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## GRA 19703 Master Thesis

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Master Thesis Report


By

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Fabio Miessi Sanches


# Market Dynamics and Strategic Interactions in the Digital Music Industry:

## An Examination of the Antitrust Case between Spotify and Apple


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**Abstract**

The rise of digital platforms as a business model has substantially increased the growth and influence of firms. The potential market implications that follow have captured the attention of regulators globally. Our thesis explores the antitrust implications of digital platforms, mainly focusing on the digital music streaming market. It introduces the ongoing antitrust case between Apple and Spotify as the focal point of our study. In the market we are examining, Apple is a platform provider and a supplier of music streaming apps. Spotify sells its product through its website and on Apple's App Store, where they must pay a 30% commission fee for App Store sales. The commission fee has potential implications for pricing strategies, market competition, and consumer welfare. Our study uses a multinomial logit model to simulate pricing strategies for both firms at different commission fee rates. We also include modified versions of the model where we close Spotify's website as a sales channel and remove the competing product Apple Music. We found that third-party sellers, like Spotify, are forced to increase their prices when the commission fee rate increases, which benefits the fee recipient at the expense of their competitors in terms of profits and market shares. The effect of the commission fee remains unchanged when including and comparing with our modified models.

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## 1.0 Introduction

Digital music streaming services have reshaped the global music industry landscape, leading to the rise of dominant platforms like Spotify and Apple Music. These platforms' market position has raised concerns about their potential involvement in anti-competitive behavior, which can negatively impact innovation and consumer welfare. The competition authorities are confronted with a rapidly expanding market driven by complex economic forces that require thorough analysis to ensure fair market regulation. The increasing use of digital platforms as business models has led to a growing interest in research on this topic. Given this, the literature has seen a massive increase in published papers in the last decade.

Our thesis will focus on the impact of commission fees, a central concept of the digital platform market. A commission fee is a payment a platform or intermediary charges for facilitating a transaction or service and is commonly used in various industries, including digital music services. The fee is typically a percentage of a sale that the platform, such as app stores, takes from the revenue generated from a developer when a customer purchases their app or in-app products. Relevant to this thesis is the "Apple Tax," a 30% commission fee rate that Apple charges third-party sellers for subscriptions sold through its App Store. The Apple tax gets accused of negatively influencing competition, pricing, and social welfare.

Central to our study is the ongoing legal dispute between Spotify and Apple. Spotify, the world's largest music streaming platform, filed a complaint against Apple's App Store rules in 2019. As a result, the European Commission opened a formal antitrust case against Apple in 2020. Spotify claims that Apple's commission fee rate unfairly forces them to raise their prices, putting them at a competitive disadvantage. In addition, the Apple App Store (hereafter App Store) policies limit Spotify from informing customers about outside options in the in-app purchasing system, like the possibility of purchasing subscriptions directly through Spotify's website. Another essential factor in this discussion is Apple Music, Apple's own music streaming app and a direct competitor to Spotify. The question is whether Apple misuses its dominant market power and systematically controls the market to make it more favorable for customers to choose Apple's products, like Apple Music.

Spotify's accusations sparked a widespread discussion about the fairness of competition, power dynamics, and the implications of commission fee rates in the digital music industry. We will examine the impact of Apple's commission fee rate and subsequent pricing strategies on the digital music market, specifically focusing on how these factors influence the profitability and competitiveness of firms like Spotify and Apple.

Research Question:

***How do Apple's App Store policies and practices influence digital platforms' competition dynamics and consumer welfare?***

To answer this question, we will investigate these specific aspects:

1: *How does Apple's commission fee structure impact the pricing strategies for third-party service providers like Spotify in the digital platform ecosystem?*

2: *How do Apple's policy choices change when we remove them as a direct competitor?*

In addition to exploring these dynamics, this thesis aims to provide policy recommendations based on the insight gathered from our model with the following question in mind: *What policy adjustments can be recommended to promote fair competition in digital platform ecosystems?*

Our thesis explains the interplay between pricing strategies, commission fee structures, and market dynamics within the digital music industry. Focusing on the strategic interaction between Spotify and Apple, we examine how these factors affect businesses, customers, and the industry. By analyzing the market through our constructed models, we hope to shed light on the potential impact of these factors on competition and profitability. We want to contribute to the ongoing debate and make ground for further research in this field of study.

Our analytical approach uses game theory, where we develop a two-stage pricing game. In the first stage, Apple sets a commission fee rate for Spotify's products sold via the App Store. In the second stage, both firms determine their product's optimal prices to maximize profit. Our model lacks historical data for precise analysis, making it challenging to estimate our model's demand and supply

parameters. We have opted to calibrate the model and its parameter values to get an optimal commission fee rate equal to the rate we see in the market. We want our model to reflect real-world corporate strategies, where each firm's decision depends on the other's moves.

We introduce both open and closed models for analysis to extend our investigation. The open model includes selling Spotify's products through its website and the App Store. In the closed model, we close Spotify's website, restricting the sales of Spotify's products solely to the App Store. Both models include sales of Apple Music through the App Store. With these varied scenarios, we aim to explore the impact of different commission fees and pricing strategies on optimal pricing, profitability, market shares, consumer welfare, and, ultimately, the equity of competition in the digital music industry. Recognizing the role of Apple as both a platform provider and a direct competitor, our study also introduces a modified model that excludes Apple Music. In this way, we can isolate Apple's actions as a platform provider to see whether its strategic decisions are designed to enhance its profitability or tilt the competitive scales in favor of Apple.

We numerically solve the calibrated model for its subgame perfect Nash equilibrium and show that an increase in chosen commission fee rate leads to an increase in prices, at least for Spotify. This holds through for all our models. The profits for Apple increase with higher commission fee rates, while it decreases for Spotify. We see a substantial increase in market share for Apple Music and a decrease in market share for Spotify. Regarding consumer welfare, we observe a negative change in expected consumer utility when moving from an open to a closed model. In the model that excludes Apple Music, the results are similar. However, we see that the optimal commission fee rate is lower in both the open and closed versions of the model.

While our model provides valuable insight, its design simplifies real-world dynamics. The model does not contain available real-world data and does not capture all the details of the market. Because of this, the conclusions from our research should be a starting point for future research.

Section 2 provides a historical overview of the digital music industry, highlighting key milestones and setting the context for our research. Section 3 presents the legal dispute between Spotify and Apple and introduces similar antitrust cases. In Section

4, we review previous studies and literature on our topic of study. Section 5 introduces the theoretical framework and presents our two-stage pricing game model. It also presents the open and closed models utilized in the study and a model without Apple Music. Section 6 focuses on the analysis and results. Here, we evaluate and interpret the outcomes of our models, providing insights into optimal pricing, profitability, and competition in the digital music market. In addition, section 6 compares our results from the modified models with the original model. The concluding section 7 summarizes our findings and outlines potential avenues for future research.

## 2.0 Industry Background and Market Definition

To help us understand the competition and potential factors that influence the specific market we are studying, we will investigate the digital music industry and how it has evolved. We will also here define the market and present the players.

### 2.1 Industry Background

Music streaming is a branch of the digital music industry enabling users to stream music directly from the internet onto their devices. The growth of music streaming services has led to a significant decline in traditional music distribution methods, such as purchasing physical CDs or individual digital downloads. The digital music industry has been fighting against unauthorized distribution and illegal downloads for a long time, leading to a significant decline in sales. However, the market now appears to have regained momentum because of innovative ways to monetize music content by offering a more convenient and cost-effective solution for music consumers (Trenker, 2022, pp. 4-6).

Figure 1 presents the evolution of global recorded music industry revenues from 2001 to 2022, highlighting changes in various segments over time. It also shows milestones that significantly impacted the industry, such as the launches of Apple and Spotify products. From 2001 to 2010, physical music sales experienced a drastic drop of more than 60%, sending the music industry revenues into a severe decline. Digital music sales grew from nothing to nearly four billion dollars in the same period. However, this growth failed to offset the sharp decline in CD sales. After reaching its lowest point in 2014, the market eventually accepted that digital distribution represented the future of music, despite initial resistance. By the end of

2022, music streaming services accounted for 67% of the industry's revenues (Richter, 2023).

Figure 1: Global recorded music industry revenues
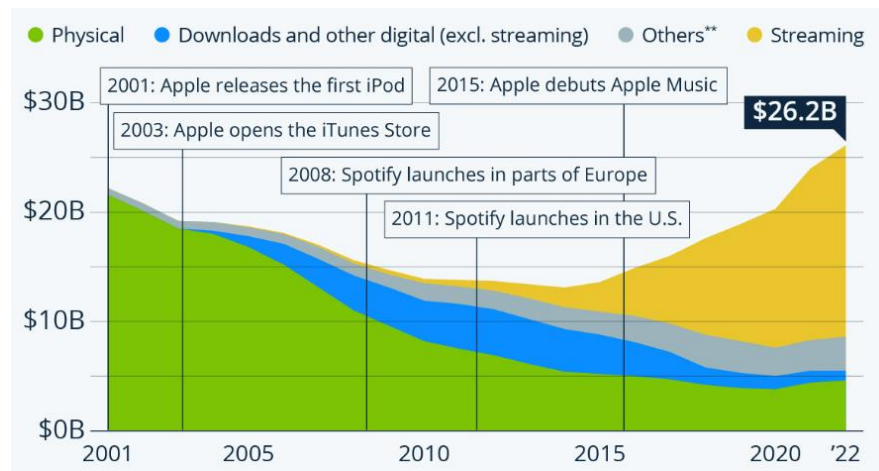
Figure 2 shows global revenue from music streaming from 2005 to 2022, adjusted for inflation. There has been an enormous increase from 2.8 billion USD in 2015 to 17.5 billion USD in 2022, more than six times the amount. It reflects the evolution of the industry and the impact of innovation in technology and the internet.

Figure 2: Music streaming revenue worldwide in billion U.S. 2005-2022
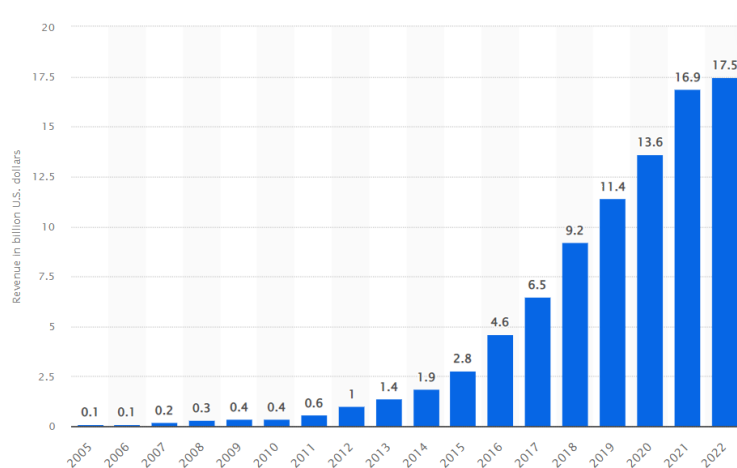
A few key players dominate the music streaming industry today, with Spotify and Apple Music leading the global market. Other noteworthy contenders include Amazon Music and YouTube Music. Music streaming services typically operate on a subscription model, where users pay a monthly fee for access to the service. Most services offer both free and paid tiers, contributing to the increased popularity of music streaming services. The free tier often includes advertisements and has limited features. In contrast, the paid tier offers ad-free listening and additional features, such as offline listening and higher sound quality, across various platforms, such as desktop and mobile (Grand View Research, n.d).

Figure 3 shows the revenue and market share of the most prominent music streaming players globally. As the figure shows, Spotify holds 30% of the market and Apple Music 13.7% as of Q2 2022.

Figure 3: Market shares of subscribers Q2 2022
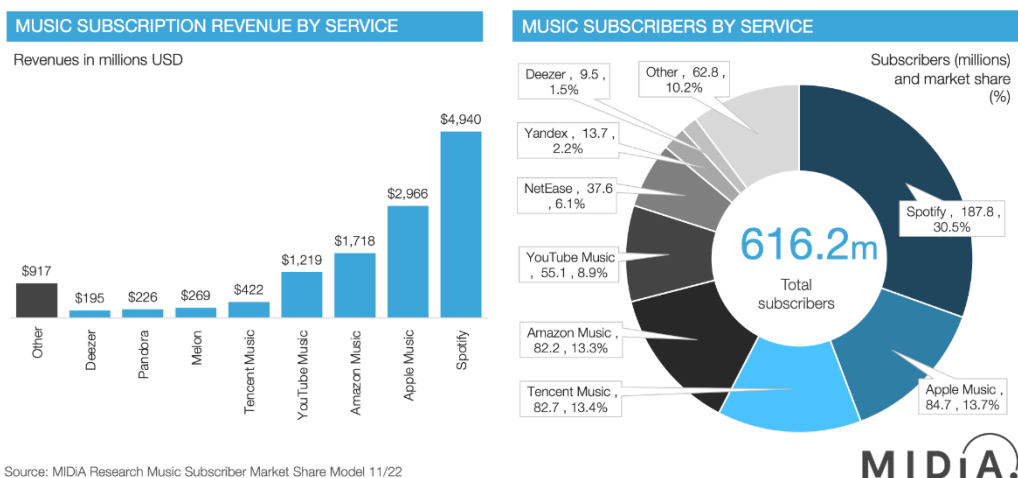


Source: *MIDiA 2022, in Mulligan 2022*

In recent years, the music streaming industry has continued to evolve, focusing more on personalized recommendations, exclusive content, and high-resolution audio. The industry also explores other revenue sources like live audio experiences and podcasts. As it continues to grow and innovate, music streaming is set to remain a vital part of the global music industry. The evolution of this industry has seen a shift towards many streaming services employing sophisticated algorithms for music recommendation based on users' listening habits (Grand view research, n.d.).

