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Language Learning and Profit-Maximizing in the Metaverse

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ABSTRACT

This thesis analyzes potential language learning benefits from metaverse software and optimal prices for metaverse-related products, such as virtual reality (VR) headsets. The metaverse is a virtual space that is created by the convergence of physical and virtual reality, enabling individuals to interact not only with each other, but also with digital objects in a three-dimensional immersive environment. Its recent growth has been consistent with the growth of previous groundbreaking technologies, such as computers and smartphones. This definition and its predicted growth will be further explored in my paper.

Undergraduate and graduate students were surveyed to find the optimal price that firms should sell their VR headsets and other equipment. This led me to construct graphs and model a Cournot Oligopoly that has been adjusted for the varying number of firms in the market. I calculated the optimal price of the monopoly to be \$466.80 and \$375.19 for the Cournot Oligopoly firms.

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Chapter 1

Introduction

Background

The motivation for this topic stemmed from my interest in foreign languages and technology. I wanted to see the correlation between the two; does interest in foreign language have any relation with the metaverse, the future of the internet and technology? There have been a few studies analyzing the relationship between the metaverse and education or gaming, but due to the modernity of the metaverse, there has not been much literature on the relationship between the metaverse and foreign language. My research seeks to be one of the first literatures analyzing their relationship by applying a Cournot model to the willingness to pay of each consumer and finding an optimal price of a VR headset.

In the fall of 2021, Facebook officially changed its name to Meta to reflect the company's ambitions beyond social media and into a virtual world. Before the change, Meta mainly grew through social media platforms such as Facebook, Instagram, and WhatsApp. However, Meta was not the first company to delve deep into the unfamiliar territory of the metaverse; there have been numerous companies, such as Nintendo, NASA, and Google who have created products that alter reality. Each of the products had different purposes, whether for research or play, but they were all innovative ideas that paved the way for Meta to develop their new products. Currently, more and more companies are segmenting part of their business (or the whole business) toward virtual reality and metaverse products and marketing. It is expected that virtual

reality and metaverse products have the potential to boost GDP globally by \$1.5 trillion by 2030(Gao, 2022). With the wide range of benefits that the metaverse provides, ranging from reducing risks during medical training to speeding up product design and delivery, there are endless benefits that this industry can provide.

From an economic perspective, the metaverse can revitalize many segments of the economy. Before the metaverse became a more tangible world, the World Wide Web took some of the costs out of industries such as music, travel, and shopping(Gao, 2022). Perhaps the most important gift that the internet brought us was the flow of information. In a matter of seconds, you can learn about anything in the world. Information is easily attainable and has been transformative in the way humans live their lives. On the other hand, the metaverse can touch the parts of the economy that the internet hasn't, such as real estate, conventions, and classroom education (Salvador Rodriguez, 2021). It has the potential to access every market and be even more transformative than the World Wide Web. A popular market that VR has broken into is the Real Estate market. For example, the Oculus Rift allows users to visit houses that they want to potentially buy in a foreign country. Or, if a consumer wants to remodel their kitchen and put in a new granite counter, they can see what it would look like by using this VR headset. There is so much potential with the headsets, and the metaverse can have an impact on countless industries.

Growth Compared to Previous Technologies

Some experts believe that the development of the metaverse will be a significant step forward for humanity, much like the development of earlier technologies such as the cell phone, the internet, and computers (van den Berghe et al., 2019). Like these earlier groundbreaking

inventions, the metaverse will likely be driven by advancements in technology, including virtual reality, augmented reality, and artificial intelligence. These technologies will enable users to enter a virtual world that is nearly indistinguishable from the real world, allowing limitless possibilities for communication, entertainment, and commerce. According to a survey published by McKinsey & Company, around 48% of C-level executives expect to engage in purchasing physical or virtual goods in the metaverse. This survey exemplifies how commerce in the metaverse is leading the way for top executives and is a new world everyone should monitor. Traditional brick-and-mortar businesses will take a hit, and entirely new virtual-based businesses will rise. The opportunities are endless, but companies must be aware of the societal and ethical dilemmas that come with them.

The development of the cell phone, internet, and computers has had a profound impact on the way we both live and work in the United States. For example, cell phones have changed the way we communicate and stay connected, and smartphones have taken that to a whole different level. Ever since the first iPhone was released in 2007, we have seen smartphones make up over 80% of the entire cell phone market in 2021 (Hollensen et al., n.d.). In addition, the internet has revolutionized the way we access and share information, with almost everyone in the United States having access to it. Similarly, the metaverse has the potential to change the way we interact with the world, as it is now possible to create immersive, shared experiences that were impossible not too long ago.

As seen in the following graphics, the metaverse is growing similar to many of the technologies previously discussed. In the graphic of technologies in their first six years as a product, the metaverse seems to be following a trend like the microwave and TV. The

smartphone seems to be an outlier, but it can be considered an update over a previously released cell phone.

