Baihas did before analyzing its competition was to study the national market he wanted to operate in. After all his years in the banking industry, he realized that “complementary lending” was a really traditional product, but it was not heavily mature or developed in Spain. He saw an opportunity, an untapped market that was not supported by banks. For instance, he explained how banks usually don't support companies when they perform badly or don't provide easier solutions to growing small companies. In general, banks do not offer reliable and quick solutions to start-ups and this event is often seen in Spain, where the banking and lending industry is rather traditional, old-fashioned and risk averse. Therefore, he decided to build a company that could offer a quick and efficient service that was not trending in Spain/South Europe at that time, having little direct competition. By analysing the national market, he also analyzed his direct competition, which was little, in comparison to the competition within other sectors.

Baihas also emphasized that there was a great period of research and development to launch his service. He explained that in the sector he wanted to operate in, it was not reasonable to launch a product to the market that was not refined and perfectly designed. He explained how in other sectors,

such as the technological sector, it is more reasonable to launch a poor product and improve it, to get ahead of competition. For example, Microsoft and Apple launch a product and then they launch different versions with improvements. They do this because in the technological sector, companies are heavily competing against each other and are in a constant race in which the company to launch the first innovative product wins, no matter the refinement of the product. However, Baihas explains this dynamic to be different in the lending services sector. To beat the competition, he didn't need to be the first in doing this service, but he had to launch a service that was effective, refined, flexible and fast.

Baihas analyzed the national market, the competition and the nature of his offering and concluded that the best he could do to beat competition was to spend time creating and bringing to life the most fitting product to the demands of his potential clients. The most important conclusion being made here, is that depending on the nature of the market, and the needs and demands of your clients, the strategy to beat the competition will have a completely different pace and procedure. For technological companies it might be to rush and be the first in launching a product, but for traditional services the best strategy might be based on waiting, researching and developing the perfect product.

*How much information asymmetry is there in your sector and how has that affected your decision making?*

When responding this question, Baihas gave a truly striking perspective to the concept of information asymmetry and explained that its general understanding had to be deeply refined, as it does not mean the same now as it did fifty years ago. According to Baihas, information asymmetry does not exist anymore in the sense of unbalanced information distribution among players. According to Baihas, the situation of one player having all the information (therefore a competitive advantage) and other players having no access to information at all, no longer exists.

In today's world, everybody can have access to all types of information and, according to Baihas, there is not a lack of information but way too much inflow of information. He reinforced that, in a world where there is an excess of information, the asymmetry of such should now be seen as the uncertainty of not knowing how to differentiate between relevant and irrelevant information. To put it in simple terms, information asymmetry used to be related to a lack of access to information and now it is related to having access to the greatest inflow of information (both useful and useless) ever seen in the history of humanity. And here is where the problem is.

He concluded that this information asymmetry has affected him in the sense that he had to spend more time learning how to filter and choose the information of interest for TWC. However, he also explained that once he learnt how to filter said information, the asymmetry of such became an advantage rather than a setback.

*Funding Decisions: When seeking funding, did TWC pursue financing from angel investors, VCs, or other resources? What factors affected this decision?*

During the development of the interview methodology, I thought it would be interesting to present this question to Baihas, as through the funding decisions made and the rational thought process underneath it, I could truly analyze how the deepest desires of the individual influence their ultimate financial decisions.

Baihas' answer surprised me as he did not choose those funding sources that could maximize the growth of his company, but the one that aligned with his needs and long-term desires better. When he decided to start the company, he raised funds from his family and friends which gave him enough allowance to develop the start-up. Later on, he had the need to raise further funds from larger investors and here's where he had to make a decision: angel investors, VCs, seed investors?

Baihas did not seek angel/seed investors funds or VC funds, even though he knew these ones would boost the firm's performance and growth. The reason why is mainly because these institutions/individuals' interests didn't align with his. Baihas wanted to manage his company and he also wanted her daughters to manage it in a future. Even though he wants to create a successful start-up, his main purpose is not only the monetization TWC can bring, but to create a long-term legacy for his family. Therefore, as banks don't usually fund start-ups, Baihas decided to look for financing within institutional investors (pension funds, credit unions, endowments, hedge funds....) He concluded this question by saying that every single step of the start-up development process when has to be carefully meditated, from the business plan to the investors and funding chosen. Baihas knew that he did not want to choose the greediest or more financially beneficial funding source, but one that aligned with his long-term strategy and what he wanted for the future of his company.

This question draws deeply interesting insights in relation to the depth and significance of game theory. First of all, it is truly enlightening to see how a (what seems) banal action such as choosing the funding source, can reveal and shed light on an individual's rational thought process and deepest desires. With only one piece of information, analyzed and looked upon carefully, an individual's main preferences can be mapped and understood. How one simple action such as

choosing institutional investors rather than angel investors, provides more information about the individual than could be imagined.

