

RESEARCH

Online advertisement in a pink-colored market

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Abstract

Did you know that women are often charged extra for items and services simply because they are explicitly marketed to females? This phenomenon, known as the *pink tax*, is a major issue that calls into question women's buying power. Nevertheless, it is not just limited to physical products - even online advertising can be subject to this type of gender-price discrimination. That is where our research comes in. We have developed a new methodology to measure what we call the *digital marketing pink tax* - the additional expense for delivering ads to female audiences. Analyzing data from Facebook advertising campaigns across 227 countries shows this issue is particularly prevalent in 92% of developed countries. Globalization policies can have a negative impact on female consumers, and the *digital marketing pink tax* only exacerbates this type of discrimination. However, our findings also suggest that there may be a connection between the *digital marketing pink tax* and the consumer pink tax - the extra charge placed on products marketed to women. Overall, our research sheds light on an important issue affecting women worldwide. Raising awareness of the *digital marketing pink tax* and advocating for better regulation.

Keywords: Marketing; Pink tax; Online social platforms; Digital marketing pink tax; Digital marketing; Online advertising

1 Introduction

Various social and historical factors have been crucial in shaping gender stereotypes. The emergence of feminism in the 1960s marked a turning point in pursuing equal opportunities for both genders. This shift towards gender equality led to changes in vocational options and household structures, particularly for females [1–5]. Moreover, the evolution of the workforce has brought about significant changes in the roles played by males and females, and this has been reflected in popular media, especially advertising [6]. Additionally, changes in traditional family roles have resulted in significant shifts in conventional female responsibilities and, more recently, in traditional male responsibilities [7].

Gender role stereotyping in advertising exists, and although it seems to have decreased over the last 50 years, the depiction of males and females in advertising still deviates from the ideal of representing both genders in a way that does not invoke stereotypes and promotes equal life opportunities [8]. As a result, the topic will remain important for advertisers, policymakers, and researchers. Most research on gender roles in

advertising has investigated print and television advertising. In contrast, research on gender role portrayals on online platforms is rare [2]. The new advertising formats we face in our digital age require a fresh view, new coding schemes, and new definitions of advertising to grasp the changing media habits of consumers and the influence of gender role portrayals in advertising. Research on gender role portrayals and stereotyping was mainly motivated by the changing role of females in society. It has neglected the fact that the role of males has changed too. Males are nowadays more often caregivers and less often providers than in the past. However, advertising seems to do little to challenge the traditional roles of paternal masculinity [9].

Critics state that advertisements show social stereotypes, which, in turn, reinforce stereotypical values and behavior in society. The criticism is based on the assumption that what people see or hear in the media influences their perceptions, attitudes, values, and behavior. Advertisers frequently utilize advertisements that integrate the interests of males/females for consumable goods according to their genders. Since people's opinion of a product or service is mainly impacted by how well they comprehend an advertisement, it stands to reason that an ad that appeals to their gender will be more successful in terms of sales [10, 11].

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Females are stereotyped as incapable of taking on leadership roles in society outside the home and are thus relegated to the role of housewife [12].

Evidence exists of the advertising and the media's impact on desired purchasing behavior and consumers' understanding of gender roles. Female and male consumers reveal significantly different emotional and attitudinal reactions to advertisements [13]. Critics assert that ads encourage stereotyped beliefs and conduct by depicting societal stereotypes. The criticism is based on the idea that what people see or hear in the media affects how they see the world, how they feel about things, what they value, and how they act. Advertisers commonly use commercials that incorporate males' and females' interests in consumable products based on their genders.

Female and male customers exhibit considerably distinct emotional and attitudinal responses, supporting the idea that advertising and the media influence consumers' purchase behavior and knowledge of gender roles [13]. Gender-specific media studies, on the other hand, have demonstrated that gendered commercials do not always result in sales success since sexist material attracts too much attention. Still, it may also lead to reluctance and tiredness [3, 14]. Stereotyping in advertising has declined over the years. However, this decline is almost entirely due to developments in countries with high masculinity levels [12].

Years of scholarly research have revealed that advertising usually perpetuates harmful gender stereotypes [15, 16]. According to surveys, these stereotypes are still prevalent in most of the world's countries. Gender role stereotypes have been demonstrated in studies to have negative impacts, such as reducing females' self-esteem, lowering societal expectations, and limiting females' access to specific academic sectors, among other problems [7, 17–20]. During these years, females were portrayed negatively compared to their potential and capabilities, while data indicated a gradual shift toward more positive role portrayals. Previous studies have demonstrated that advertising contributes to gender inequality by validating and accepting 'sexism' and distorted body image representations [1, 21–24].