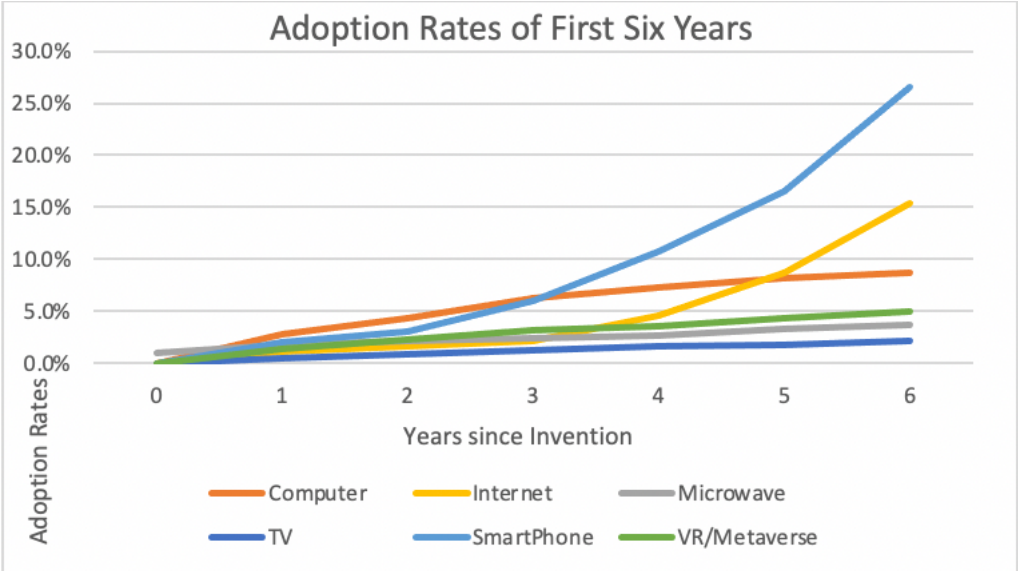


Figure 1. Adoption rates during the first six years of breakthrough technologies

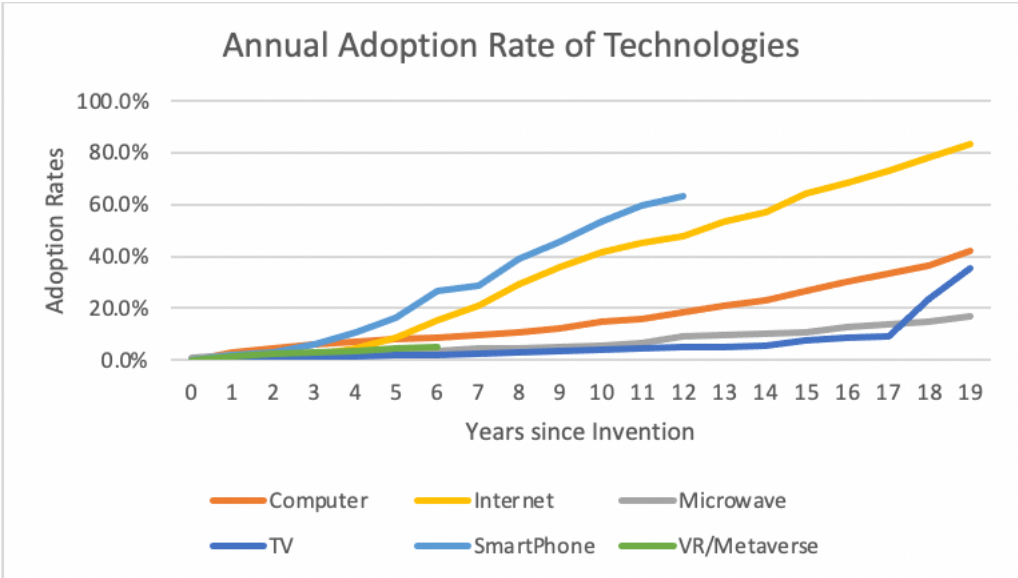


Figure 2. Annual adoption rates since the technology was invented

Two of the most common industries that the metaverse has a foot in the door with after gaming are the fitness and education industries. Over 40% of Gen Z individuals are Very Excited or Excited about fitness and education in the metaverse, as seen in Figure 3 below (Khartukov, 2022). These workouts include 360-degree landscapes, audio, and live interaction of avatars with friends and coaches. There are live classes and pre-recorded workouts, similar to what Peloton has done in the fitness industry. The idea that you can get a very good workout with what feels like in-person instruction is why some companies, such as OliveX, reported over \$20 Million in revenue in just 6 months (Khartukov, 2022). From personal experience, I can confidently confirm that these fitness classes provide a legitimate workout. I tried the *Creed* app on the Oculus Headset and have gotten numerous challenging workouts from boxing all-time legends, such as Muhammed Ali and Mike Tyson. In addition to the great workout, you receive custom coaching after each match. With Artificial Intelligence becoming more powerful, this coaching is scalable for the future and helps fitness users perform better each workout.

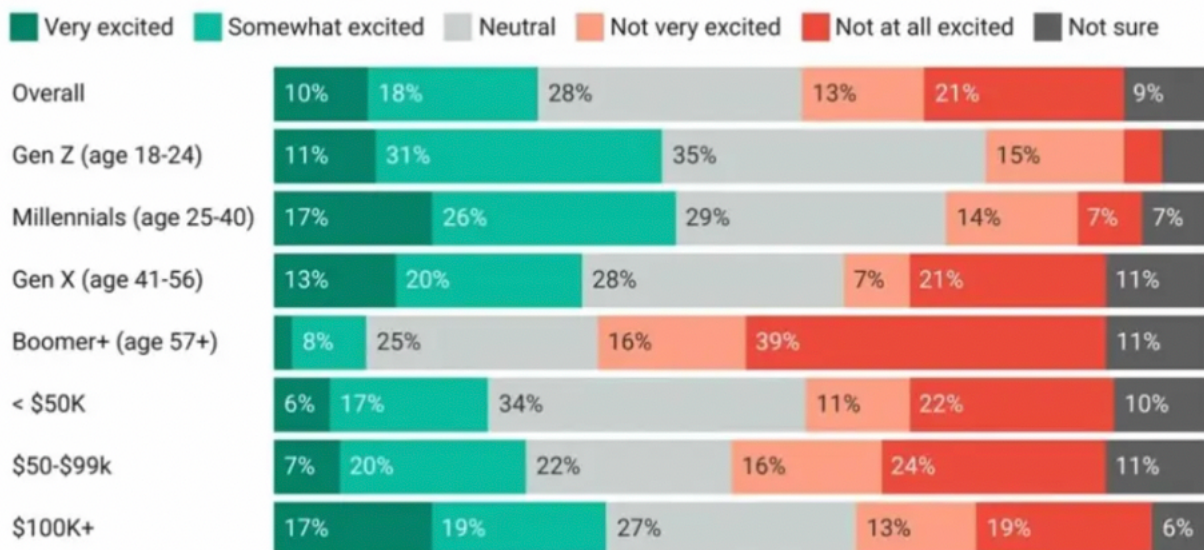


Figure 3. Demographic breakdown of interest in metaverse education & fitness

In addition to the growing fitness space, the education sector of the metaverse is widely popular among consumers. Traditional learning, and even remote learning (which has become traditional recently), incorporates learning that is very static with printed pictures, textbooks, videos, and other materials (Zhang et al., 2022). The metaverse has learning resources that are visualized and decentralized, both encouraging and enabling users to interact more frequently than traditional methods. Instead of reading about the colosseum in textbooks, the metaverse allows students to visit the colosseum in 400 B.C. and truly comprehend its brilliance through gladiator battles and ancient Roman archaeology. Later, in my paper, I break down education into language learning and examine how that will look in the metaverse.