## 2.2 Market Definition

The music streaming market presents various segments, reflecting the diverse nature of the industry. Service type represents a fundamental segment, differentiating between on-demand and live-streaming services. The on-demand segment accounted for over 75% of the market in 2020 (Growth Market Reports, 2020).

The platform on which services are accessed is another determinant, with users accessing services through iOS, Android, or other platforms. The market of platform types is divided into apps and browsers, where the app segment dominates, with a market share of 84.7% as of 2021 (Stratview Research in GlobeNewswire, 2022).

The market is also divided by content type, with some consumers favoring music and others preferring alternative content such as podcasts. Differing usage scenarios lead to another categorization differentiating individual and commercial end-users. Regions are another influential factor that segments the market, as geographical location plays a substantial role in usage patterns and availability of services. North America dominates the market share in terms of revenue with 29% as of 2021 (Stratview Research in GlobeNewswire, 2022).

Regarding market shares, Android is significantly more popular than the iOS system. Based on continents, Android holds the highest market share in Africa, Asia, Europe, and South America. Apple holds the highest market share in North America and Australia. Combined, these two industry giants account for over 99% of the global phone market share as of January 2023 (World Population Review, n.d.).

Market demand is driven by numerous causes. These include the rise in smartphone usage, the expansion of internet access, consumers' preferences shifting toward online content, and the transition from ownership-based models towards models favoring access to music. These factors collectively drive the growth and dynamism of the music streaming market. In terms of revenue, the music streaming market earns from both subscription fees and advertising revenue. The former is collected from premium subscribers, while the latter is generated from ads served to free-tier users. (Statista-b, 2023)

Furthermore, an essential aspect of the music streaming market is the digital platforms that distribute the streaming apps. These platforms, such as Apple's App Store and Google's Play Store, impose a commission fee on in-app purchases, significantly affecting the revenue and pricing strategies of the music streaming services. This relationship between streaming services and digital platforms introduces a unique dynamic in the music streaming market, and it is often a focal point for legal and strategic discussions in the industry. In the coming sections, we will explain these dynamics and the role of commission fees in detail.

## 2.3 Players

Our analysis centers on the price competition between two key players in the music streaming market, Apple Inc. and Spotify. These companies were explicitly chosen for their significant influence within the market, making them ideal for understanding the dynamics and strategic interactions in play. By studying a model with fewer players, we can more easily understand and analyze it. This simplified structure permits a more comprehensive understanding of consumer choice and competition dynamics through demand modeling. Moreover, the specific choice of Apple and Spotify allows us to investigate complex market aspects, such as the role of app distribution platforms and the effects of commission fee rates on pricing, which are particularly relevant given their recent legal and regulatory dispute.

### 2.3.1 Apple

Apple Inc. founded in 1976 by Steve Jobs, Steve Wozniak, and Ronald Wayne, is a multinational technology company headquartered in Cupertino, California. Apple is globally recognized as a leader in designing, developing, and selling consumer electronics, computer software, and online services. Its portfolio includes popular products such as the iPhone, iPad, Mac computers, iPod, and Apple Watch, along with software platforms like iOS and macOS (Statista-c, 2023; Business of Apps-a, 2023).

A significant part of Apple's business model, and one of its fastest-growing segments, is its Services sector, which includes the App Store and Apple Music. These services have established a firm footprint in their respective markets, strengthening Apple's position in the digital marketplace and contributing significantly to its revenue. The App Store is Apple's digital application distribution

platform, where users can download apps for their iOS devices. It was launched in 2008 and has evolved into a vital ecosystem for millions of developers, businesses, and over 1.5 billion active iPhone users as of 2023 (Statista-d, 2023; World population review, n.d.).

Apple uses an agency model as an intermediary between app developers (like Spotify) and users. Developers set the price of their apps, and Apple takes a commission on in-app purchases with a standard fee of 30%. Despite controversies regarding its commission policies, the App Store remains a dominant platform in the app distribution market (Statista-c, 2022). In our model, Apple's role is primarily as the operator of the App Store, its digital distribution platform.

Apple Music is Apple's music streaming service, competing directly with Spotify. Like Spotify's Premium Model, users pay a monthly subscription fee for ad-free listening, downloads for offline listening, and access to the entire Apple Music library. Unlike Spotify, Apple Music only offers free listening for a limited period before charging for a monthly subscription. Figure 4 shows the increase in Apple Music subscribers, from 6.5 million in 2015 to 78 million in 2021.

Figure 4: Share of Apple Music paying subscribers globally in millions
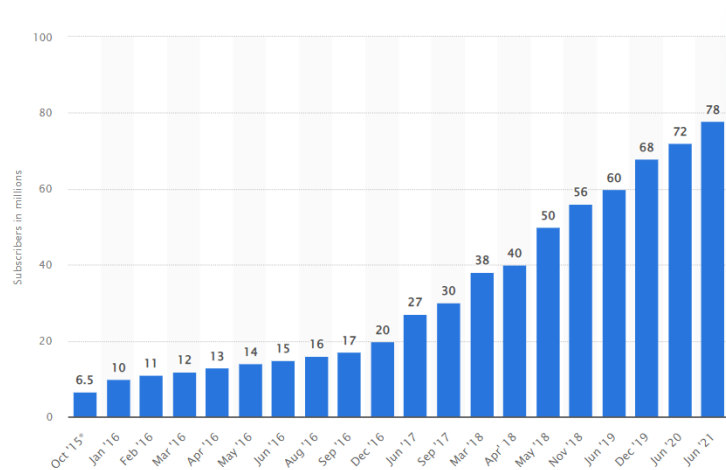


Source: 9to5Mac 2022, in Statista, 2023

### 2.3.2 Spotify

Established in 2006, Spotify emerged as a pioneering online music streaming service provider. The company was founded by Daniel Ek and his partner Martin Lorentzon and has gained immense popularity. It has evolved into one of the leading global platforms for streaming music and provides its services predominantly through two models. The freemium model, which serves as a user entry point, offers access to a large portion of Spotify's content. This includes songs and podcasts for free but with certain limitations. These limitations include advertisements, limited song skips, and an absence of offline listening. This model intends to attract users to engage with the service without the financial commitment, creating an environment that eventually encourages a transition to a paying subscription. On the other hand, the premium model requires a monthly subscription fee that unlocks additional benefits such as ad-free listening, unlimited skips, high-quality audio, and offline listening. Moreover, Spotify offers different tiers of premium subscriptions, such as Student, Individual, Duo, and Family plans (Trenker 2022 p. 21; Business of Apps-b, 2023).

Spotify distributes its subscription sales across various platforms to reach a broader customer base. The primary platform for Spotify subscription sales is its website, where users can directly purchase subscriptions without intermediaries. This direct sales channel gives Spotify complete control over the customer experience and ensures that it retains the entire subscription revenue. Spotify's products are also available on various app stores like Apple's App Store and Google's Play Store. Here, customers can subscribe to Spotify within the app on their devices. However, using these platforms for distribution often involves commission fees, which Spotify must pay the app store owners.

With a vast user base of more than 489 million active monthly users by the end of 2022 (Figure 5), Spotify is one of the most prominent entities in music-streaming services. The share of Spotify users with premium subscriptions reached 205 million in the same period (Figure 6). The most significant market share measured geographically is in Europe, with 39%, followed by North America, with 28% in Q1 2023 (Spotify-a, 2023, p.15).

Figure 5: Share of Spotify monthly active users globally in millions
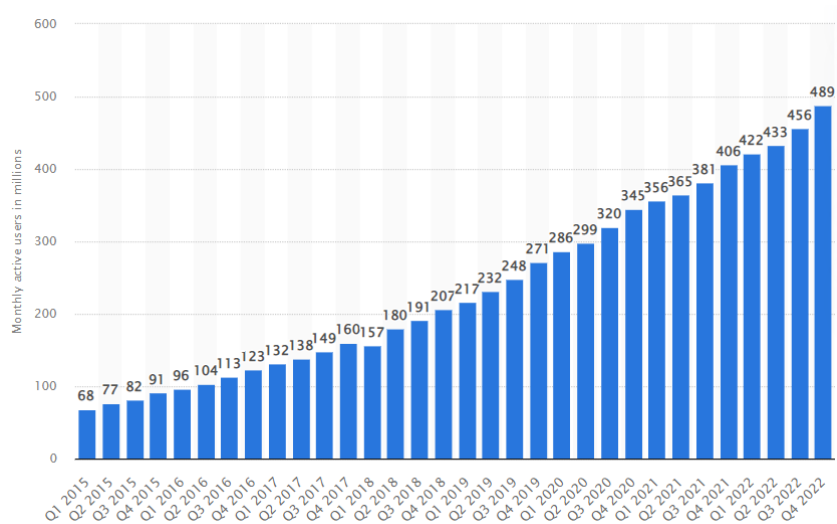


Source: Spotify-b 2023 in Statista 2023

Figure 6: Share of Spotify premium subscribers globally in millions
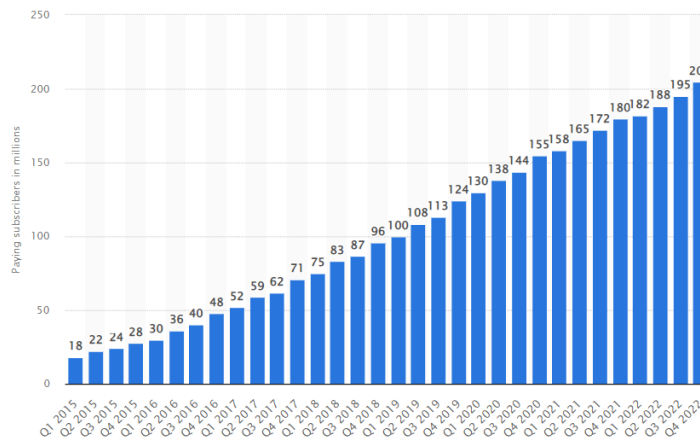


Source: Spotify-c 2023 in Statista 2023

The Business Model Analyst presents a canvas of Spotify's business model (Figure 7), giving us a visual chart with elements describing its product's value proposition, infrastructure, customers, and finances. Spotify offers its customers a vast selection of songs on demand, personalized recommendations, sorted playlists, and podcast streaming across various devices, primarily through its mobile and desktop applications. The platform serves multiple customer segments, including individual consumers (free and premium subscribers, as presented above), advertisers on its free tier, and podcast creators. Premium subscriptions and advertising sales drive

Spotify's revenue. The company's essential resources include its software platform, licensing agreements with music and podcast creators, and extensive data on user listening habits used to enhance personalization and analytics. Spotify's key activities encompass maintaining its software platform, managing licensing agreements, organizing playlists, and processing data for personalization. The firm establishes key partnerships with music record labels, individual artists, podcast creators, advertisers, and tech companies for device integration. Significant costs for Spotify are royalty payments to rights holders, technology infrastructure, marketing, and customer service (Pereira, 2023).

Figure 7: Business Model Canvas
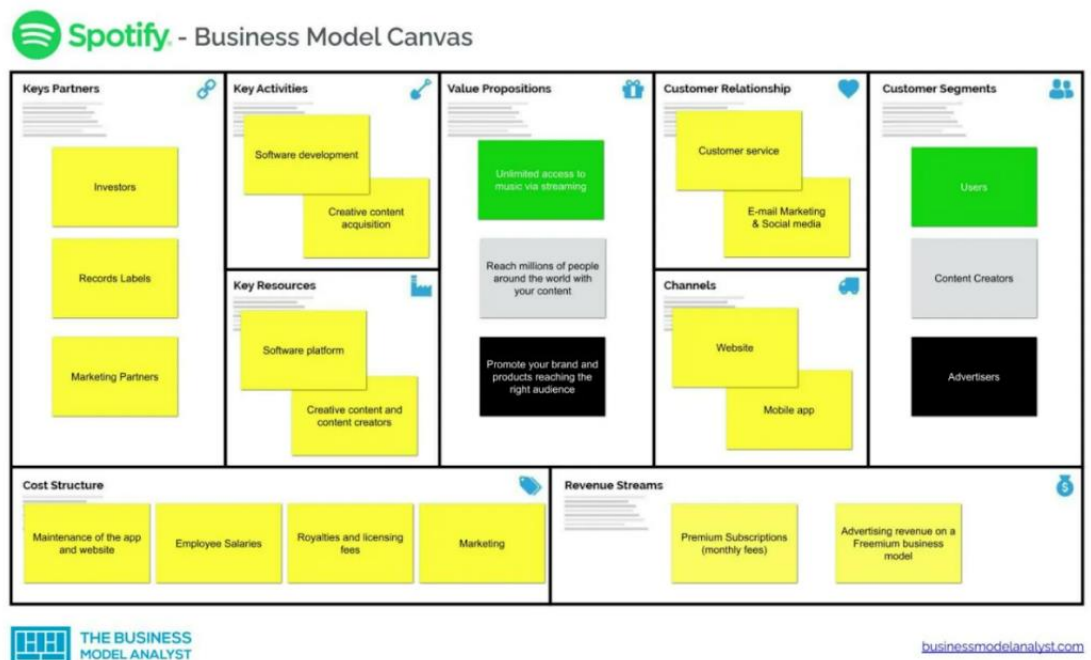


Source: The Business Model Analyst, in Pereira 2023

The company adopts a royalty payment system whereby artists and record labels receive compensation proportionate to the number of streams their music accumulates with the overall songs streamed. To support this arrangement, Spotify allocates a substantial portion of its total revenue, up to 70%, to cover royalty costs. These costs encompass payments to artists, their respective record labels, copyright holders, writers, and producers associated with the content uploaded onto the platform. Including licensing fees further contributes to the platform's considerable expenses (Pereira, 2023).