Consumers perceive gender role stereotypes by social, cultural, economic, and religious variables. As a result, it is not unusual to notice distinct gender-based advertising behaviors worldwide [25]. The advertising industry and its governing bodies have recently challenged gender role stereotypes. Advertising corporations commit to developing ads that depict more positive gender roles by joining the Unstereotype Alliance [26]. Regulatory organizations are also actively involved in enacting the necessary adjustments. The World Federation of Advertisers(WFA) developed a

guideline in 2018 to improve awareness of possible negative gender stereotypes. In June 2019, the UK's Advertising Standards Authority (ASA) banned gender stereotypes in advertisements. Advertising regulatory organizations have raised similar concerns in countries such as Belgium, Finland, France, Greece, Norway, South Africa, and India [27].

1.1 Gender price discrimination

Price discrimination is the practice of requesting different prices from various target groups. It occurs when two or more comparable items are offered at different prices. Companies intend to increase company profits by skimming off consumers' willingness to pay for prices or individual market segments [28]. Price discrimination is classified into three types: first, second, and third. However, there are more forms of price discrimination in contemporary cultures, such as gender, ethnic, and religious price discrimination [28].

1.1.1 *Pink tax*

Gender-based pricing discrimination has a considerable impact on gender inequality. Several laws have been put into place; as a result to encourage a gender-equal advertising ecosystem [29]. One example of these regulations is the CEDAW (Convention on the Elimination of All Forms of Discrimination Against Women), which the UDHR formed in 1979 [30]. Despite the imposed limits on gender stereotypes in ads, marketers can still target internet audiences by gender and implement gender-segmented marketing strategies. Gender-based price discrimination is used in the literature to describe the practice of manufacturers, merchants, and service providers offering the same or similar items with differential pricing for females and males. It is the most common method of third-degree discrimination [31]. Price discrimination based on gender can hurt the market and is a form of gender discrimination. Online marketing platforms show ads to audiences depending on their gender and differentiate advertising pricing based on the gender of the audience.

Gender-based pricing discrimination is so widespread that scholars call it the "Pink Tax." Scholars and the media have undertaken numerous studies to clarify the controversy regarding discriminatory pricing based on a consumer's gender. The "pink tax" refers to the additional price added to female items, which can be equal to that of male goods. These distinctions are solely for simple product features, such as pink color, which indicates that this product is built for females [32]. The previous research found that 80% of the products are gender-targeted. The pink tax operates differently in different product markets such as personal

care products [33, 34], labor market [35], car retail and car maintenance services [36–40], and real estate [41]. The 2015 study by the New York City Department of Consumer Affairs showed that females products cost on average 7% more than similar products for males, which vary depending on the industry as follows:

- 7 percent more for toys and accessories
- 4 percent more for children's clothing
- 8 percent more for adult clothing
- 13 percent more for personal care products
- 8 percent more for senior/home health care products [42].

1.1.2 Digital marketing pink tax

According to the pink tax literature, female customers spend more on things designed exclusively for females [43]. In the accounting literature, advertising charges comprise a large share of marketing costs. A high advertising cost might result in higher end-user pricing [44]. Marketers tend to expose their gendered ads only to the relevant genders and restrict access to non-relevant genders. This online advertising behavior from marketers may result in higher advertising costs for female audiences than male audiences. We introduced the concept of *digital marketing pink tax* as the extra cost marketers should pay to target female audiences.

We structured this paper as follows: Section 2 will provide a theoretical explanation of the *digital marketing pink tax* phenomena and present three main hypotheses. We will then move on to section 3, introducing Facebook as the primary data source and explaining the process we used to gather data from its marketing platform. Next, section 4 will present the methodology used to calculate the *digital marketing pink tax* using Facebook marketing data. Finally, in section 5, we will analyze and explore the results and devise statistical tools to test our hypothesis and compare it with the findings of the existing literature on the consumer pink tax.

2 Theoretical context

Studies have demonstrated that the effectiveness of advertising is significantly impacted by the demographics of the intended audience, particularly concerning aligning the ad with the gender of the audience [45]. In addition, recent research has uncovered gender bias in Facebook's interests [46]. To further investigate this issue, we have employed several advertising theories, such as *Social Comparison theory*, *Congruity theory* and *Global Consumer Culture theory* to analyze the concept of the *digital marketing pink tax* and develop our hypotheses. In the upcoming sections, we will delve into these theories and discuss how these theories explain the pink tax.