Structurally, I have broken my paper into five chapters. In Chapter 2, I will dive deeper into relevant applications of the metaverse, particularly the ones that the consumers are most interested in: Gaming, Shopping, Education, Fitness, and Real Estate. In Chapter 3, I will go over language learning and tie in how my personal experience manifests the confidence I have in this field in the future. In Chapter 4, I will analyze experimental data from the survey I conducted with Penn State students. In Chapter 5, I will discuss what it takes to create value in the metaverse and grow in the field. Finally, in Chapter 6, I will conclude with roadblocks to consumers accepting the metaverse and its development.

Chapter 2

Potential Applications of the Metaverse

At the forefront of metaverse development is the interactive gaming that it provides. Many tech companies have recognized the large user base that online gaming has, in addition to the extensive infrastructure already in place (Wiederhold, 2022). For years, gamers have been excited about the potential that the metaverse has. Fortnite, a world-building platform created by Epic Games, is one of the most popular games in the market and opened gamers' eyes to potential metaverse games (Garton, 2023). One of the most intriguing aspects of this game is that users can customize their avatars with in-game purchases. The interactive gaming industry as a whole reports that 75% of its revenue is from users purchasing virtual goods such as clothes for their player's avatar (Wiederhold, 2022). The potential for gaming in the metaverse is vast, and it is expected to be a significant revenue stream for companies that develop and operate metaverse platforms.

In the metaverse, players can buy and sell virtual goods and services, such as clothing, weapons, and housing. This creates a new economy that is entirely digital and can generate significant revenue for developers and operators of metaverse platforms. In fact, it is estimated that the virtual goods market will be worth over \$200 billion by 2025 (Li, 2021).

Another potential application of the metaverse is the healthcare industry. Healthcare in the metaverse refers to the use of virtual reality technology to provide medical care, education, and training in a digital environment. There has not been too much done inside the metaverse since this is a new concept, but it is still expected to play a significant role in the future of healthcare (Brown, 2022).

One of the primary benefits of healthcare in the metaverse is the ability to provide remote care and education. With the use of virtual reality technology, patients can receive medical care and education from anywhere in the world. This is similar to how Zoom would operate, but the metaverse allows the physician gain deeper knowledge of an injury or sickness (Brown, 2022). This is particularly useful for patients who live in rural areas or for those who have difficulty accessing medical care due to physical disabilities or transportation issues (Philips, 2021). Furthermore, virtual reality technology can provide a more immersive and engaging learning experience for medical students and healthcare professionals. Another benefit of healthcare in the metaverse is the ability to provide a more personalized experience for patients. In the metaverse, healthcare professionals can create virtual environments that are tailored to the specific needs of each patient. This can help patients to feel more comfortable and relaxed during medical procedures, which can lead to better outcomes (Brown, 2022). Additionally, virtual reality technology can be used to simulate medical procedures, which can help patients better understand what to expect and could reduce anxiety.

Healthcare in the metaverse also has the potential to improve the efficiency and effectiveness of medical care. With virtual reality technology, healthcare professionals can simulate medical emergencies and practice responding to them (Malik, 2021). This can help to improve the skills of healthcare professionals and can help to reduce medical errors. Additionally, virtual reality technology can be used to monitor patients remotely, which can help to identify potential medical issues before they become serious. These immersive environments can help caregivers learn how to care for family members at home, thus leading to improved health literacy and outcomes.

In addition to the applications above, language learning is another potential benefit of the metaverse. It is a promising and exciting new field that has the potential to revolutionize language education. The metaverse offers a unique platform for language learners to practice and improve their skills. One of the primary benefits of language learning in the metaverse is the opportunity for immersive language practice. In traditional language education, students often struggle to find opportunities to practice speaking and listening in real-life situations. However, in the metaverse, language learners can engage in real conversations with virtual characters or other users, which can provide an immersive and engaging language practice experience.

Another benefit of language learning in the metaverse is the ability to learn from native speakers. Many metaverse platforms offer the opportunity for users to connect with native speakers of the language they are learning, which can provide valuable cultural insights and language practice opportunities. This can be particularly beneficial for learners who may not have access to native speakers in their local communities. This can be done on the regular internet, but the seamless interaction and constant feedback that the metaverse allows will prove to be more beneficial than a simple Zoom meeting. In addition, language learning in the metaverse can provide a more personalized learning experience. metaverse platforms can use artificial intelligence (AI) and machine learning algorithms to tailor language learning experiences to the specific needs and learning styles of individual learners. This can help learners to progress more quickly and effectively than in traditional classroom settings because of the extra practice and exposure.

Chapter 3

Language Learning in the Metaverse

Over 30 million people tried to learn a new language in 2020, with Spanish being the top choice for Americans (Dominguez-Noriega et al., 2011). According to the ACTFL, a membership organization for language educators and learners, learning a new language is not only beneficial but necessary for success in life. Globalization grows each day, many thanks to powerful technology and the openness of many countries. Diverse cultures and communities have become more intertwined and interact constantly, both in person and over the internet. I recently had the opportunity to study abroad in Florence, Italy, and got immersed in a completely different culture than the United States. It helped manifest a strong passion that I have not only for different cultures, but also for the many foreign languages that exist in the world.

There are many benefits to learning a foreign language that people are not aware of. Many employers seek students that are at least proficient in another language, as many large companies are global and eager to find students that can navigate different cultures. Also, learning a language has not only been proven to enhance academic achievement, but has also led to cognitive development, enhanced problem-solving skills, improved memory function, and more flexible/creative thinking (Maccallum & Parsons, n.d.). Numerous studies found that the acquisition of a foreign language leads to increased scores on the SAT, in both the English and Math sections. Learning a language is more accessible than it ever has been, and there is no better time to start than now.