Moreover, Spotify faces significant competition from other major players in the music streaming industry, primarily those backed by tech giants. Among these competitors, Apple Music is the most significant competitor to Spotify. Apple Music comes pre-installed on Apple's iOS devices, making it a popular choice for consumers immersed in the Apple ecosystem (Pereira, 2023).

## 3.0 The Case

*"Apple shouldn't be able to use their power to give themselves an unfair advantage – harming fans like you and companies like us"* (Time to Play Fair, n.d.) is how Spotify presents the case on its website and further outlines the issues in the contractual relationship between Spotify and Apple.

Spotify accuses Apple of restricting consumer choice by continuously controlling and modifying the rules for competitors. It prohibits Spotify from directly communicating with customers using Apple's platform, preventing them from receiving information about deals, service upgrades, and product purchases. Additionally, Spotify claims that Apple has systematically delayed and rejected updates to its app, hindering functionality improvements and customer experiences. These hindrances are not imposed on Apple's services, thus creating an uneven competitive landscape. Again, the streaming giant alleged that these restrictions further tilt the playing field in favor of Apple Music (Time to Play Fair, n.d.; Ek, 2019).

Furthermore, Spotify asserts that Apple imposes an unfair 30% tax on its app, giving Spotify two unfavorable options: accept Apple's payment system and the commission fee, or refuse the tax and potentially miss out on the customers inside of the Apples iOS system. Spotify claims this tax system negatively affects the customer experience and makes Spotify's pricing uncompetitive. The Apple tax forced them to inflate their Premium membership's price beyond Apple Music's to compensate for the commission fee. According to Spotify, Apple's actions violate competition law, suggesting it abandoned its earlier stance supporting fair competition. Spotify asserts that the market has sufficient potential for multiple companies to thrive, urging Apple to allow free competition (Time to Play Fair, n.d.; Ek, 2019).

In March 2019, Spotify filed a complaint with the European Commission (hereafter EC) based on these claims, accusing Apple of anti-competitive behavior and abusing its dominant position in the market. In response to the complaint, the EC launched a preliminary investigation to assess the credibility of Spotify's accusations (European Commission-a, 2020).

In June 2020, the EC announced it had opened two antitrust investigations into Apple's App Store and Apple Pay practices. Regarding the App Store, the investigation centers on whether Apple's rules for app developers on distributing apps via the App Store violate EU competition rules (European Commission-a, 2020).

The emphasis of the case has evolved. The European Commission's investigation focuses on Apple's contractual limitations on app developers. These restrictions prevent developers from informing iPhone and iPad users about alternatives, such as more affordable music subscription options outside the app. The restrictions inhibit users' ability to make such choices effectively. Suppose the EC determines that there is adequate evidence of a violation. In that case, it possesses the authority to issue a decision "*prohibiting the conduct and imposing a fine of up to 10% of the company's annual worldwide turnover*" (European Commission-b, 2023). The ongoing investigation could have substantial implications for the digital music streaming market and potentially reshape the relationships between app developers and platform operators like Apple.

In this thesis, we build a theoretical model that allows us to analyze the effects of the practices adopted by Apple on Spotify and consumers.

## 3.1 Similar cases

The previous sections presented the expansion of major technology companies such as Apple and Google. The position of these companies has led to increased scrutiny from regulators worldwide. This section will briefly introduce essential information on similar antitrust cases to see how regulators previously approached cases close to the Apple versus Spotify antitrust case. Examining these cases can provide us with the information needed to speculate on the potential outcomes of the case we are analyzing.

**Google Shopping**

In 2017, EU Commission fined Google 2.42 billion euros for misusing its market dominance to give its shopping service an unfair advantage by systematically controlling information and algorithms on the Google search engine (European Commission-c, 2017). This case resembles the case we are studying regarding restrictions on consumer communication, i.e., information control.

**Epic Games vs. Apple**

The focal point of this case revolves around restricting the distribution of iOS apps outside the App Store and Apple's policies that required app developers to use its in-app purchase system exclusively. Epic Games opted to violate these terms, resulting in Apple removing the application from the App Store. This action sparked a lawsuit from Epic Games, claiming that Apple behaved in an anti-competitive way. This case draws two similarities to the case we are studying: Epic Games get forced to pay a commission fee from its sales on the App Store, and restrictions on developers' abilities to inform consumers about alternative options in Apple's in-app purchases system. The case concluded in Apple's favor as there was no evidence of anti-competitive behavior. The main argument was that Apple is not direct competitors in the gaming app industry. However, Apple was ordered to stop its policies regarding restrictions on app developers' ability to inform consumers about other payment options (Belloso, 2021).

## 4.0 Literature Review

In the expanding digital music streaming market, gaining insight into the strategic interplay between platforms and firms has become crucial. The appearance of the previously mentioned dominant market actors, such as Spotify and Apple, has reshaped how consumers access music, resulting in changes in the dynamics of the music industry. Moreover, this led to new economic models and the use of theory to decipher these unique situations. The following literature review aims to investigate the relevant ideas and tools used to handle these market dynamics.

The use of digital platforms as a business model has become common, and companies that have used the power of platform business models have achieved a massive increase in scale and size (Evans & Gawer, 2016). Consequently, there has been a significant increase in research on digital platforms as a business model.

However, the increase in research on this topic is not without complications. The need for more diversity in the adopted methodologies creates a gap in recent research on this topic, as most current research is dominated by empirical studies (Asadullah, Faik & Kankanhalli, 2019). This thesis aims to use an underutilized methodology, namely simulations, to examine the effect of different strategies on digital platform competition. This will ideally contribute to a lacking area of the research.

Our thesis contributes to the growing literature on digital two-sided markets and optimal pricing. Specifically, we add to existing research by examining the optimal pricing on duopolistic and monopolistic platforms at the equilibrium point, as seen in papers like Rochet & Tirole (2003; 2006) and Rys & Sobolewski (2020). Our thesis presents a static model of two-sided markets similar to the one proposed by Rochet and Tirole.

There are concerns that the digital platforms' market power might lead to anti-competitive behavior. Many papers have studied the role of regulations and the market in addressing these concerns (Parker, Petropoulos & Alstyne, 2020; Hylton, 2019). Our thesis aims to contribute to this literature by analyzing potential anti-competitive behavior in music streaming platforms.

Central to our analysis is game theory, a field of study that models strategic situations where the outcome is interdependent on the players' actions. The solution will describe the optimal strategy for the players and the corresponding outcomes that follow from these decisions (Davis & Brams, 2023). The applications of game theory as an analysis tool are widespread in economic research (Yeung, 2016).

There have been several studies on the dynamics of duopoly markets. In 2009, Zhang, Da & Wang studied the dynamics of a duopoly market accounting for potential product differences. More specifically, horizontal product differentiation implies that distinctions between products cannot be easily valued. In other words, the model needs to consider consumers' subjective preferences (Zhang et al., 2009). This study, among others, aims to highlight and handle some of the limitations of the classical tools used in these types of research.

In our thesis, we introduce a differentiated Bertrand model, which involves a parameter in the demand and profit functions that accounts for the differences in

consumer preferences (Ginevicius & Kriyka 2008). This model allows us to remove the homogeneity of products assumption. However, we still need to discuss the advantages and disadvantages of game theory to analyze duopoly markets. We will, in detail, explain the model and theory used in the next section. Although game theory has limitations when analyzing a duopoly market, our thesis presents a unique scenario where one participant holds a predetermined advantage, precisely the commission fee.

Our thesis closely connects to the research of Gutierrez (2022), who examined a comparable market where Amazon functions as both a platform provider and a seller on its platform. Like Apple, Amazon enforces strict fee policies on third-party sellers. Many papers have also researched the regulation of commission fees for digital platforms, and close to our thesis is the paper by Bisceglia and Tirole (2022). It explores the interplay between platform fees to suppliers and whether the platform steers consumers to its apps or hinders sales of third-party apps. Several other papers have also studied the regulation of platform fees (Wang & Wright, 2022; Gomes & Mantovani, 2020).

## 5.0 The Model

We have developed a microeconomic model to simulate a market with two firms as sole providers. The model is built upon game theory and economic principles mentioned in the literature review. We will introduce relevant demand- and profit functions and profit maximization strategies in our unique case. Subsequently, we establish the equilibrium concept utilized to solve the model.

The market represented in our model can be described as a duopoly characterized by two dominant firms. Apple's market power is related to its control of the App Store as a platform, allowing it to set commission fee rates for transactions made within the platform. Spotify holds significant market power in terms of its service offering. It provides a unique music streaming service, which cannot be perfectly substituted by other services, thus granting it some degree of price-setting power. It is crucial to mention that this market power is not absolute and is subject to competition from similar services.

## 5.1 Preliminaries

The baseline model focuses on the case where Spotify sells its services on its website and the App Store. In contrast, Apple only sells its music service on the App Store. This market structure sets the stage for a complex strategic interaction as Apple charges a commission fee for each sale of Spotify's service through its platform, which influences Spotify's pricing strategy. Our model considers a range of commission fee rates and analyzes how they influence the pricing strategies and resulting profits of Spotify and Apple. Each firm's demand is created using a multinomial logit model. This model is widely used in economics for examining categorical outcomes where consumers must choose among multiple options (Berry & Haile, 2021; Werden & Froeb, 2002; Lee & Musolff, 2021; Johari et al., 2022; Hausman & McFadden, 1983).

Our model can be described as a two-stage game that simulates the market and predicts optimal pricing strategies for Spotify and Apple. The complexity of our model makes us unable to find an exact solution to the problem, which is common when using non-linear systems. Given the calibration of supply and demand parameters, we solve the model numerically. The accuracy of the solution will largely depend on the precision of our calibration of these parameters. We will introduce both an open model, where all sales channels are present, and a closed model, where Spotify's website is closed.

## 5.2 The Supply Side

In our model, the supply side is influenced by the strategic pricing decision of the two players. Parameters representing sales of Spotify through its website and the App Store are denoted with **s** and **a**, respectively. Parameters representing sales of Apple Music are denoted with **a_music**. Both companies strive to maximize their profits by setting an optimal price for their services.

The prices are symbolized as $p_s^o$, $p_a^o$ and $p_{a\_music}^o$, where each price is a value such that $p_s^o, p_a^o, p_{a\_music}^o \in [0, \infty)$. Here $p_s^o$ represent the prices for Spotify's services on its website and $p_a^o$ represent the price for Spotify`s services on App Store. Apple set price $p_{a\_music}^o$ for its Apple Music service. In addition, Apple determines a commission fee rate represented as **t**, which is a value such that t ∈ [0, 1]. The notation 'o' represents that we are in an open model where all sales channels are

present. This notation will be changed to 'z' when looking at a closed model, i.e., we close Spotify's website as a sales channel.

The price Spotify sets for its service on the App Store must account for Apple's commission fee, which increases Spotify's costs on that platform. Consequently, Spotify's pricing strategy is a direct function of the commission fee imposed by Apple. On the other hand, Apple Music operates solely on its platform, setting its price to maximize its profit. This profit contains revenue from its service and the commission from Spotify's sales on the App Store. As previously mentioned, the firms engage in a two-stage game, where each firm chooses the price of its services simultaneously and bears symmetric marginal production costs, denoted as **c**, where $c \geq 0$ (Ginevicius & Krivka, 2008, p. 212).

In view of NZ Safiullin and BL Safiullin's paper on "static and dynamic models in economics" (2018), our static model provides a snapshot of the market system under specific conditions. This approach is warranted because our primary focus is not on dynamic effects, such as changing consumer behavior, technological progress, or regulatory shifts. Instead, we assume these dynamics to be relatively minor or slow-moving compared to the impacts we study in our specific scenario. By employing a static model, we can concentrate on the fundamental relationship between prices, demand, and profits in a direct and computationally manageable manner. We define the profit functions of the two players:

**Spotify's profit open model**:

$$\Pi_{\text{Spotify}} = ( p_s^o - c ) \times d_s^o ( p_s^o, p_a^o, p_{a\_music}^o) + ((1 - t) \times p_a^o - c ) \times d_a^o ( p_s^o, p_a^o, p_{a\_music}^o)$$

**Apple's profit open model**:

$$\Pi_{\text{Apple}} = t \times p_a^o \times d_a^o ( p_s^o, p_a^o, p_{a\_music}^o) + ( p_{a\_music}^o - c ) \times d_{a\_music}^o ( p_s^o, p_a^o, p_{a\_music}^o)$$

Each firm aims to maximize its profit, defined as the difference between total revenue and cost. Here, a firm's revenue is a product of its prices ($\boldsymbol{p_s^o}, \boldsymbol{p_a^o}, \boldsymbol{p_{a\_music}^o}$) and the quantity demanded for each product, presented by $\boldsymbol{d_s^o}, \boldsymbol{d_a^o}$ and $\boldsymbol{d_{a\_music}^o}$. The total cost is the product of the marginal cost and the quantity. These profit functions are pivotal as they are the entities that firms aim to maximize, given their pricing

strategies. Including Apple's commission fee on Spotify's in-app purchases is critical to these profit functions. From Spotify's perspective, it reduces the net revenue they receive per in-app subscription. From Apple's perspective, it provides an additional source of revenue.