Another pattern that kept repeating when researching papers, is that game theory models often fail to consider and give importance to all the subjective factors that go underneath every single step of an entrepreneur's decision-making process. For example, the prisoner's dilemma example concludes that both players reach the Nash equilibrium by choosing the option that gives them the most beneficial result for both players (less amount of years in jail). However, in real life, choosing the option that gives you the best financial results (in this case) is not always the most fulfilling outcome for the player. There are so many underlying, and even unconscious, needs, biases and long-term aspirations that will more likely determine the outcome of a decision and that are not measured by game-theoretical statistical models.

*Funding Decisions: Why do you think your clients prefer to come to you in search of financing rather than traditional funding resources, when your interest rates are usually higher?*

Just as I was interested in knowing the rational thought process that Baihas went through when making a funding decision, I thought it would also be interesting to know his clients' rational thought process. Strong needs and preferences that go against what seems to be the most rational option, must drive an individual who seek alternative investment to banks, as this form of funding usually demands higher interest rates and risk.

First, Baihas responded that his business was supposed to be a complementary source of funding to traditional funding sources, not an alternative. Therefore, he did not want his clients to rely on him as the only source of funding. In fact, Baihas is very careful with the clients he interacts with and explicitly said that "he would never collaborate with a client that does not compliment his service with traditional financial services". When I analyzed this, I thought it was truly intriguing as the different clients' funding portfolio, gives Baihas an idea of the clients' expertise, thought processes, desires and needs. To make it more specific, if a client comes to TWC looking for their services as their unique source of funding, Baihas instantly gets information on how the other player thinks and meditates his actions. If the driving needs of the second player (the client) don't align with TWC's main purpose, the most likely thing is that Baihas won't collaborate with such client.

Strategies of competitive vs cooperative games: during the development of TWC, did TWC adapt its strategy due to strategic movements from the competition? How does TWC cope with the competition's changes in tactics and strategies?

Game theory in economic markets is about players reacting to each other's strategies and actions in a sensible way that aligns with the main purpose of one's personal business. In sectors where the competition is high, such as the technological sector, competitors fight to reach the most innovative product and companies usually change their tactics and strategies when their competitor beats them with a new competitive move. Even though this dynamic depends on the nature of the sector, I asked this question to Baihas, so he could give me a small insight on how he reacts to the movements of his competition.

It was interesting to see how Baihas didn't allow himself to be guided by competition, even though he recognized the importance of considering it, to be successful. TWC keeps track of the competition's latest advancements and piggybacks to the technology or processes that Baihas thinks will be beneficial for his company.

However, he heavily stated that he won't change his long-term strategy because of the moves the competition might make. He reiterated that the financial services sector is not as competitively hot as the technological sector or start-up sector, so the reaction to the competition does not have to be immediate in order not to be left behind. In the financial services sector, the development of a company is slow, requires past performance and is built on trust. It is more important to have a clear objective and a set long-term strategy, rather than constantly adapting to the changes made by the competition. Besides, in the sector that TWC operates in, innovation is not as highly present as in other sectors as the product offered is highly homogeneous. What differentiates one company from the other, is the way in which they deliver the product, not the product itself. Therefore, after taking all of this into account, Baihas stated that, above all, the best he can do in respect to changes made by the competition, is to stay updated but also stay truthful to his final mission and not deviate from his long-term strategy.

Strategies of competitive vs cooperative games: Has TWC ever thought about collaborating with other players in the market instead of directly compete with them?

As shown previously in the theoretical study, in certain occasions the way to reach Nash equilibrium is not always by directly competing and achieving the best individual benefit, but by collaborating with other players. In order to see this displayed in real life, I asked Baihas whether he



has ever considered the idea of collaborating with different partners instead of aggressively competing against them.

Baihas stated that he had thought about collaborating with other companies across Europe and the US, and he expressed his belief that collaboration in his case is a higher driver for success rather than competing. Besides, this desire for collaboration is not only due to his own preferences but also because he believes that in the medium-long term the market is going to keep on consolidating further. After this, I was also curious to know what are the different factors he took into account when choosing a partner; does he care about objective factors or more subjective factors? What ultimately drives an individual, such as Baihas, to partner with player A and not player B?

According to Baihas, the first factor that he considers when choosing a partner is the tracking performance, career path and also the result of the due diligence process. However, he stated that the most important factors he considered were often not objective, but rather subjective. He places more importance on factors such as the trust built, or the relationship formed with a partner rather than their knowledge or performance. He also stated that he prefers to do business with somebody with whom he connects personally rather than with a partner that has great knowledge but no personal chemistry. Baihas said, “It is much better to close the right deal at the wrong price rather than the wrong deal at the right price”. Through this sentence he explained that, even if his partners were not the best ones in the market, he preferred partnering with professionals that aligned with his personality and interests in the long term, as this is what will maximize value in the long term.