Nowadays, there are many ways to learn a new language. One of the more common ways is to take a foreign language course throughout high school and college, and possibly even study the language in its respective country. There were lengthy textbooks full of vocabulary and

phrases that would be helpful for students. However, due to the evolution of technology, there have been more ways for students to learn a foreign language. Recently, Rosetta Stone and Duolingo became prominent in the language learning industry, as they offer tens of different languages to learn through an intensive yet laid-back approach to learning languages. They offer a new twist on learning language, through interactive games, reading stories, and even listening to podcasts. Not only are these more fun ways to learn a language, but numerous studies have proven that these apps lead to some type of comprehension.

Nowadays, inside the metaverse, there are a few apps that VR users can try to learn a language. As of right now, from my own experience, there are not many great options. Some of the modes include situational modes, such as checking in to a hotel or ordering a taxi, or game modes as simple as naming animals. These beginner lessons are similar to what I have seen on Duolingo, but I think language learning in the metaverse could use some reconstruction. A recent game that I have been playing, called Mondly, has a few game modes that are not too fascinating. In the image shown below, the hospitality worker asks what type of room I would prefer, and I have a few responses to choose from in the respective foreign language. Inside the app, I see that there is a multiplayer demo that is soon to come out, and I think it will be much more promising than what is currently offered. There are already so many apps that do what Mondly offers, but actual human interaction will elevate language learning.



Figure 4. Example of Metaverse Language Learning Application

To be a successful metaverse app in enhancing language learning, I believe there needs to be a few adjustments. First, I believe that the multiplayer mode needs to have more interaction between online users. For example, if I was a student interested in learning more French, I think the app should allow me to speak to a student in France trying to help me learn French. Or, a more evolved robot that could interact with the student would be very effective. Either way, allowing a user to have actual interaction leads to a completely new world of language comprehension. It has always been a challenge for language instruction and applications on smartphones to implement a more interactive way of expressing language (Golf-Papez et al., 2022). With the metaverse, it is now a reality for different language speakers to interact without being with each other.

The development of robots has proved to be very beneficial to the language learning field. Computers, tablets, and smartphones offer unlimited possibilities for language learning,

mainly due to their automatic speech recognition programs, instructive virtual programs, and various chat programs. It has made language learning accessible from pretty much anywhere, at any time. It is no longer necessary for in-person instruction to learn a foreign language, which I believe is an awesome benefit of the developed technology. In 2014, social robots began teaching foreign languages to students in Japan, and the results were better than expected, with the average student learning 4 of the 6 phrases asked in the post-test examination (Lee & Hwang, 2022). Ever since then, the robotics industry has taken off, with billions of dollars invested in it each year (Lee & Hwang, 2022). Inside the metaverse, the robots will eventually be able to have full conversations with VR users, leading to even more advanced knowledge of the language. There is infinite potential due to the mass research going on in robots and the metaverse.

The Center for University Education at Brookings believed that at first, the metaverse would have a major negative effect on learning (Buhalis et al., n.d.). In their article, they state that the education system would be completely interfered with and the metaverse would only benefit as a gaming platform. This was in early 2021, but the CUEB and other educational institutions have changed their minds about what the metaverse can mean for younger generations and learning. Since Duolingo and Rosetta Stone laid the groundwork for learning outside of a classroom, the metaverse has a lot of room to expand upon what those applications did well and what did not work out as well (Hwang & Chien, 2022).

Rosetta Stone became very successful ever since the company was founded in 1992 (Rosetta Stone). They were the top way outside of a classroom to learn a foreign language, and they were among the few to break into the industry as well (Mystakidis, 2022). When Duolingo was founded a few years after them, they gave them a real run for their money. Duolingo introduced shorter lessons and a very functional mobile application, while Rosetta Stone built its

foundation with more in-depth lessons on the internet. Comparatively, Rosetta Stone has the best voice recognition technology in the business, emphasizes conversational skills, and has numerous supplemental resources for those looking to delve deeper into a language (van den Berghe et al., 2019). If Rosetta Stone combined their state-of-the-art technology with the power of the metaverse, the language learning industry could reach a new level of dominance. An immersive environment with high-functional technology is the groundwork of a metaverse app that could skyrocket the industry.

As I stated earlier, for language learning to become more relevant in the metaverse, the games I have experienced need a few more aspects to become effective and preferred over in-person instruction and mobile applications. Gamified educational experiences need numerous features to have a genuinely positive impact on learning. First, the games must be active. Many language learning games are more passive, including swiping motions of correct and incorrect answers (van den Berghe et al., 2019). Having games where learners interact with words and verb phrases will help them remember what they learned in the future. Coming from personal experience, I believe that games on Duolingo sometimes distract me from the main goal, and this can be a major problem with metaverse games, as many teachers worry that students will get too distracted by VR games (Tlili et al., 2022). Each game must be meticulously crafted so that it is engaging and meaningful to the learner. Lastly, the games must be joyful; I think one of the many things that Duolingo does well is that it engages learners and has many different game modes that make it fun to do. Having an enjoyable metaverse game goes a long way when it

comes to learning it. Implementing language learning games that are enjoyable will attract new users to the game and keep them locked in to continue their journey with the language.

Chapter 4

Analysis of Experimental Survey

Gathering Data

For the analysis part of my thesis, I surveyed 245 students of different demographics including age, family income, major, understanding of the metaverse, and language interest. The survey was created to collect data from a random sample of Pennsylvania State University undergraduate students and to scale up to predict the willingness to pay for Virtual Reality (VR) headsets. Everyone that participated in the survey was randomly selected from a database of emails containing freshmen, sophomores, juniors, seniors, and graduate students at Penn State University Park. They did not know what the survey entailed until they virtually received and opened the survey. When they opened the survey, they were shown a short video about VR (in Appendix B) and all the fascinating activities you can embark on. The survey included a variety of questions that were collected in a way so that the person taking the survey had no idea what the intention of the survey was. This prevented biased answers in the survey. Below, I have listed Table 4.1, which lays out some of the questions that I have presented in my survey.



Figure 5. An image representing what the metaverse can look like

The rest of the data (170 data points) were collected in person at the HUB-Roberson center on Penn State's campus. To make sure not one methodology was stronger than another, I prompted the students to answer the questions in the same manner. However, instead of an introductory video simply showing the extravagance of the metaverse, I allowed students to try on the headset and run through a quick demo game. They had the option to choose from "Epic Roller Coaster", which is a realistic experience of some of the most highly rated rollercoasters in the world, or "Mondly", which I discussed previously in my thesis, but shows a quick example of what learning a foreign language may look like in the future. There was a great turnout of students and demographics came from all over the United States and some foreign countries.