## 5.3 The Demand Side

Three multinomial logit demand functions describe the demand side of the model. In these functions, the demand for each service is a function of its price and the prices of the other services. A unique feature of these functions is that the demand for a service is always positive and less than one, reflecting the nature of competition and choice in the market (Train, 2009, p.37).

We have made the following demand functions for our model:

**Demand Spotify's website:**

$$d_s^o = \frac{exp(\beta \times p_s^o + a_s)}{exp(\beta \times p_a^o + a_a) + exp(\beta \times p_{a\_music}^o + a_{a\_music}) + exp(\beta \times p_s^o + a_s) + 1}$$

**Demand Spotify on the App Store:**

$$d_a^o = \frac{exp(\beta \times p_a^o + a_a)}{exp(\beta \times p_a^o + a_a) + exp(\beta \times p_{a\_music}^o + a_{a\_music}) + exp(\beta \times p_s^o + a_s) + 1}$$

**Demand Apple Music:**

$$d_{a\_music}^o = \frac{exp(\beta \times p_{a\_music}^o + a_{a\_music})}{exp(\beta \times p_a^o + a_a) + exp(\beta \times p_{a\_music}^o + a_{a\_music}) + exp(\beta \times p_s^o + a_s) + 1}$$

The parameter $\boldsymbol{\beta}$ captures the specific form of elasticity in this model. In this case, $\boldsymbol{\beta}$ is a negative constant, representing the negative relationship between price and demand (Härdle, Hildenbrand & Jerison, 1991).

$\boldsymbol{a_s}$, $\boldsymbol{a_a}$, and $\boldsymbol{a_{a\_music}}$ are parameters in the demand functions. They can be interpreted as each service's intrinsic attractiveness or utility when the price is zero, also called intercept terms or base utilities. The relative sizes of these intercepts can indicate the inherent preference of consumers for one service over the others, independent

of price. For instance, if $a_s > a_a$, it would imply that all else being equal (particularly when the price is zero), consumers prefer buying Spotify from its website over Spotify on the App Store. The intercepts can include factors such as brand reputation – and loyalty, switching costs due to the ecosystem of Apple, user experience, content library size, and more. Note that all the parameters, including the intercepts, are given as inputs to the model based on assumptions and reflect hypothetical values. In an empirical analysis, these parameters must be estimated using real-world data.

In our model, the consumers can buy through three channels (this will change when modifying our model in later sections) or not buy at all, i.e., choosing the outside option. In our model, the outside option is reflected in the term '+1'. As prices increase, the total market share of both firms decreases. We assume that the utility of the outside option is normalized to zero.

## 5.4 Two-stage pricing game and sub-game perfect Nash equilibrium

The game theoretical structure of our model reflects the strategic interaction between the two firms as they each select an optimal price to maximize their profit, considering the other's pricing decisions. Central to this dynamic is the commission fee rate set by Apple, which directly impacts Spotify's pricing strategy on the App Store. Although the commission fee rate is a parameter rather than a strategic variable, its effect on the firms' strategies and profits is a crucial aspect of our analysis. In essence, the model allows us to explore the implications of varying commission fee rates on the pricing strategies of both firms and their resulting profits.

The game assumes complete information, meaning that each player is fully aware of the other player's strategies and payoff. This aligns with the nature of corporate strategy in the real world, where companies thoroughly research market conditions and competitors' behavior.

The stages of the game are:

**Stage 1:** Apple chooses the commission fee rate **t** for subscriptions to Spotify's products through the App Store. This commission fee rate can be viewed as a strategic decision made by Apple, ranging from 0 to 1 (0 to 100 in terms of

percentage). Apple needs to consider the immediate effect of the commission fee rate on its profits and how Spotify will adjust its prices in response, which will further affect Apple's profits.

**Stage 2:** After observing Apple's chosen commission fee rate, both players choose its optimal prices. Spotify sets the optimal prices, $p_s^o$ and $p_a^o$ for the products on its website and the App Store to maximize its profits. For each commission fee rate, Spotify's optimal prices are determined by maximizing its profit function $\Pi_{\text{Spotify}}$, which depends on the prices $p_s^o$ and $p_a^o$ and the commission fee rate $t$. Apple sets the price $p_{a\_music}^o$ to maximize its profit function $\Pi_{\text{Apple}}$.

We solve the model using backward induction and find its sub-game perfect Nash equilibrium. First, we solve Stage 2 of the game for the optimal prices of Spotify and Apple, given each possible commission fee rate. Then, we use these solutions to solve Stage 1 for Apple's optimal commission fee rate. Finding the sub-game perfect Nash equilibrium in this model is done iteratively. In each iteration, given the price of the other player, each player adjusts their price in the direction that increases their profit. This process continues until the prices converge.

Through this game-theoretical approach, we observe how strategic pricing interactions play out in a duopolistic market structure under the effect of a digital platform's commission fee rate. Under this structure, each firm's optimal price will generally depend on the price set by the other firm. An increase in the commission fee rate could lead to higher prices on the platform as firms try to maintain their profit margins.

The sub-game perfect Nash equilibrium reflects the best response strategies of Spotify and Apple Music to each other's prices while accounting for the platform's commission fee rate. This equilibrium gives us insight into how each player can best navigate their pricing strategy in the face of competition and platform fees.

However, it could also impact the demand and the prices on the firms' other sales channels as the platform becomes relatively more expensive. In the case of Spotify and Apple, Spotify must balance the increased cost of selling through the App Store against potentially losing out on the large customer base that the platform provides.

Meanwhile, Apple must consider how the commission fee rate will affect Spotify's pricing strategy and, thus, its profits from the commissions.

## 5.5 Open versus Closed Model

We are examining two distinct market scenarios in our model: The open and closed model. The closed model assumes that the App Store is the only platform where Spotify and Apple can sell their products, i.e., Spotify's website is closed. This model modification aims to simulate the effect of the restrictions on consumer communication, an essential claim in the ongoing Apple versus Spotify dispute.

**Open Model:** This model refers to the model described in the previous sections, where Spotify sells subscriptions through its website and the App Store. This scenario acknowledges the benefits of multi-channel marketing, where Spotify can reach customers who prefer purchasing directly and those who prefer using the App Store. This model captures a real-world situation where a provider like Spotify can bypass a platform's commission by selling directly to consumers.

**Closed Model:** In the closed model, Spotify sells subscriptions exclusively through the App Store. This model calculates the optimal price that maximizes Spotify's profit for each commission fee rate while identifying Apple's optimal rate. This scenario reflects a situation where Spotify has no outside option for selling its product. The interpretation of the profit functions below follows the same logic as profit functions presented in the open model, excluding terms related to Spotify's website.

**Spotify's profit closed model:**

$$\Pi_{\text{Spotify-closed}} = (\,(1 - t) \times p_a^z - c\,) \times d_a^z\,(\,p_a^z, p_{a\_music}^z\,)$$

**Apple's profit closed model:**

$$\Pi_{\text{Apple-closed}} = t \times p_a^z \times d_a^z\,(\,p_a^z, p_{a\_music}^z\,) + (\,p_{a\_music}^z - c\,) \times d_{a\_music}^z\,(\,p_a^z, p_{a\_music}^z\,)$$

From the strategic decision-making perspective, comparing profits in the open and closed models can guide Spotify in its decisions about its choice of sales platforms. For example, if the open model yields substantially higher profits than the closed

model, it could justify the added complexity and costs of selling through multiple channels.

In terms of price optimization, the analysis presents the optimal prices for both the App Store and Spotify's website under different commission fee rates, thus offering valuable insight to shape Spotify's pricing strategy. Understanding how the commission fee rate affects profits for both Spotify and Apple in various market scenarios, such as open and closed models, can provide useful information in negotiating commission fees. For example, if Apple's profits are maximized at a commission fee rate lower than the current one, Spotify could leverage this information during negotiation.

Analyzing the open and closed models offers a comprehensive understanding of the dynamics between Spotify and Apple in the digital music streaming market. This analysis can help both entities make informed pricing strategies and negotiation decisions, enhancing their competitive stance in the market.

## 5.6 Model without Apple Music

We have also created a model that excludes Apple Music, effectively removing a player from the duopolistic market structure. This exclusion changes the market dynamics and competitive landscape significantly. In the context of our model, this transforms the scenario so that Spotify's product only competes with itself across the two platforms. It allows us to study the effect of product competition (or the lack thereof) on pricing and commission-setting strategies in a two-sided market.

The profit functions below follow the same logic as previous profit functions and show Spotify's and Apple's profits in the open model, excluding Apple Music. The closed model profit functions behave similarly, excluding terms related to Spotify's website.

**Spotify's profit open model without Apple Music:**

$$\Pi_{\text{Spotify}} = ( p_s^o - c ) \times d_s^o ( p_s^o , p_a^o ) + ((1 - t) \times p_a^o - c) \times d_a^o ( p_s^o , p_a^o )$$

**Apple's profit open model without Apple Music:**

$$\Pi_{\text{Apple}} = t \times p_a^o \times d_a^o ( p_s^o , p_a^o )$$

We want to study the following four potential effects of this change:

**1: Impact on Spotify's Pricing Strategy:** Spotify may change its pricing strategy significantly because it no longer needs to compete with Apple Music. The prices on Spotify's platform and the App Store could increase or decrease depending on other market factors.

**2: Impact on Apple's Commission Fee Rate**: Apple's optimal commission fee rate may change. With no direct competition from Apple Music, Apple's only income source on its platform is now solely from Spotify's sales. Thus, Apple needs to consider how changes in the commission fee rate can affect Spotify's pricing strategy and sales volume, which again impacts Apple's profits.

**3: Impact on Market Shares:** The market share of Spotify's products on its platform and the App Store will likely change without Apple Music. If Apple's commission fee rate is too high, it could drive more users to purchase directly from Spotify's website. On the other hand, a lower commission fee rate could indirectly attract more sales to the App Store.

**4: Changes in Profits:** The profits of Spotify and Apple will probably change in response to the new pricing and commission strategies and the subsequent changes in market shares. Depending on how the strategies evolve, one or both parties could see their profits increase and decrease.

## 5.7 Consumer Welfare

In our analysis, we aim to calculate and compare the consumer welfare in the model with and without Apple Music. To achieve this, we used the Log-sum formula, which measures the variation in consumers' expected utility caused by any change in a market (Train, 2009, pp. 55-56).

$$\Delta CS = \frac{1}{-\beta} \times (\ln [\exp (a_{a\,music} - \beta \times p^z_{a\,music}) + \exp (a_a - \beta \times p^z_a) + 1]$$
$$- \ln [\exp (a_{a\,music} - \beta \times p^o_{a\,music}) + \exp (a_a - \beta \times p^0_a) + \exp (a_s$$
$$- \beta \times p^0_s) + 1])$$

The equation above quantifies the sum of utilities the consumers derive from each of the three products in the model with Apple Music. We calculate this sum in the closed and open model, and the difference between these two gives us the change in consumer welfare. The function follows the same logic in the model that excludes Apple Music. This computation aims to see whether Apple's communication restrictions policies also affect the consumers.

## 5.8 Limitations and Justifications

As our model only is a simplification of a real-world scenario, it does not capture every nuance and variable in the intricate dynamics of the digital music streaming market. However, it is designed to provide valuable insights into the strategic interactions between Spotify and Apple and the impact of Apple's commission fee rate on market outcomes. Despite its inherent simplifications and limitations, the model has several justifications from a microeconomic perspective.

We present Spotify and Apple as the market's sole players, and our model is premised on the assumption of perfect competition. In reality, the digital music streaming market is characterized by imperfect competition, with significant players such as Amazon Music and YouTube Music. Incorporating these additional players could yield different results.

Our model employs a multinomial logit demand function. While this offers a good approximation in many situations, it may not capture all aspects of consumer behavior. This model might fall short if consumers' heterogeneous preferences or network effects are at play. Our model is also static, meaning it does not account for changes over time. Real-world pricing strategies and market conditions, influenced by factors such as the changing popularity of songs or artists, dynamically evolve, which our model does not capture.

Our model does not consider fixed costs, like developing and maintaining the streaming platform. These costs can significantly impact the profitability of each player. The model also presupposes uniform pricing, i.e., Spotify and Apple set one singular price for all consumers. Firms often use price discrimination, offering different prices to different consumer segments, which could lead to higher profits. Finally, the model focuses exclusively on revenue derived from subscription fees,

overlooking other substantial sources of revenue like advertising and other in-app purchases.

Despite these limitations, our model has several justifications. Its simplicity and analytical tractability allow a detailed investigation into Spotify and Apple's strategic interactions. By focusing on these key players, we can better understand the dynamics of the digital music streaming market. Despite its simplification, the logit model for demand is a widely used and accepted economic model capturing consumers' trade-offs between different products. Understanding the impact of Apple's commission fee rate on Spotify's pricing strategy and the overall profitability of both firms is a crucial aspect of our model. This is particularly relevant given the ongoing debates about the fairness of digital platforms' commission fee rates.

We explore strategic trade-offs linked to different distribution strategies by comparing open and closed scenarios, i.e., Spotify is available on its website and the App Store versus only on the App Store. Our model's two-stage game setup captures the firms' decision-making process, mirroring real-world decision-making. Using backward induction to solve the game is a standard method in game theory. It ensures that the strategies identified are sub-game perfect Nash equilibria, where no player has incentives to deviate from their strategy given other players' strategies.

The parameters, including price sensitivity and cost structure, closely resemble real-world conditions. This makes our model's predictions applicable to the actual market scenario. Despite the limitations of our model, its justifications suggest that it can provide useful information about the strategic interactions between Spotify and Apple and the effects of commission fee rates on the digital music streaming market.