Personally, I found this truly interesting as it is a real-life example of one of the papers mentioned previously in the theoretical background, “An entrepreneur’s choice of venture capitalist or angel-financing: A behavioral game-theoretic approach” by Richard Fairchild. In this paper, the author talked about how start-ups and entrepreneurs often chose those investors that focused on building trust and gave them a “warm-glow” feeling, rather than those investors that had better performance metrics. This ultimately means players’ decisions are often more guided by feelings and intuition, rather than objective facts or financial performance ratios.

Just as the paper studied, Baihas also chooses his partners based of different criteria than what researchers might expect. In game theory, the players reach an equilibrium when they find the best outcome possible for both players, based on the assumption that players will choose the path that will lead them to the best outcome and will only consider those intermediate factors that will lead them to said outcome. However, as we have previously seen, sometimes players guide themselves by factors

that might not lead them to the best possible outcome but that they weight to be more important to them personally.

## **5. MAIN CONCLUSIONS**

As stated in the introduction, when I began this study, I thought I would reach conclusions on how start-ups interact between each other and would find a statistic model that would predict it. However, what I found, through personal experiences and papers in start-up development, were two main issues that challenged the most basic assumptions of game theory.

The first issue is the assumption within game theory that all players will choose the path that will give them the best outcome no matter what. The problem with this assumption is not that it is wrong, but that some terms within it miss important factors. For instance, often in game theory “best outcome” refers to a “physical, objective and measurable” outcome such as earning more money, getting less years in jail, beating the competition, etc. However, as seen in the interview with Baihas, sometimes the best outcome for a player is unmeasurable and subjective. Sometimes the best outcome for an entrepreneur is to create a long-lasting project that can be passed on to their children. The problem with game theory models is that they have no way of measuring these kind of factors because these are not quantifiable. Of course, a lot of players are driven by objective preferences, but they are also driven by sentimental, unquantifiable preferences that, in fact, seem to have more importance and relevance when the player has to make a decision.

Therefore, what do game theory models predict? Game theory models predict the interaction between players based on a dangerous assumption; that such players are rational machines rather than heavily emotional beings. There is an important bias in game theory, in which the players are reduced to have clear and simple preferences when in real life, human psyche is incredibly complex, and preferences can quickly change. This does not mean game theory and its statistical models are wrong but that it should always be considered that there is a degree of uncertainty closely related to the complexity of each player’s cognitive process that is unmeasurable and can’t be modelled.

The second issue was previously mentioned and is the assumption of information asymmetry that game theory models have. Even though the flow of information within venture capital is incredibly different to other sectors, information asymmetry is no longer what it was before. With the rise of the internet and social media, information has become widely available to everyone. Decades ago, information asymmetry referred to an unbalanced distribution of information among players due to a lack of information. However, nowadays, this unbalanced distribution is not due to a lack of information but due to an excess of information availability. Now the problem is not who is in possession of relevant information, but which player is able to discern between relevant and irrelevant information and create a competitive advantage out of it. I have not found any article or game theory

model that includes information asymmetry as an excess of information rather than a lack of information, which is concerning as it is one of the founding factors within game theory models.

## **Declaración de Uso de Herramientas de Inteligencia Artificial Generativa en Trabajos Fin de Grado**

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Por la presente, yo, Ángela Oliver Grosso, estudiante de E2 Bilingüe de la Universidad Pontificia Comillas al presentar mi Trabajo Fin de Grado titulado “GAME THEORY IN VENTURE CAPITAL AND STARTUP DEVELOPMENT: HOW ENTREPRENEURS CHALLENGE THE ASSUMPTIONS OF GAME THEORY THROUGH PERSONAL EXPERIENCE” declaro que he utilizado la herramienta de Inteligencia Artificial Generativa ChatGPT u otras similares de IAG de código sólo en el contexto de las actividades descritas a continuación [el alumno debe mantener solo aquellas en las que se ha usado ChatGPT o similares y borrar el resto. Si no se ha usado ninguna, borrar todas y escribir “no he usado ninguna”]:

1. **Brainstorming de ideas de investigación:** Utilizado para idear y esbozar posibles áreas de investigación.
2. **Corrector de estilo literario y de lenguaje:** Para mejorar la calidad lingüística y estilística del texto.
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5. **Traductor:** Para traducir textos de un lenguaje a otro.

Afirmo que toda la información y contenido presentados en este trabajo son producto de mi investigación y esfuerzo individual, excepto donde se ha indicado lo contrario y se han dado los créditos correspondientes (he incluido las referencias adecuadas en el TFG y he explicitado para que se ha usado ChatGPT u otras herramientas similares). Soy consciente de las implicaciones académicas y éticas de presentar un trabajo no original y acepto las consecuencias de cualquier violación a esta declaración.

Fecha: 4 de Junio de 2024

Firma: \_\_Angela Oliver Grosso\_\_

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