Since there was such a positive turnout when I was collecting data, I wanted to compute what the response rate was for my survey. With 245 students filling out the questionnaire and a potential of approximately 650 students, I had a response rate of about 38%, which is considered

an above-average rate (Ramshaw, 2018). I do not believe there was much, if any, selection bias in my survey because of the randomization design of the survey.

Perhaps the most important part of this process was the formulation of the questions I gave to the students. The questions and the answer choices are presented in Table 4.1 below and developed with guidance from two Penn State economics librarians.

Later in my thesis, I dive into three companies that are spearheading the growth of Virtual Reality. The questions were selected below because they either directly or indirectly led me to my result of a profit-maximizing price that the companies can charge for VR headsets. The original survey consisted of more questions; however, they were either not important to the data or were already answered by a different question. The full survey is available in Appendix A.

Table 4.1. Example questions used for survey

#	Question	Answer Choices
4	Are you aware of the metaverse?	<ul style="list-style-type: none"> • Yes/No
6	Family Per Capita Income?	<ul style="list-style-type: none"> A) \$0 - \$49,999 B) \$50,000 - \$99,999 C) \$100,000 - \$199,999 D) \$200,000 - \$399,999 E) \$400,000+
8	Did you travel abroad?	<ul style="list-style-type: none"> • Yes/No
11	Do you have interest in metaverse technology?	<ul style="list-style-type: none"> • Yes/No
13	Are you interested in foreign language?	<ul style="list-style-type: none"> • Yes/No
15	What is the most you would pay to have access to the metaverse?	<ul style="list-style-type: none"> A) \$0-\$99 B) \$100-\$199 C) \$200-\$299 D) \$300-\$499 E) \$500+

Measures

The questions in the survey were formulated so that I could analyze the data into four different groups: *high willingness to pay (WTP) & high interest in studying abroad (Group 1)*, *low willingness to pay & high interest in studying abroad (Group 2)*, *high willingness to pay & no interest in study abroad (Group 3)*, and *low willingness to pay & no interest in study abroad (Group 4)*. Breaking the students into these groups allowed me to generate data on each specific group. If a student already studied abroad, they were considered “interested in studying abroad”. High willingness to pay students were those responding to question 16 with D or E, and low willingness to pay were those responding with A, B, or C. This breakdown was because the average VR headset currently costs around \$300-\$350 for firms to produce (Mystakidis, 2022).

After calculating the average willingness to pay for each group, I analyzed the firms acting as either a monopoly or an oligopoly. I extracted data to make a prediction for what the marginal cost (MC) would be for a firm looking to profit maximize. Finally, I created a profit-maximizing graph for the firms if they colluded as a monopoly, as shown below.

Analysis

I started by calculating the total number of students in each of the groups listed above: 65 in Group 1, 60 in Group 2, 68 in Group 3, and 52 in Group 4. Then, since I broke down the willingness to pay into different brackets (and not precise values), I used the median of each letter as the value for that person. Table 4.2 below shows the average willingness to pay based on each of the groups.

Table 4.2. WTP of each Group

Group #	Average WTP
1	\$480
2	\$163
3	\$437
4	\$203

I started by plotting quantity on the x-axis and price on the y-axis. I am going to assume a constant marginal cost; given the history of products by the large companies I listed before, most of their big-name products have historically started with a flatter MC curve. Since these headsets are relatively new, I assumed the same.

To calculate the demand curve, I used each of the groups as a singular data point (4 total) and calculated a line of best fit that yielded a demand curve of $P = 633 - 2.158Q$ and a marginal revenue curve of $MR = 633 - 4.316Q$. Setting the $MR = MC$ yields a monopoly quantity, Q_M , equal to 77.2. Finally, plugging Q_M into the original demand curve yields a monopoly price, P_M , equal to \$466.80.

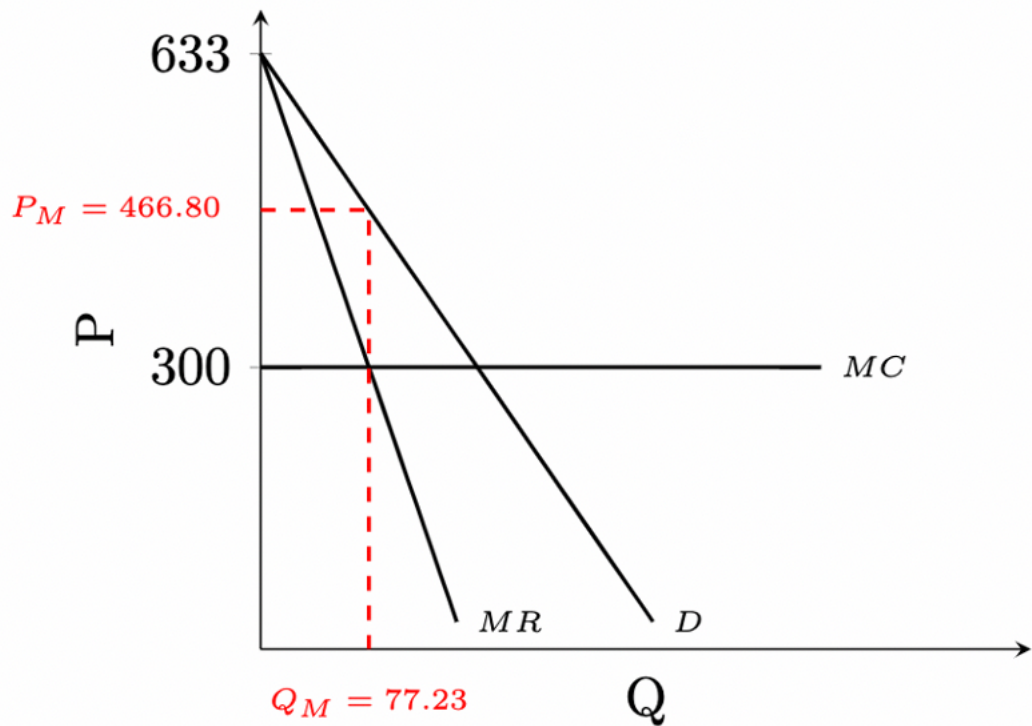


Figure 6. Monopoly Graph using Group WTP

Cournot Analysis

Allowing the firms to collude and charge a price of \$466.80 is just one way the firms may behave. The firms can also behave in a way that can be portrayed by the Cournot Oligopoly model. The Cournot model is the most popular model of imperfect competition during which firms choose a quantity to produce independently and simultaneously.