## 5.9 Calibration of Parameter values

Table 1 shows the chosen parameter values in the open and closed model with Apple Music. Similarly, Table 2 presents the chosen parameter values in the model without Apple Music.

Table 1: Parameter values in the model with Apple Music

| Including Apple Music | Open Model | Closed Model |
|---|---|---|
| Intercept own website ($\alpha_s$) | 3 | |
| Intercept App Store ($\alpha_a$) | 1.25 | 1.25 |
| Intercept Apple Music ($\alpha_{a\_music}$) | 2.5 | 2.5 |
| Costs (c) | 5 | 5 |
| Price sensitivity ($\beta$) | -0.33 | -0.33 |

Table 2: Parameter values in model without Apple Music

| Excluding Apple Music | Open Model | Closed Model |
|---|---|---|
| Intercept own website ($\alpha_s$) | 3 | |
| Intercept App Store ($\alpha_a$) | 1.25 | 1.25 |
| Costs (c) | 5 | 5 |
| Price sensitivity ($\beta$) | -0.33 | -0.33 |

Finding good approximations for the values of the parameters used in our model is challenging without historical data. Given this, our justification for the parameters will be somewhat abstract and limited. When setting the parameter values, our primary goal is to get the optimal commission fee equal to 30%, reflecting the commission fee rate Spotify needs to pay to Apple to sell through App Store. Most likely, several combinations of parameter values can help us achieve the targeted commission fee rate, but this is the only combination we found.

**Intercepts**

Our intercept values are based on limited historical data, as the information on user counts on the different sales channels is left out of any company reports. Therefore, we need to make an assumption on the distribution of demand on the various sales channels. Based on the background information presented in section 2, we assume the demand for Spotify through its website to be larger than the demand through the App Store, mainly because of the geographical distributions and total numbers of users of the different streaming services and operating systems. Whether this assumption holds in the real world is, at best, questionable, but with limited crucial information, it is a good starting point for our model calibration. The chosen values aim to reflect the real-world distribution between Spotify and Apple's user count.

**Costs**

We assume the costs to be constant (a reasonable assumption given the product's characteristics), and the value chosen reflects the firms' relatively high costs as discussed in Section 2. We also justify this value based on the quarterly report from Spotify, including information on the premium subscription profit margin (Spotify-a, 2022, p. 7). In our model, we assume that the goods are substitutes, and both firms will face the same costs for sales of their premium subscriptions.

**Price sensitivity**

In economic research, using a negative beta to illustrate the negative relationship between price increase and demand is common. Our value is relatively low to reflect high consumer loyalty. Regarding the ongoing antitrust case, this number also reflects the potential limitations in how Spotify can communicate with consumers.

# 6.0 Results & Analysis

This section examines the model's outcomes derived from the specified parameter values. The critical components under investigation include optimal pricing strategies and commission fee rates, profit implications, market power dynamics, and issues about fair competition. It also includes implications specific to the Spotify versus Apple case.

## 6.1 Optimal Pricing Strategies in the Open and Closed Model

The following analysis (Figure 8) examines the relationship between increasing commission fees and optimal pricing strategies for Spotify and Apple on the different sales channels. The results demonstrate that the optimal prices for Spotify's product on the App Store increase as the commission fee increases. However, the price seems relatively stable on Spotify's website. The price increase on the App Store supports Spotify's claim that higher commission fees force them to raise their prices to maintain profitability.

Interestingly, Apple Music's pricing strategy mirrors this trend. As the commission fee increases, the prices for Apple Music also rise. One potential explanation could be Apple's attempt to capitalize on Spotify's increased prices, allowing them to boost their profit margins without appearing uncompetitive.

Figure 8: Optimal prices different commission fees open model
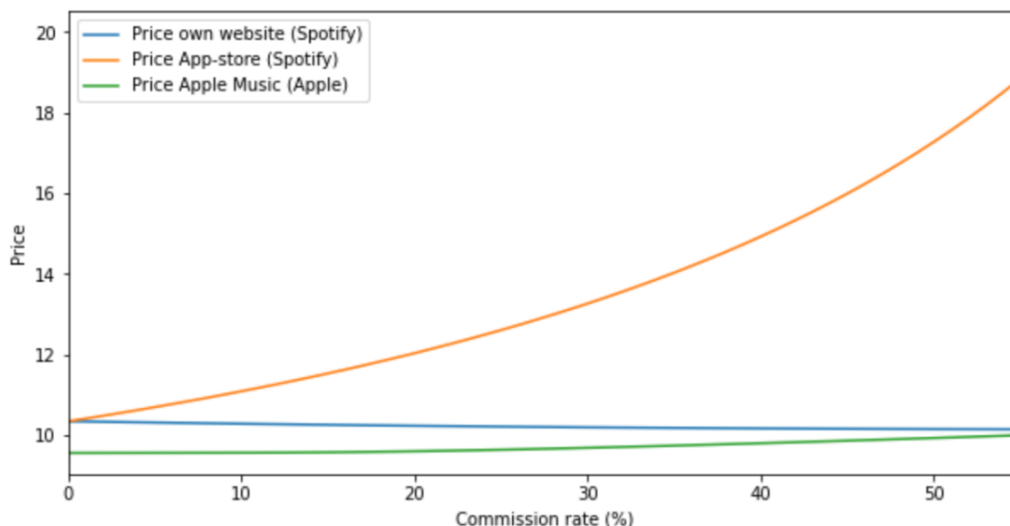
In the closed model (Figure 9), where sales are limited to the App Store, we see that the optimal pricing strategy for Spotify remains the same as in the open model. However, the prices for Apple Music seem to stay relatively unchanged. The consistency across both models further underscores the significant influence of commission fees on optimal pricing strategies in digital music services.



Figure 9: Optimal price at different commission fees closed model
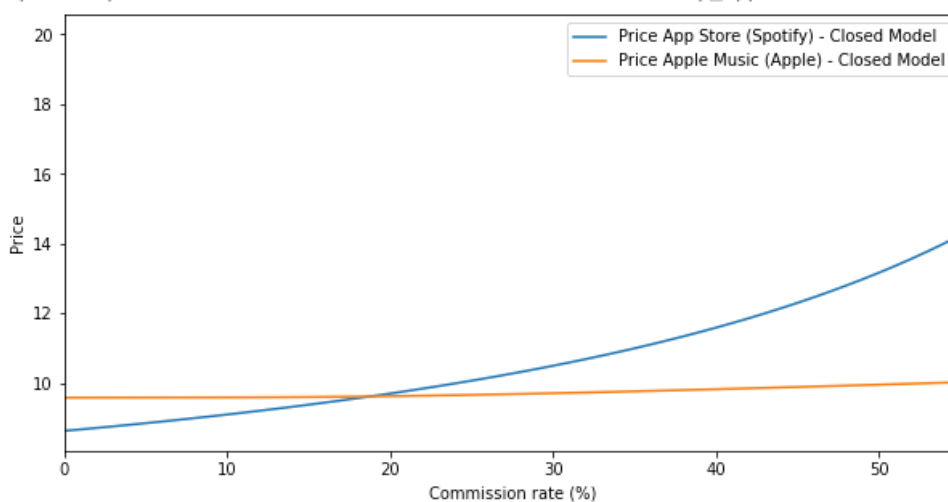
## 6.2 Profit Implications

Changes in the commission fee significantly impact the profit outcomes for both Apple and Spotify. As the commission fee rate increases, Spotify experiences a

30

downward trend in profit. This is as expected, considering that with a higher commission fee rate, Spotify must share a more significant portion of its revenue with Apple. This impact is even more pronounced in the closed model, where Spotify's profit trends towards zero and ultimately a deficit.

On the other hand, Apple's profits demonstrate an upward trend with the increasing commission fee rate. This observation aligns with expectations, illustrating how Apple could capitalize on its marketplace position to maximize its profits. The dynamics between commission fees and profit outcomes are shown in Figure 10 and Figure 11 highlighting the significant role of commission fees in determining profitability in the digital music streaming market.

Figure 10: Profits at different commission fees open model with Apple Music.
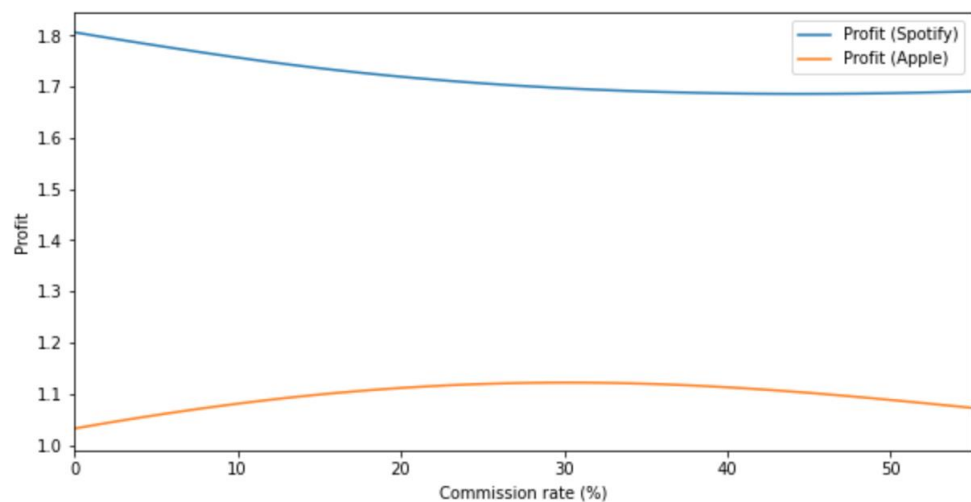


Figure 11: Profits at different commission fees closed model with Apple Music
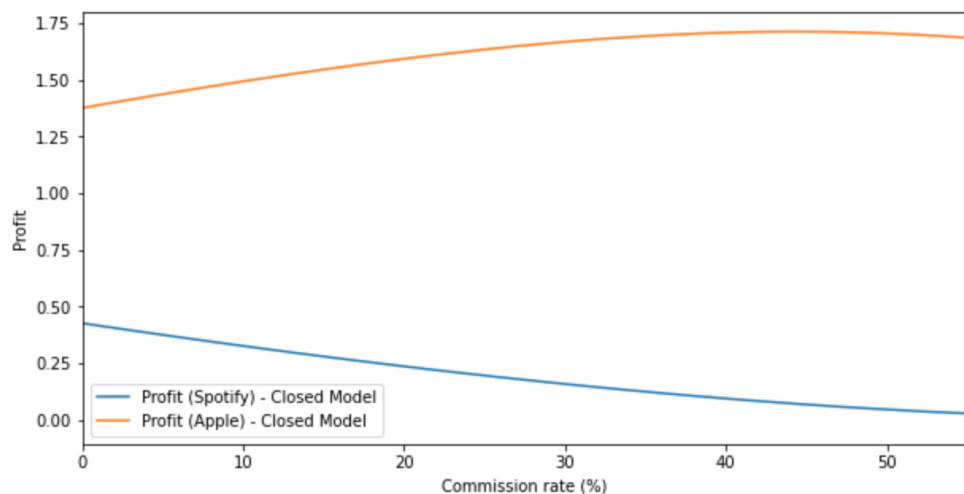
## 6.3 Market Power and Competitive Equity

Apple has complete control over the App Store, which gives the company significant market power. This power is demonstrated through Apple's ability to set commission fee rates. As previously discussed, this market power impacts profit and pricing strategies. In our models, the rate is chosen to maximize Apple's profit. Due to our calibration process, the optimal commission fee rate in the open model is 30% (Figure 10). However, the closed model suggests a higher rate of 44% (Figure 11).

## 6.4 Contrast Between Open and Closed Models

Table 3 compares elements such as the optimal commission fee rate, prices, respective profits, and market shares for Spotify and Apple, as well as the variation in consumer welfare going from the open to the closed model.

Table 3: Comparison of key statistics in the open and closed model

|  | Open Model | Closed Model | Ratio |
|---|---|---|---|
| Optimal Commission (%) | 30 | 44 | 0.697674 |
| Optimal Price own website | 10.19353548 | | |
| Optimal Price on App Store | 13.2629417 | 12.14769606 | 1.189747 |
| Optimal Price Apple Music | 9.685009443 | 9.876929102 | 1.091032 |
| Market Share own website | 0.310622266 | | |
| Market Share App Store | 0.019602822 | 0.041383499 | -0.02045 |
| Market Share Apple Music | 0.222825997 | 0.305587247 | -0.32088 |
| Profit Spotify | 1.697207409 | 0.074602439 | -1.83403 |
| Profit Apple | 1.121939228 | 1.711521571 | 1.576817 |

| Variation in Consumer Welfare | -2.479859503 |
|---|---|

The comparison reveals that Apple's optimal commission fee rate is higher in a closed model. We also noticed a pricing strategy change between open and closed models. In the closed model, the optimal price for Spotify's product on the App Store is 12.15, compared to 13.26 in the open model. This difference can potentially be attributed to the altered market dynamics and the fact that Spotify no longer sells through its website in the closed model.

When Spotify only sells its products through the App Store, Apple's market share increases from 22% to 30%. This is an expected increase because Spotify's website is no longer a competitor. On the other hand, Spotify's market share on the App Store goes slightly up, but not as much as Apple's. This shows that Apple benefits more than Spotify in terms of market share when Spotify is limited to selling on the App Store. These results strengthen the argument surrounding Apple's potential for an unfair advantage using its communication restriction policies.