Let q_1 be the quantity produced by Meta, q_2 be the quantity produced by Microsoft, and q_3 be the quantity produced by Apple, the three largest companies involved in metaverse research and production. Based on data points from my survey, I have constructed a graph with an intercept of 633 and a slope of -2.158 , so

$$\text{Market Demand: } P = a - bQ$$

$$P(Q) = 633 - 2.158Q$$

$$Q = q_1 + q_2 + q_3$$

Each firm, q_i , has a demand and maximum profit function with the following derivation:

$$\text{Firm } D: P = a - b(q_i + Q_{-i})$$

$$\text{Revenue} = [a - b(q_i + Q_{-i})]q_i$$

$$\pi_i = aq_i - bq_i^2 - bQ_{-i}q_i - cq_i$$

$$\max \pi_i: 0 = a - 2bq_i - bQ_{-i} - c$$

Solving the $\max \pi_i$ equation in terms of q_i yields:

$$q_i = \frac{a - bQ_{-i} - c}{2b} = \frac{a - c}{2b} - \frac{Q_{-i}}{2}$$

By symmetry, $q_1 = q_2 = q_3$, thus $Q_{-i} = 2q_i$

$$q_i = \frac{a - c}{2b} - \frac{2q_i}{2}$$

$$2q_i = \frac{a - c}{2b}$$

$$q_i = \frac{a - c}{4b}$$

Plugging in our values of $a = 633$, $b = 2.158$, and assuming a cost (c) of

\$300 per headset, we get:

$$q_i = 39.823$$

$$q_1 = q_2 = q_3 = 39.823$$

$$Q = 119.469$$

Thus, plugging Q back into $P(Q)$ will yield the price all three firms should charge:

$$P(Q) = 633 - 2.158(Q) = \$375.19$$

Overall, the Cournot Oligopoly produced a price of \$375.19 that firms should charge for their headsets. Given the varying prices of headsets due to make, model, software, and hardware, this price point sits at a reasonable rate for both producers and consumers to gain a surplus. This lower price leads to more consumer surplus but less producer surplus in the market, and while this price would be better for consumers, firms may not obey it.

Real World Prices

Common VR headsets are mostly priced between \$300-600, with some of the new higher end headsets (such as the MetaQuest Pro) sell for around \$1,000 (Meta, 2023). Given the monopoly price found of \$466.80, it seems that firms may be selling some headsets above the optimal price; however, the varying amount of technology required to make each headset can change the cost to produce and thus increase the firm's selling price. With an oligopoly price of \$375.19, other firms are displaying Cournot tendencies with hopes of selling more units than those firms with a more monopolized price.

For firms to fully maximize their profit, they must target the right audience for headsets. By selling their product at a lower price, they can establish brand loyalty. Firms can establish a large initial consumer base by selling their VR headset at prices lower than the given monopoly price; hopefully, this consumer base will grow due to the novelty of the metaverse. The longevity

of the company's customer base can be secured by the introduction of more advanced products, thereby promoting sustained sales and revenue over time. This strategy can lead to a bolstering of the company's long-term profitability, as customers are incentivized to continue purchasing products due to their ongoing innovation and improvement.

Limitations

Although I had access to a wide variety of data from numerous different sources and databases, there were a few limitations in this analysis. First, I only had access to students in the age range of 17-22. This is not representative of the national population and will not give a firm a completely accurate profit-maximizing number if it were to expand this price point to other ages and users. However, approximately 35% of the users of Virtual Reality headsets are between the ages of 15-20, so there is some overlap (Zhang et al., 2022).

Secondly, Penn State University Park is not a completely representative sample of all students in the United States. There is a significant number of students that are in the higher income bracket than there are in the lower income bracket. According to Statista, there 85% of college students have a household per capita income of less than \$200,000 (Buhalis et al., n.d.).

A third limitation of this study is that the metaverse and VR are inherently new and there is not too much data out there to capture. For a researcher to compute a more accurate marginal cost and average total cost of this product, it would be more helpful if there was more data out there, rather than using numerous assumptions to arrive at a number. With the time and growth of the metaverse, there will soon be plenty of data to refine this study and present a more accurate price point.

Lastly, the virtual nature of part of the study leads to an issue. Ideally, every student would try Virtual Reality equipment in person to fully understand how realistic the metaverse feels. I believe that more in-person use would lead to a higher number of students wanting to try Virtual Reality and thus a higher willingness to pay for the product. However, there was not enough time in the research process to get a sufficient sample size from only the in-person survey.

Future Research

Further research is needed to capture more of the population and thus a better price point for firms wanting to profit-maximize their hardware. As I addressed in the previous section, the metaverse is a very new concept. The idea of Virtual Reality has been around longer than most people realize, but the metaverse started gaining press as soon as Facebook changed its name to Meta. In the future, further research will be necessary when more of the world understands what the metaverse is and how it can positively impact our lives.

Chapter 5

Creating Value

With the rapid development of the metaverse comes numerous speculations as to how individuals and businesses will create value in this new world. Creating value in the metaverse will require a unique approach, as traditional models and approaches may not translate seamlessly to its digital counterpart. However, by understanding the opportunities and challenges presented by the metaverse, and by leveraging emerging technologies and innovative ideas, it is possible to create meaningful and impactful value within this exciting frontier.

The metaverse is already a tool that many educational departments are using to maximize both student and teacher learning. There are endless possibilities with this new virtual world, such as visiting a distant planet in astronomy class or going inside the human body to observe its various systems. In addition to the educational world, employees and employers can maximize their output through the metaverse.

Teachers can use the metaverse to create immersive learning experiences that engage students in new and exciting ways. For example, a history teacher could create a virtual tour of ancient Rome, allowing students to explore the architecture of the city and interact with historical figures in a way that would not be possible in a traditional classroom. A study published in the *Journal of Educational Psychology* found that students who participated in a virtual learning environment that included interactive simulations and games reported higher levels of engagement and motivation compared to those who participated in a traditional classroom setting (Plass et al., 2019). This realistic visit to ancient Rome will accelerate learning and will help teachers keep their students engaged in their classwork. In addition, the visit will allow students to retain the learning longer than if they simply studied Rome in a textbook.

Teachers could also use the metaverse to create interactive simulations that allow students to experiment with scientific concepts or practice real-world skills in a safe and controlled environment. They will have an additional platform that they can leverage to assess and evaluate student learning. A metaverse assessment tool can provide teachers with real-time data on how students are performing with their teaching style. Teachers can thus maximize student learning by adjusting their delivery to address student deficits.

With teachers creating value in the metaverse, students can also utilize the metaverse to maximize their creations, whether that be applications they're developing or learning how to use medical devices on patients.

For example, a study published in the *Journal of Educational Computing Research* found that students who participated in a virtual collaborative learning environment reported higher levels of engagement and satisfaction with the learning experience compared to those who participated in a traditional face-to-face classroom setting (Jung et al., 2014). This is especially true with more learning nowadays coming via remote platforms like Zoom. The metaverse allows learning by doing, rather than learning by watching.

For a long time, there were no courses that could be strictly web-based, but soon enough there will be thousands of courses specifically taught in the metaverse. At Stanford, the rapid development of VR technology has allowed Professor Jeremy Balienson to teach his class, *Virtual People*, fully in the metaverse (Hadhazy, 2021). The learning-by-doing mindset is instilled in each of Balienson's students, as they can experience and build applications that previous students only read about.

Not only can the students learn in the classroom, but they can fully connect and interact with each other. A study published in the *Journal of Interactive Learning Research* found that

virtual environments can promote social presence and a sense of community among students, which can in turn lead to increased motivation and learning outcomes (Cooke-Plagwitz & Reiners, 2012). Balienson's class validated this study, as students cited that they were "finally eager to learn again" after the pandemic disrupted in-person learning.

Employees can use the metaverse to collaborate with colleagues and clients from around the world in a more immersive and engaging way. The Journal of Business Research found that virtual environments can promote communication and collaboration among distributed teams, leading to increased productivity and job satisfaction (Hertel et al., 2018). Since the pandemic, more jobs have been following either a hybrid model, where the worker splits time between in-person and online, or a strictly work-from-home model. With the development of the metaverse, employees that are working from home can have a more immersive, in-person experience. Many metaverse worlds, such as Somnium, have conference rooms and group study rooms that are for educational purposes. Employees can utilize these rooms to meet with their co-workers to work on their projects. Even if an employee does not have access to a headset, they can still join the conference room without an avatar and interact with his or her coworkers.

The metaverse can also provide employers with new ways to recruit and train employees. Virtual onboarding can be more immersive than the usual onboarding processes that companies follow. The experience can be more memorable and even save money when compared to the traditional method.

Lastly, on the employer's side, they can use the virtual environment to provide a safe and controlled space for employees to practice and develop their skills, such as conflict resolution or customer service (van der Meijden et al., 2019). Having a developed team working virtually is effective for maintaining business practices within the firm. Journal of Vocational Education &

Training found that virtual environments can help to bridge the gap between theoretical knowledge and practical application, allowing employees to develop their skills in a more realistic and relevant context (Böhm et al., 2016).

To create and provide value in the metaverse, all stakeholders need to have a basic understanding of the metaverse and its capabilities. This may require investing in training or hiring experts who can help design and develop virtual environments that are both engaging and effective. It is also important to consider issues of accessibility and equity, ensuring that all students, employees, and users have equal access to the opportunities and resources available in the metaverse.

Chapter 6

Roadblocks to Metaverse Acceptance

The development of the metaverse, while potentially revolutionary, is not without its challenges and potential roadblocks. One of the major concerns with the metaverse is the lack of privacy and security. Currently, cybersecurity issues are among the most pressing worries about the metaverse. The metaverse is a world without boundaries, and with that comes privacy concerns. As users enter the metaverse, they will be creating and sharing vast amounts of personal information and data, thus making them vulnerable to hacking and data breaches.

A major reason why there will be a lack of security – and this is currently just based on fundamental characteristics of the metaverse – is that it's built on a decentralized infrastructure, which means that there will be no single entity responsible for protecting user data and ensuring privacy on the platform (Patalay). This also builds on the fact that since the metaverse is still being developed, the laws and regulations are not fully fleshed out and this makes it difficult to know how user data will be protected. In addition, the metaverse may seem like and could be used as a surveillance tool for the government, companies, and other entities. This has been a common concern with other technologies, and the metaverse presents the same issue.

Another possible roadblock is the issue of social isolation and addiction. This is very common with new technologies, as there have been previous studies on this with smartphones, video games, and social media, but the metaverse presents a more extreme possibility. As the metaverse becomes more and more realistic, some people may find themselves spending more time in virtual worlds at the expense of their real-world relationships and responsibilities.

According to a McKinsey study, over 60% of users interested in the metaverse consider gaming

their top interest inside the metaverse. It will be interesting to see how many of these people end up feeling completely isolated and completely fall in love with this new space. The metaverse could also prove to be a detriment to mental health, which has also been a concern with previous emerging technologies (Mystakidis, 2022).

Economic and ethical issues that are arising with the development of the metaverse pose another threat. The rise of the metaverse could lead to a displacement of jobs, as we have seen with numerous companies cutting employees. (It could also be argued that this displacement of jobs leads to an increase of jobs in this new world). In addition, economic inequality can start to rise, with those with lower incomes being unable to participate in the metaverse. This is a concern that many tech companies are aware of, but there are almost always high fixed costs in the early stages of a new product.

Overall, all these concerns raise important questions about the development and use of the metaverse, and it is important to consider some of these roadblocks as the technology is developed. Its development should be done in a responsible, ethical, and meticulous manner, with an emphasis on privacy, security, social interactions, and mental health. With any new technology, there come pros and cons. It is vital to weigh the potential drawbacks with the benefits and ensure that the metaverse is developed in a way that benefits society.