The negative variation in consumer welfare of -2.48 implies that the change in consumer welfare is negative when moving from an open to a closed model. In aggregate, consumers are worse off in the closed model than in the open model in terms of the economic benefit they receive.

## 6.5 The Spotify versus Apple Dispute

According to our analysis, Spotify's claims about the impact of commission fees on their prices and profits are accurate. As Spotify raises its prices to cover the increased commission fees, its profits decrease. In contrast, Apple sees increased profits and prices, which could be considered an unfair advantage. However, it is essential to note that our analysis is based on a simplified model and may not fully capture the complexities of the market situation.

Drawing definitive conclusions based solely on this model could be misleading, as the parameters and model structure cannot reflect all the nuances of the real world. Further analysis using actual market data would be necessary for more precise and realistic outcomes. However, given the constraints of our study, this is not feasible.

To better understand Apple's strategies, we will analyze a modified model that does not include its own product, Apple Music. By comparing the results with those from the original model, we can see if Apple's practices focus on increasing product sales. This method will help us understand Apple's actions as a platform provider without being influenced by its role as a direct competitor in the music streaming industry.

## 6.6 Cross-Comparison between the Modified and Original Model

The outcomes from both open and closed versions of the modified model are displayed in Table 4.

Table 4: Comparison of key statistics in the open and closed model without Apple Music

|  | Open Model | Closed Model | Ratio |
|---|---|---|---|
| Optimal commission (%) | 28 | 38 | 0.756757 |
| Optimal Price own website | 10.25 |  |  |
| Optimal price on App Store | 12.95 | 11.3 | 1.257282 |
| Market Share own website | 0.394129859 |  |  |
| Market Share App Store | 0.028097496 | 0.077343533 | -0.03045 |
| Profit Spotify | 2.190675328 | 0.155151128 | -2.59298 |
| Profit Apple | 0.101881519 | 0.332113133 | -0.15254 |

| Variation in consumer Welfare | -5.306085903 |
|---|---|

A notable observation from the modified model is the diminished optimal commission fee rate in both open and closed versions. A variety of reasons could justify this pattern. A plausible explanation could be the absence of Apple's proprietary product, which incentivizes a lower commission fee rate to stimulate demand for Spotify's product and indirectly increase Apple's profit.

From comparing these models, we also observe a decline in optimal prices when Apple Music is excluded. This may lend credit to Spotify's claims, as Apple's optimal behavior within the original model seems to be aimed at profit maximization by using the commission fee to inflate Spotify's product price, elevating Apple's market share. However, we see a larger negative number in the variation in consumer welfare of -5.31 in the modified model. This implies that consumers are even worse off in a model that goes from open to closed, where Apple Music is excluded.

While it is intuitively logical that Spotify's market share would be more significant in a model lacking competition, Apple may exploit its market dominance to construct an unfair advantage within the music streaming industry's marketplace.
It is essential to remember that these values come from predetermined values of the price sensitivity and the different prices at given initial values for the different parameters. Changes in these parameters can lead to changes in the computed variation in consumer welfare.

# 7.0 Concluding Remarks

In our thesis, we aimed to analyze the market dynamics in the digital music streaming services, primarily through the ongoing Spotify versus Apple antitrust case. Through the lens of our models, we observed how commission fee structures significantly impact pricing, profits, market shares, and, arguably, competition fairness within the industry.

We found that increased commission fee rates resulted in higher prices for Spotify's services, adversely affecting their profitability. Simultaneously, this fee structure benefited Apple by inflating its profits and strengthening its market presence.

When comparing the original model inclusive of Apple Music to a modified model excluding Apple Music, we noted a decrease in optimal commission fee rates and prices. This finding may support Spotify's claim that Apple's fee structure creates an unfair market advantage by making Spotify's products more expensive, thereby indirectly boosting Apple Music's market share.

While our models offer a valuable glimpse into market dynamics, they rely on simplified assumptions and need more input in the form of real-world data and complexity considerations.

We include similar antitrust cases to strengthen our analysis. The Apple vs. Epic Games lawsuit has similarities to the case we are analyzing. However, there is a key difference that we need to consider. In the market we are studying, Apple is a direct competitor to Spotify, as opposed to the Apple vs. Epic Games lawsuit. This difference can be a tipping point in whether Apple behaves anti-competitively.

Our analysis, along with insights from previous cases, indicates that Apple is leveraging its dominant market position to gain an unfair advantage over competitors. Regulatory measures may need to be implemented to prevent harm to consumers and ensure fair competition.

Future research should aim to refine these models with additional competitors, consumer preferences, and technological changes supported by incorporating real-world data to improve accuracy. These improvements could help us better understand the complex relationship between Apple and Spotify and how it impacts the music streaming industry.

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# 9.0 Appendix

In the following four pages, we will show the optimal prices at the different commission fees for our four different models: An open and closed model that includes Apple Music and an open and closed model that excludes Apple Music.

The optimal choice of the commission fee and the corresponding prices that maximize Apple's profit are marked in orange. We have also put an upper limit on prices of 20. This does not affect the optimal commission fee choice, and the purpose of this is to minimize the time required to run through the codes.

# Open Model that includes Apple Music

| Price own website | Price App-store | commission_rate (%) | Price Apple Music | Profit Spotify | Profit Apple |
|---|---|---|---|---|---|
| 10,34413207 | 10,34400817 | 0 | 9,557100307 | 1,806486732 | 1,032068469 |
| 10,33754273 | 10,41129641 | 1 | 9,557792521 | 1,80120303 | 1,037629128 |
| 10,33107094 | 10,47996415 | 2 | 9,558370489 | 1,795978798 | 1,043044757 |
| 10,32470155 | 10,55015118 | 3 | 9,559014595 | 1,790839132 | 1,048306443 |
| 10,31843429 | 10,62190909 | 4 | 9,559627771 | 1,785771848 | 1,053415307 |
| 10,31221283 | 10,69545814 | 5 | 9,560240361 | 1,780783351 | 1,058363787 |
| 10,30614031 | 10,77054652 | 6 | 9,560810237 | 1,775866213 | 1,063158125 |
| 10,30017248 | 10,8473576 | 7 | 9,561464264 | 1,771039321 | 1,067788529 |
| 10,29437714 | 10,92577617 | 8 | 9,56207615 | 1,76628463 | 1,072263134 |
| 10,28860594 | 11,00625184 | 9 | 9,5626889 | 1,761613186 | 1,076565289 |
| 10,28290519 | 11,08872623 | 10 | 9,56346434 | 1,757045815 | 1,080690771 |
| 10,27736489 | 11,17303875 | 11 | 9,564656742 | 1,752613744 | 1,084637559 |
| 10,27193279 | 11,25939466 | 12 | 9,566320171 | 1,748326136 | 1,088397137 |
| 10,2666109 | 11,3478619 | 13 | 9,568525546 | 1,744192591 | 1,091965484 |
| 10,26139848 | 11,43851871 | 14 | 9,571157725 | 1,740198413 | 1,095344534 |
| 10,25629646 | 11,53145017 | 15 | 9,574486059 | 1,736379005 | 1,09852352 |
| 10,25133014 | 11,62666082 | 16 | 9,578399948 | 1,732719337 | 1,101507258 |
| 10,24643647 | 11,72439417 | 17 | 9,582888856 | 1,729220466 | 1,104286961 |
| 10,24166498 | 11,82464636 | 18 | 9,587959882 | 1,725881644 | 1,106866158 |
| 10,23701473 | 11,9274806 | 19 | 9,593558714 | 1,722696251 | 1,109245 |
| 10,23251756 | 12,03201348 | 20 | 9,599712837 | 1,719671021 | 1,111430973 |
| 10,22808058 | 12,14144098 | 21 | 9,606416677 | 1,71679559 | 1,113391833 |
| 10,22378774 | 12,25276643 | 22 | 9,613512499 | 1,714060253 | 1,115161371 |
| 10,21962461 | 12,36715757 | 23 | 9,621148909 | 1,711480056 | 1,116724482 |
| 10,2154976 | 12,4845586 | 24 | 9,629116529 | 1,709033689 | 1,118078451 |
| 10,21154918 | 12,60540399 | 25 | 9,637553598 | 1,706730835 | 1,119230641 |
| 10,20772295 | 12,72969968 | 26 | 9,646342824 | 1,704560011 | 1,120179281 |
| 10,20401099 | 12,85752808 | 27 | 9,655453202 | 1,702518069 | 1,120924831 |
| 10,20039641 | 12,98893296 | 28 | 9,665104904 | 1,70063394 | 1,121458191 |
| 10,1968783 | 13,12408015 | 29 | 9,674780001 | 1,698842589 | 1,121799032 |
| 10,19353548 | 13,2629417 | 30 | 9,685009443 | 1,697207409 | 1,121939228 |
| 10,19031833 | 13,40736097 | 31 | 9,69535053 | 1,695670483 | 1,12186982 |
| 10,18713099 | 13,55525908 | 32 | 9,70603306 | 1,694271786 | 1,121600731 |
| 10,18413767 | 13,70807307 | 33 | 9,716893387 | 1,692979458 | 1,121143267 |
| 10,18118104 | 13,86503778 | 34 | 9,727969749 | 1,691808143 | 1,120493029 |
| 10,17839169 | 14,0274569 | 35 | 9,73934866 | 1,690759291 | 1,119649456 |
| 10,17578441 | 14,19554918 | 36 | 9,75087181 | 1,689812623 | 1,118624169 |
| 10,1731684 | 14,36826721 | 37 | 9,762633387 | 1,68899121 | 1,117412629 |
| 10,17064214 | 14,54648913 | 38 | 9,774513303 | 1,688273713 | 1,11602731 |
| 10,1683825 | 14,7321311 | 39 | 9,786646902 | 1,687664695 | 1,114464684 |
| 10,16621261 | 14,92380457 | 40 | 9,798774485 | 1,687143666 | 1,112745142 |
| 10,16403508 | 15,12150163 | 41 | 9,811229524 | 1,686755311 | 1,110852164 |
| 10,16202808 | 15,32653745 | 42 | 9,823763547 | 1,686458609 | 1,108811355 |
| 10,16012536 | 15,53890321 | 43 | 9,836470558 | 1,686267673 | 1,106622832 |
| 10,15838086 | 15,75932957 | 44 | 9,849238378 | 1,686164956 | 1,104301862 |
| 10,15664819 | 15,98749297 | 45 | 9,862187834 | 1,686171526 | 1,101843462 |
| 10,15505909 | 16,22450847 | 46 | 9,875175971 | 1,686261923 | 1,0992708 |
| 10,15357629 | 16,47075985 | 47 | 9,888472195 | 1,686468604 | 1,096576417 |
| 10,15218246 | 16,72658471 | 48 | 9,901614142 | 1,686735994 | 1,093795498 |
| 10,15087572 | 16,99254509 | 49 | 9,914974113 | 1,687106574 | 1,090918672 |
| 10,14966004 | 17,26930774 | 50 | 9,928321452 | 1,68755089 | 1,08796974 |
| 10,14853449 | 17,55755996 | 51 | 9,941985756 | 1,688105664 | 1,084941508 |
| 10,14749771 | 17,85799586 | 52 | 9,955625974 | 1,688728602 | 1,081865595 |
| 10,14653743 | 18,17138788 | 53 | 9,969394669 | 1,689435797 | 1,078744524 |
| 10,14566841 | 18,49860527 | 54 | 9,98320393 | 1,690213753 | 1,075597922 |
| 10,14487284 | 18,8406092 | 55 | 9,997050213 | 1,691060226 | 1,072436939 |
| 10,14414954 | 19,19832276 | 56 | 10,01108107 | 1,691989613 | 1,06926638 |
| 10,14350764 | 19,57300924 | 57 | 10,0251579 | 1,692982393 | 1,066107898 |
| 10,14288564 | 19,94120344 | 58 | 10,03915711 | 1,694031647 | 1,063135307 |
| 10,14233514 | 20 | 59 | 10,05332828 | 1,695225598 | 1,06221858 |
| 10,14178578 | 20 | 60 | 10,06760641 | 1,696444442 | 1,061662926 |
| 10,14123637 | 20 | 61 | 10,08186825 | 1,697655906 | 1,061098008 |
| 10,140687 | 20 | 62 | 10,09633898 | 1,698885597 | 1,060508816 |
| 10,14013816 | 20 | 63 | 10,11065441 | 1,700092019 | 1,059919795 |
| 10,13958814 | 20 | 64 | 10,12519206 | 1,701318053 | 1,05930523 |
| 10,1390397 | 20 | 65 | 10,13966252 | 1,702530762 | 1,058685148 |
| 10,13849002 | 20 | 66 | 10,15424922 | 1,703750932 | 1,058046584 |
| 10,13794139 | 20 | 67 | 10,16888402 | 1,704970722 | 1,057394474 |
| 10,13739161 | 20 | 68 | 10,1835834 | 1,70619202 | 1,05672747 |
| 10,13684332 | 20 | 69 | 10,1983363 | 1,707413416 | 1,056046332 |
| 10,13629407 | 20 | 70 | 10,21311414 | 1,708631799 | 1,055353145 |
| 10,13574441 | 20 | 71 | 10,22794088 | 1,709849771 | 1,054646145 |
| 10,13519594 | 20 | 72 | 10,2428102 | 1,711066517 | 1,05392598 |
| 10,13464672 | 20 | 73 | 10,25775967 | 1,712286206 | 1,053189604 |
| 10,13409817 | 20 | 74 | 10,27269111 | 1,713497959 | 1,052444566 |
| 10,13354902 | 20 | 75 | 10,2876258 | 1,714704177 | 1,05168922 |
| 10,13300039 | 20 | 76 | 10,30277895 | 1,715928184 | 1,050907153 |
| 10,1324521 | 20 | 77 | 10,31784939 | 1,717137164 | 1,050121475 |
| 10,13190307 | 20 | 78 | 10,33297385 | 1,718346006 | 1,049321577 |
| 10,13135417 | 20 | 79 | 10,34811534 | 1,719550645 | 1,04851048 |
| 10,13080594 | 20 | 80 | 10,36323983 | 1,720747402 | 1,047691038 |
| 10,13025686 | 20 | 81 | 10,37858677 | 1,721961929 | 1,046843885 |
| 10,12970851 | 20 | 82 | 10,3938497 | 1,723161321 | 1,045993791 |
| 10,12915992 | 20 | 83 | 10,40923305 | 1,724367389 | 1,045124148 |
| 10,12861158 | 20 | 84 | 10,42456003 | 1,725561312 | 1,044249491 |
| 10,12806246 | 20 | 85 | 10,43987954 | 1,726748353 | 1,043365804 |
| 10,12751471 | 20 | 86 | 10,45528839 | 1,727938592 | 1,042465419 |
| 10,1269663 | 20 | 87 | 10,47068364 | 1,729121266 | 1,041556645 |
| 10,12641813 | 20 | 88 | 10,4862096 | 1,730311389 | 1,040627204 |
| 10,12586953 | 20 | 89 | 10,50171834 | 1,731493502 | 1,039690303 |
| 10,12532093 | 20 | 90 | 10,51724408 | 1,732671151 | 1,038742435 |
| 10,12477309 | 20 | 91 | 10,53283715 | 1,733849484 | 1,037779623 |
| 10,12422476 | 20 | 92 | 10,5484029 | 1,735018769 | 1,036809997 |
| 10,12367654 | 20 | 93 | 10,56402352 | 1,736187427 | 1,03582652 5 |
| 10,12312836 | 20 | 94 | 10,57968547 | 1,737354032 | 1,034830404 |
| 10,12258024 | 20 | 95 | 10,59536848 | 1,738516486 | 1,03382348 |
| 10,12203196 | 20 | 96 | 10,61106926 | 1,739674453 | 1,032806089 |
| 10,1214846 | 20 | 97 | 10,62680343 | 1,740829454 | 1,031777014 |
| 10,12093626 | 20 | 98 | 10,64257164 | 1,741981604 | 1,030736018 |
| 10,12038815 | 20 | 99 | 10,65836199 | 1,743129636 | 1,029684379 |
| 10,11984107 | 20 | 100 | 10,67417472 | 1,744273528 | 1,028622234 |