Chapter 7

Conclusion

At the beginning of this paper, I investigated whether firms were charging consumers the most optimal price for their technology. With the constant development of new hardware and software comes more advanced and unique products that firms can offer. However, I concluded that the major firms in the market were mainly charging at the monopoly price, even though there were oligopoly tendencies. This may be due to the newness of this product, or simply because the current fixed costs of the software coerce the firms to charge a higher price.

Contrary to the firm's belief, I believe that firms should charge a lower price for the few reasons that I outlined in Chapter 4. 37% of Generation Z (ages 18-25) feels that the metaverse can be just as fun as real life (Kapler, 2023). Compare this to millennials and Gen X, as less than 50% of that population has some understanding of what the metaverse is. The large firms that dictate the prices of metaverse technology are adhering to the older generation's incomes, yet younger generations have exhibited much higher demand. In addition, the long-run profit for these firms could grow by establishing brand loyalty while these products are new, similar to the strategies Apple uses to dominate the cell phone industry. By setting lower prices for metaverse products, while also being one of the first movers in the metaverse industry, any of these companies must seek long-term growth through brand loyalty.

Within the next decade, the metaverse has the potential to be groundbreaking. By 2030, it is plausible that more than 50% of all daily activities are done in the metaverse, with more than 80% of commerce taking place there (McKinsey). As discussed previously, colleges and universities are using the metaverse for learning and development, and this will only grow in the future. Generational changes like this do not happen overnight, but after incremental

advancements and thoughtful experimentation, the future of the metaverse is coming fast. Employers, entrepreneurs, professors, and students must be aware of the way the metaverse increases access to education and acts as a catalyst for social interaction. It will never be a substitute for the real world, but understanding and implementing the benefits it can have on a person or business is paramount.

The data collected in this thesis were mainly collected from Penn State University students, with a portion of cost data from Meta and other small metaverse-minded firms. There were difficulties collecting completely accurate cost data and breakdowns of VR products, as many of these products are completely new to the market and there is no public information on their cost structures. In addition, since there is not much literature on this topic, it was hard to get a basis for what direction this thesis would go in. Given the fact the survey had a very limited sample in terms of diversity across the United States, the numbers in Chapter 4 must be taken with a grain of salt and cannot be completely generalized to the entire country.

With more time and a larger population to collect data from, this thesis can be expanded upon. Future research can include broader populations from all demographics of the United States and internationally, as well as a more accurate cost breakdown – mainly, the marginal cost for firms to produce one more virtual reality headset. As the metaverse continues to grow and most of the population becomes aware of it, more data will be readily available to analyze, including customer preferences and their willingness to pay for the various headsets that will be available from different firms. As with every breakthrough technology, the metaverse's growth will soon emulate the likes of the internet, cell phone, and television, and stakeholders must be prepared to adapt and embrace it.

Appendix A

Full Survey Given To Students

#	Question	Answer Choices
1	What is your name?	• (manual entry)
2	What is your hometown?	• (manual entry)
3	What is your age?	• (manual entry)
4	What is your major?	• (manual entry)
5	What is your gender?	• (manual entry)
6	Are you aware of the metaverse?	• Yes/No
7	If yes, please explain in further detail	• (manual entry)
8	Family Per Capita Income?	A)\$0 - \$49,999 B)\$50,000 - \$99,999 C)\$100,000 - \$199,999 D)\$200,000 - \$399,999 E)\$400,000+
9	Did you travel abroad?	• Yes/No
10	If yes, where did you travel abroad?	• (manual entry)
11	Do you have interest in metaverse technology?	• Yes/No

12 Are you interested in foreign language?	• Yes/No
13 Do you already speak another language or want to learn a new one?	• Yes/No
14 What is the most you would pay to have access to the metaverse?	A)\$0-\$99 B)\$100-\$199 C)\$200-\$299 D)\$300-\$499 E)\$500+

Appendix B

Video Shown to Surveyed Students

<https://youtu.be/7DEVfUk2zCk>

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Eberly College of Science | Bachelor of Science in Applied Mathematics *May 2023*
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ISI Florence **Florence, IT**
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PROFESSIONAL EXPERIENCE

KPMG LLP **New York, NY**
Financial Services Risk and Compliance Advisory Intern *Jun 2022 – August 2022*

- Executed a company-wide analysis of an elite commodities firm's trade execution and focused on their surveillance, rule implementation, and controls testing to mitigate risk and follow compliance rules
- Leveraged risk analytics to help client deploy automation on their derivatives trading model and reduce maintenance margin requirements by 10-20% while meeting their business needs

Pfizer Inc. **New York, NY**
Worldwide Safety and Business Management Intern *May 2021 – Aug 2021*

- Created an innovative process for Pfizer's Worldwide Medical and Safety team to promptly and consistently complete an annual 50-question survey given to over 70 pharmaceutical companies
- Provided meaningful input into company projects through statistical analysis in 3-time studies, weekly PSSR meetings with 2 directors, and 2 major excel projects for Pfizer's Drug and Safety Unit

LionTutors **State College, PA**
Linear Algebra Tutor *Jan 2020 – Dec 2020*

- Facilitated the creation of 100-150 linear algebra practice problems, 3 practice exams, and 2 on-demand review videos used in private and group study sessions for over 300 undergraduate students
- Conducted monthly 30-50 person exam review sessions to supplement students' classroom learning which yielded an average increase of 1-2 letter grades to their final grade

LEADERSHIP EXPERIENCE

Nittany Lion Consulting Group **University Park, PA**
Associate Consultant *Mar 2021 – May 2022*

- Led a team of 4 consultants working with a humanitarian-focused start-up company to assist them in implementing their state-of-the-art generator in the renewable energy field in Kenya
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Phi Gamma Nu Professional Development Organization **University Park, PA**
Recruitment Chair *Dec 2020 – May 2023*

- Coordinated our organization's first-ever virtual recruitment with a team of 4 using unfamiliar software to ensure a smooth recruitment process and spark a 50% increase in chapter involvement
- Spearheaded a new growth program for 35 new members built on our pillars of professional development, philanthropy, and THON that lead to a productivity increase of 60%

AWARDS

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