# Closed Model that includes Apple Music

| Price App-store | commission_rate (%) | Price Apple Music | Profit Spotify | Profit Apple |
|---|---|---|---|---|
| 8,632807053 | 0 | 9,584581436 | 0,427551714 | 1,375651716 |
| 8,674976751 | 1 | 9,585204657 | 0,417173165 | 1,387967548 |
| 8,718105385 | 2 | 9,585833479 | 0,406873007 | 1,400157778 |
| 8,762224516 | 3 | 9,586458033 | 0,396652541 | 1,412217842 |
| 8,807367637 | 4 | 9,587079873 | 0,386513581 | 1,424142838 |
| 8,853616766 | 5 | 9,587707406 | 0,376457966 | 1,435929576 |
| 8,900933574 | 6 | 9,58832854 | 0,366487496 | 1,447569713 |
| 8,949385768 | 7 | 9,588991532 | 0,356605601 | 1,459058632 |
| 8,999012009 | 8 | 9,589598583 | 0,346810674 | 1,470391691 |
| 9,049855037 | 9 | 9,590243675 | 0,337107989 | 1,481562219 |
| 9,101957638 | 10 | 9,590953097 | 0,327500298 | 1,492564138 |
| 9,155366359 | 11 | 9,592077315 | 0,318000674 | 1,503389427 |
| 9,210127925 | 12 | 9,593644441 | 0,308610951 | 1,514032703 |
| 9,266092818 | 13 | 9,595729522 | 0,299335141 | 1,524483625 |
| 9,323920491 | 14 | 9,598372563 | 0,29017275 | 1,534750448 |
| 9,383051044 | 15 | 9,601606563 | 0,281127967 | 1,5448131 |
| 9,443750082 | 16 | 9,60549351 | 0,272202392 | 1,554670085 |
| 9,506078409 | 17 | 9,609849301 | 0,263391748 | 1,564315241 |
| 9,570100262 | 18 | 9,614843742 | 0,254701618 | 1,573741261 |
| 9,635882152 | 19 | 9,620366944 | 0,24613008 | 1,582940928 |
| 9,703493984 | 20 | 9,626437398 | 0,237678763 | 1,591906418 |
| 9,773010309 | 21 | 9,633083317 | 0,229349526 | 1,600629548 |
| 9,84450766 | 22 | 9,640054793 | 0,22113796 | 1,609101772 |
| 9,91806954 | 23 | 9,647726129 | 0,213054068 | 1,617314091 |
| 9,993781333 | 24 | 9,655721409 | 0,205091054 | 1,625257212 |
| 10,0717344 | 25 | 9,664082091 | 0,197251773 | 1,632921486 |
| 10,15202466 | 26 | 9,672836143 | 0,189538751 | 1,640296976 |
| 10,23475387 | 27 | 9,682058464 | 0,181955351 | 1,647373423 |
| 10,32002787 | 28 | 9,691471126 | 0,174498501 | 1,654140483 |
| 10,40796051 | 29 | 9,701412843 | 0,167176507 | 1,660587252 |
| 10,49867122 | 30 | 9,7115241 | 0,159985353 | 1,666703158 |
| 10,59228009 | 31 | 9,721919171 | 0,152929497 | 1,67247724 |
| 10,68893368 | 32 | 9,73267838 | 0,146012563 | 1,67789803 |
| 10,78876816 | 33 | 9,743544817 | 0,139233242 | 1,682955081 |
| 10,8919347 | 34 | 9,754708271 | 0,132596955 | 1,687636799 |
| 10,99859226 | 35 | 9,766179379 | 0,126106329 | 1,691931959 |
| 11,1089121 | 36 | 9,777789659 | 0,119761793 | 1,695830265 |
| 11,22307432 | 37 | 9,789569114 | 0,113566495 | 1,699320955 |
| 11,34127181 | 38 | 9,801646838 | 0,107524562 | 1,702392714 |
| 11,46370926 | 39 | 9,813775157 | 0,101635902 | 1,705037082 |
| 11,59060658 | 40 | 9,826069741 | 0,095904501 | 1,707243698 |
| 11,72219445 | 41 | 9,838555354 | 0,090333183 | 1,709003304 |
| 11,85872472 | 42 | 9,851188403 | 0,084924061 | 1,710307796 |
| 12,00046314 | 43 | 9,86400607 | 0,079679907 | 1,711149142 |
| 12,14769606 | 44 | 9,876929102 | 0,074602439 | 1,711521571 |
| 12,30072811 | 45 | 9,890021992 | 0,069694425 | 1,711418694 |
| 12,45988942 | 46 | 9,903144121 | 0,064957023 | 1,710838246 |
| 12,62553133 | 47 | 9,916401093 | 0,060392989 | 1,709775876 |
| 12,7980366 | 48 | 9,929816847 | 0,056004237 | 1,708229619 |
| 12,97780974 | 49 | 9,943255356 | 0,051791601 | 1,706202682 |
| 13,16429784 | 50 | 9,956909924 | 0,04775768 | 1,703726874 |
| 13,35986472 | 51 | 9,970605266 | 0,043902295 | 1,700747138 |
| 13,5641577 | 52 | 9,984361965 | 0,040226632 | 1,697299228 |
| 13,77773489 | 53 | 9,998201585 | 0,036731339 | 1,693392305 |
| 14,00118249 | 54 | 10,01223387 | 0,033416984 | 1,689036245 |
| 14,23611781 | 55 | 10,02627186 | 0,030282644 | 1,684221138 |
| 14,48122587 | 56 | 10,04038006 | 0,027328182 | 1,679029162 |
| 14,7383461 | 57 | 10,05459723 | 0,024552595 | 1,673446637 |
| 15,00839742 | 58 | 10,06886783 | 0,02195428 | 1,667498938 |
| 15,29225429 | 59 | 10,08329457 | 0,019531521 | 1,661213186 |
| 15,58884426 | 60 | 10,09761521 | 0,017281436 | 1,654689295 |
| 15,90428573 | 61 | 10,11205518 | 0,015201347 | 1,64781816 |
| 16,23665257 | 62 | 10,12652747 | 0,013287691 | 1,640732447 |
| 16,58828695 | 63 | 10,14121071 | 0,011536578 | 1,633444391 |
| 16,95911699 | 64 | 10,15588122 | 0,009943079 | 1,626048777 |
| 17,3492716 | 65 | 10,17059667 | 0,008502037 | 1,618620687 |
| 17,77032556 | 66 | 10,18533427 | 0,007207528 | 1,611022818 |
| 18,21072573 | 67 | 10,20022911 | 0,006053383 | 1,60356843 |
| 18,6809638 | 68 | 10,21506871 | 0,005032452 | 1,596169423 |
| 19,19096138 | 69 | 10,22998845 | 0,004137331 | 1,588782772 |
| 19,71600887 | 70 | 10,24494295 | 0,003360242 | 1,581846971 |
| 20 | 71 | 10,26009354 | 0,002680452 | 1,57822669 |
| 20 | 72 | 10,27506455 | 0,002013226 | 1,577951285 |
| 20 | 73 | 10,29017427 | 0,001344089 | 1,577649314 |
| 20 | 74 | 10,30534609 | 0,000673016 | 1,577325463 |
| 20 | 75 | 10,32055282 | 0 | 1,57698146 |
| 20 | 76 | 10,33580052 | -0,000674959 | 1,576616884 |
| 20 | 77 | 10,3510838 | -0,001351862 | 1,576232087 |
| 20 | 78 | 10,3664124 | -0,002030712 | 1,57582637 |
| 20 | 79 | 10,38178161 | -0,002711509 | 1,575400037 |
| 20 | 80 | 10,39718796 | -0,003394254 | 1,574953325 |
| 20 | 81 | 10,41263327 | -0,004078947 | 1,57448609 |
| 20 | 82 | 10,42811438 | -0,004765589 | 1,573998563 |
| 20 | 83 | 10,44363195 | -0,005454179 | 1,573490696 |
| 20 | 84 | 10,45918408 | -0,006144717 | 1,572962638 |
| 20 | 85 | 10,47476904 | -0,0068372 | 1,572414537 |
| 20 | 86 | 10,49040276 | -0,00753164 | 1,571845123 |
| 20 | 87 | 10,506055 | -0,008228016 | 1,571256837 |
| 20 | 88 | 10,52174345 | -0,008926338 | 1,570648278 |
| 20 | 89 | 10,53746888 | -0,009626608 | 1,57001939 |
| 20 | 90 | 10,5532169 | -0,01032881 | 1,569371412 |
| 20 | 91 | 10,5689997 | -0,011032955 | 1,568703346 |
| 20 | 92 | 10,58481584 | -0,01173904 | 1,568015337 |
| 20 | 93 | 10,60068112 | -0,012447082 | 1,567306005 |
| 20 | 94 | 10,61653403 | -0,013157009 | 1,566580857 |
| 20 | 95 | 10,63244861 | -0,013868904 | 1,56583333 |
| 20 | 96 | 10,64837256 | -0,014582703 | 1,565068179 |
| 20 | 97 | 10,66440608 | -0,015298534 | 1,564276164 |
| 20 | 98 | 10,68033098 | -0,016016105 | 1,563477661 |
| 20 | 99 | 10,69624609 | -0,016735533 | 1,56266373 |
| 20 | 100 | 10,7123156 | -0,017457057 | 1,561818691 |

# Open Model that excludes Apple Music

| Price own website | Price App-store | commission_rate (%) | Profit Spotify | Profit Apple |
|---|---|---|---|---|
| 10,4 | 10,4 | 0 | 2,335344364 | 0 |
| 10,4 | 10,4 | 1 | 2,328685645 | 0,006658719 |
| 10,4 | 10,55 | 2 | 2,322110146 | 0,012896956 |
| 10,4 | 10,55 | 3 | 2,315661668 | 0,019345434 |
| 10,4 | 10,7 | 4 | 2,309269141 | 0,024970938 |
| 10,4 | 10,7 | 5 | 2,303026407 | 0,031213672 |
| 10,4 | 10,85 | 6 | 2,296832697 | 0,036249325 |
| 10,25 | 10,85 | 7 | 2,290852002 | 0,04150789 |
| 10,25 | 11 | 8 | 2,284981503 | 0,045891871 |
| 10,25 | 11 | 9 | 2,27924502 | 0,051628355 |
| 10,25 | 11,15 | 10 | 2,273593974 | 0,055478609 |
| 10,25 | 11,15 | 11 | 2,268046114 | 0,06102647 |
| 10,25 | 11,3 | 12 | 2,262622809 | 0,06436617 |
| 10,25 | 11,3 | 13 | 2,257258962 | 0,069730017 |
| 10,25 | 11,45 | 14 | 2,252069712 | 0,072582289 |
| 10,25 | 11,6 | 15 | 2,246944256 | 0,075144905 |
| 10,25 | 11,6 | 16 | 2,241934596 | 0,080154566 |
| 10,25 | 11,75 | 17 | 2,23705523 | 0,082270901 |
| 10,25 | 11,9 | 18 | 2,232257762 | 0,084129068 |
| 10,25 | 11,9 | 19 | 2,227583925 | 0,088802906 |
| 10,25 | 12,05 | 20 | 2,223038647 | 0,090254869 |
| 10,25 | 12,2 | 21 | 2,218587879 | 0,091478987 |
| 10,25 | 12,35 | 22 | 2,214238389 | 0,092487669 |
| 10,25 | 12,35 | 23 | 2,210034404 | 0,096691654 |
| 10,25 | 12,5 | 24 | 2,205939645 | 0,09734921 |
| 10,25 | 12,65 | 25 | 2,201952216 | 0,097819463 |
| 10,25 | 12,8 | 26 | 2,198075973 | 0,098113715 |
| 10,25 | 12,95 | 27 | 2,194313954 | 0,098242893 |
| 10,25 | 12,95 | 28 | 2,190675328 | 0,101881519 |
| 10,25 | 13,1 | 29 | 2,187160681 | 0,101725316 |
| 10,25 | 13,25 | 30 | 2,183760124 | 0,101428803 |
| 10,25 | 13,4 | 31 | 2,180474744 | 0,101001681 |
| 10,25 | 13,55 | 32 | 2,177305084 | 0,10045327 |
| 10,25 | 13,7 | 33 | 2,174251197 | 0,099792505 |
| 10,25 | 13,85 | 34 | 2,171312699 | 0,099027939 |
| 10,25 | 14 | 35 | 2,168488814 | 0,098167754 |
| 10,25 | 14,3 | 36 | 2,165779871 | 0,093591637 |
| 10,25 | 14,45 | 37 | 2,163194524 | 0,09258742 |
| 10,25 | 14,6 | 38 | 2,160720926 | 0,091513393 |
| 10,25 | 14,75 | 39 | 2,158356866 | 0,090376051 |
| 10,25 | 14,9 | 40 | 2,156099968 | 0,089181559 |
| 10,25 | 15,2 | 41 | 2,153960412 | 0,084581241 |
| 10,25 | 15,35 | 42 | 2,151930467 | 0,083328096 |
| 10,25 | 15,5 | 43 | 2,149999757 | 0,08203658 |
| 10,25 | 15,8 | 44 | 2,148187694 | 0,077593644 |
| 10,25 | 15,95 | 45 | 2,146468524 | 0,076282721 |
| 10,25 | 16,25 | 46 | 2,144862072 | 0,072028488 |
| 10,1 | 16,55 | 47 | 2,143364136 | 0,066591454 |
| 10,1 | 16,7 | 48 | 2,141977502 | 0,065337478 |
| 10,1 | 17 | 49 | 2,14068845 | 0,061544365 |
| 10,1 | 17,3 | 50 | 2,139488766 | 0,0579251 |
| 10,1 | 17,6 | 51 | 2,138376933 | 0,054476926 |
| 10,1 | 17,9 | 52 | 2,137350567 | 0,051196407 |
| 10,1 | 18,2 | 53 | 2,136406621 | 0,048079553 |
| 10,1 | 18,5 | 54 | 2,135541564 | 0,045121922 |
| 10,1 | 18,95 | 55 | 2,134752499 | 0,040604303 |
| 10,1 | 19,25 | 56 | 2,134037909 | 0,038052506 |
| 10,1 | 19,55 | 57 | 2,13339017 | 0,035639819 |
| 10,1 | 20 | 58 | 2,132810094 | 0,031994171 |
| 10,1 | 20 | 59 | 2,13225847 | 0,032545794 |
| 10,1 | 20 | 60 | 2,131706847 | 0,033097418 |
| 10,1 | 20 | 61 | 2,131155223 | 0,033649041 |
| 10,1 | 20 | 62 | 2,130603599 | 0,034200665 |
| 10,1 | 20 | 63 | 2,130051976 | 0,034752289 |
| 10,1 | 20 | 64 | 2,129500352 | 0,035303912 |
| 10,1 | 20 | 65 | 2,128948729 | 0,035855536 |
| 10,1 | 20 | 66 | 2,128397105 | 0,03640716 |
| 10,1 | 20 | 67 | 2,127845481 | 0,036958783 |
| 10,1 | 20 | 68 | 2,127293858 | 0,037510407 |
| 10,1 | 20 | 69 | 2,126742234 | 0,038062031 |
| 10,1 | 20 | 70 | 2,12619061 | 0,038613654 |
| 10,1 | 20 | 71 | 2,125638987 | 0,039165278 |
| 10,1 | 20 | 72 | 2,125087363 | 0,039716901 |
| 10,1 | 20 | 73 | 2,12453574 | 0,040268525 |
| 10,1 | 20 | 74 | 2,123984116 | 0,040820149 |
| 10,1 | 20 | 75 | 2,123432492 | 0,041371772 |
| 10,1 | 20 | 76 | 2,122880869 | 0,041923396 |
| 10,1 | 20 | 77 | 2,122329245 | 0,04247502 |
| 10,1 | 20 | 78 | 2,121777621 | 0,043026643 |
| 10,1 | 20 | 79 | 2,121225998 | 0,043578267 |
| 10,1 | 20 | 80 | 2,120674374 | 0,04412989 |
| 10,1 | 20 | 81 | 2,120122751 | 0,044681514 |
| 10,1 | 20 | 82 | 2,119571127 | 0,045233138 |
| 10,1 | 20 | 83 | 2,119019503 | 0,045784761 |
| 10,1 | 20 | 84 | 2,11846788 | 0,046336385 |
| 10,1 | 20 | 85 | 2,117916256 | 0,046888009 |
| 10,1 | 20 | 86 | 2,117364632 | 0,047439632 |
| 10,1 | 20 | 87 | 2,116813009 | 0,047991256 |
| 10,1 | 20 | 88 | 2,116261385 | 0,04854288 |
| 10,1 | 20 | 89 | 2,115709761 | 0,049094503 |
| 10,1 | 20 | 90 | 2,115158138 | 0,049646127 |
| 10,1 | 20 | 91 | 2,114606514 | 0,05019775 |
| 10,1 | 20 | 92 | 2,114054891 | 0,050749374 |
| 10,1 | 20 | 93 | 2,113503267 | 0,051300998 |
| 10,1 | 20 | 94 | 2,112951643 | 0,051852621 |
| 10,1 | 20 | 95 | 2,11240002 | 0,052404245 |
| 10,1 | 20 | 96 | 2,111848396 | 0,052955869 |
| 10,1 | 20 | 97 | 2,111296772 | 0,053507492 |
| 10,1 | 20 | 98 | 2,110745149 | 0,054059116 |
| 10,1 | 20 | 99 | 2,110193525 | 0,054610739 |
| 10,1 | 20 | 100 | 2,109641902 | 0,055162363 |

# Closed Model that excludes Apple Music

| Price App-store | commission_rate (%) | Profit Spotify | Profit Apple |
|---|---|---|---|
| 8,6 | 0 | 0,610795688 | 0 |
| 8,75 | 1 | 0,596275236 | 0,014245483 |
| 8,75 | 2 | 0,582029752 | 0,028490967 |
| 8,75 | 3 | 0,567784269 | 0,04273645 |
| 8,75 | 4 | 0,553538785 | 0,056981934 |
| 8,9 | 5 | 0,539570034 | 0,069495996 |
| 8,9 | 6 | 0,525670835 | 0,083395195 |
| 8,9 | 7 | 0,511771636 | 0,097294394 |
| 9,05 | 8 | 0,498095259 | 0,108424825 |
| 9,05 | 9 | 0,484542156 | 0,121977928 |
| 9,05 | 10 | 0,470989053 | 0,135531031 |
| 9,2 | 11 | 0,457681508 | 0,145286602 |
| 9,2 | 12 | 0,444473635 | 0,158494475 |
| 9,2 | 13 | 0,431265762 | 0,171702347 |
| 9,35 | 14 | 0,418394067 | 0,18009794 |
| 9,35 | 15 | 0,405529929 | 0,192962078 |
| 9,5 | 16 | 0,392810542 | 0,20035974 |
| 9,5 | 17 | 0,380288058 | 0,212882223 |
| 9,65 | 18 | 0,367775963 | 0,219302042 |
| 9,65 | 19 | 0,355592516 | 0,231485488 |
| 9,65 | 20 | 0,343409069 | 0,243668935 |
| 9,8 | 21 | 0,331488828 | 0,248797961 |
| 9,8 | 22 | 0,319641306 | 0,260645483 |
| 9,95 | 23 | 0,308016091 | 0,264848703 |
| 9,95 | 24 | 0,29650093 | 0,276363864 |
| 10,1 | 25 | 0,285207372 | 0,279669365 |
| 10,1 | 26 | 0,274020597 | 0,290856139 |
| 10,25 | 27 | 0,263090116 | 0,293293816 |
| 10,4 | 28 | 0,252229909 | 0,295214427 |
| 10,4 | 29 | 0,241686536 | 0,305757799 |
| 10,55 | 30 | 0,231242986 | 0,306869623 |
| 10,55 | 31 | 0,221013998 | 0,31709861 |
| 10,7 | 32 | 0,21100524 | 0,317434948 |
| 10,85 | 33 | 0,201141855 | 0,317333515 |
| 10,85 | 34 | 0,191525688 | 0,326949682 |
| 11 | 35 | 0,182127716 | 0,326135678 |
| 11,15 | 36 | 0,172910606 | 0,324935942 |
| 11,3 | 37 | 0,163890947 | 0,323373314 |
| 11,3 | 38 | 0,155151128 | 0,332113133 |
| 11,45 | 39 | 0,146623233 | 0,32992998 |
| 11,6 | 40 | 0,138312877 | 0,327434565 |
| 11,75 | 41 | 0,130230017 | 0,324648439 |
| 11,9 | 42 | 0,122382769 | 0,321592575 |
| 12,05 | 43 | 0,114777552 | 0,318287334 |
| 12,2 | 44 | 0,107419235 | 0,314752432 |
| 12,35 | 45 | 0,100311272 | 0,311006916 |
| 12,5 | 46 | 0,093455827 | 0,307069146 |
| 12,65 | 47 | 0,086853896 | 0,302956784 |
| 12,8 | 48 | 0,080505421 | 0,298686778 |
| 12,95 | 49 | 0,074409396 | 0,294275366 |
| 13,1 | 50 | 0,068563971 | 0,289738069 |
| 13,4 | 51 | 0,063005059 | 0,274953112 |
| 13,55 | 52 | 0,05770037 | 0,270317028 |
| 13,85 | 53 | 0,052643172 | 0,255996821 |
| 14 | 54 | 0,047874685 | 0,251342095 |
| 14,3 | 55 | 0,043347422 | 0,23758012 |
| 14,45 | 56 | 0,039097375 | 0,232971986 |
| 14,75 | 57 | 0,035103233 | 0,219836449 |
| 15,05 | 58 | 0,031362608 | 0,207240127 |
| 15,35 | 59 | 0,027877485 | 0,195185501 |
| 15,65 | 60 | 0,024645957 | 0,183671063 |
| 15,95 | 61 | 0,021663031 | 0,172691898 |
| 16,25 | 62 | 0,018921316 | 0,162240219 |
| 16,55 | 63 | 0,016411606 | 0,152305841 |
| 17 | 64 | 0,01413122 | 0,137274708 |
| 17,3 | 65 | 0,012070791 | 0,12865976 |
| 17,75 | 66 | 0,010223913 | 0,115722845 |
| 18,2 | 67 | 0,008577772 | 0,103973508 |
| 18,65 | 68 | 0,007123123 | 0,093321744 |
| 19,25 | 69 | 0,005848308 | 0,080289556 |
| 19,7 | 70 | 0,004745591 | 0,071913959 |
| 20 | 71 | 0,00378057 | 0,067105119 |
| 20 | 72 | 0,002835428 | 0,068050261 |
| 20 | 73 | 0,001890285 | 0,068995404 |
| 20 | 74 | 0,000945143 | 0,069940547 |
| 20 | 75 | 0 | 0,070885689 |
| 20 | 76 | -0,000945143 | 0,071830832 |
| 20 | 77 | -0,001890285 | 0,072775974 |
| 20 | 78 | -0,002835428 | 0,073721117 |
| 20 | 79 | -0,00378057 | 0,074666259 |
| 20 | 80 | -0,004725713 | 0,075611402 |
| 20 | 81 | -0,005670855 | 0,076556544 |
| 20 | 82 | -0,006615998 | 0,077501687 |
| 20 | 83 | -0,00756114 | 0,078446829 |
| 20 | 84 | -0,008506283 | 0,079391972 |
| 20 | 85 | -0,009451425 | 0,080337114 |
| 20 | 86 | -0,010396568 | 0,081282257 |
| 20 | 87 | -0,01134171 | 0,082227399 |
| 20 | 88 | -0,012286853 | 0,083172542 |
| 20 | 89 | -0,013231995 | 0,084117684 |
| 20 | 90 | -0,014177138 | 0,085062827 |
| 20 | 91 | -0,01512228 | 0,086007969 |
| 20 | 92 | -0,016067423 | 0,086953112 |
| 20 | 93 | -0,017012565 | 0,087898254 |
| 20 | 94 | -0,017957708 | 0,088843397 |
| 20 | 95 | -0,01890285 | 0,089788539 |
| 20 | 96 | -0,019847993 | 0,090733682 |
| 20 | 97 | -0,020793135 | 0,091678824 |
| 20 | 98 | -0,021738278 | 0,092623967 |
| 20 | 99 | -0,02268342 | 0,09356911 |
| 20 | 100 | -0,023628563 | 0,094514252 |