2.1 Social comparison theory

Social comparison theory explains that consumers compare themselves with those portrayed in advertisements. Humans have the drive to evaluate themselves by comparison with others when nonsocial means are unavailable [47]. Social comparison theory was initially proposed to evaluate abilities and opinions, but further research proves that it also applies to evaluating personal traits and circumstances. [48]. The social comparison theory is an illuminating concept that explains why marketers often depict their ideal target audience in advertisements. According to this theory, young females tend to compare their attractiveness with the models featured in ads specifically aimed toward them. This phenomenon sheds light on the impact that advertising can have on an individual's self-perception, and how it can shape their idea of what is considered attractive or desirable [49].

2.2 Congruity theory

Some advertisers use gender stereotypes in their product promotions because they believe it will benefit their brand. This aligns with the congruity theory, suggesting that people prefer depictions that fit their established social and cognitive patterns [50]. The concept of gender roles is widely accepted in society, as it delineates specific traits and actions deemed appropriate or desirable for individuals of each gender [51]. Something that does not fit the typical norm may be judged unfavorably [52]. According to research, advertising that incorporates gender role stereotypes may elicit a positive response from consumers who hold stereotypical views. This is because such individuals view these depictions as more aligned with their beliefs, which leads to a favorable perception of both the advertisement and the brand being promoted [53]. In addition, research has shown that individuals respond better to advertisements that conform to their gender role expectations, whether male or female [54]. Applying the social comparison theory and congruity theory to advertising suggests that displaying ads that match a person's gender increases the effectiveness of the advertising. However, this may result in a difference in marketing costs for different genders, potentially impacting the end user price and leading to a gender-based pricing disparity known as the *pink tax*.

2.3 Global consumer culture theory

Consumer culture theory comprises a set of fundamental concepts that delve into the intricate relationship between consumer behavior, the marketplace, and cultural significance. This theory aims to examine how these three elements interconnect with one another and how they shape our society and economy as a

whole. By exploring the complex dynamics that underlie consumer culture, we can gain a deeper understanding of the factors that drive consumer behavior and shape our collective cultural identity [55]. The *global consumer culture theory* is a concept that delves into the typical desires and needs of individuals worldwide when it comes to consumption. Researchers in this field are dedicated to studying the emergence of shared consumer segments, aiming to better understand the nuances and complexities of consumer behavior in a global context [56, 57]. The theory of global consumer culture states that consumers across various nations share similar attitudes, values, and actions concerning consumption. This suggests that the influence of culture on consumer behavior is becoming increasingly homogenized worldwide [58]. The existing literature in marketing states that males and females exhibit distinct preferences in online shopping. This difference can be attributed to an average difference in information processing between the sexes [59]. These differences may cause different advertising costs for targeting male and female audiences. If targeting females is systematically more expensive, we refer to this phenomenon as the *digital marketing pink tax*, and if it is contrary, targeting males is more expensive than targeting females; we refer to it as the *digital marketing green tax (DMGT)*.

Studies have shown that various products and goods are subject to a *pink tax*. This leads us to speculate that there may also be a *digital marketing pink tax*, where advertisers are willing to pay more to target females than males. The underlying theory behind this notion motivates us to propose the following hypothesis: *Marketers, in general, pay more to target female audiences (digital marketing pink tax exists)(H1), the digital marketing pink tax is not equally distributed across countries (H2), and the digital marketing pink tax is unequal across industrial sectors(H3).*

3 Online advertising platforms

This paper investigates the prevalence of gender-based price discrimination and the pink tax in online advertising. To achieve this, we used Facebook to gather data on advertising costs and compare the expenses of ads targeted toward females and those targeted at males. Facebook is a well-known and widely used online advertising platform that allows businesses to launch campaigns across several channels, such as *Facebook, Instagram, Audience Network, and Messenger*. In addition, it offers ad-targeting features that enable businesses to reach their target audience precisely. Ads Manager is the primary tool for buying Facebook, Instagram, and Audience Network ads. This Facebook-owned ad management tool helps businesses set budgets, establish bids, and obtain results regardless of

budget constraints [60]. The following section will explain why we chose Facebook as a dependable data source for our research.

3.1 Why Facebook?

The Facebook marketing platform is a highly sought-after tool for advertisers seeking to optimize their campaigns. With a staggering 93% of marketing specialists utilizing Facebook's platform for their digital ads campaigns, it is no wonder why it is considered one of the most popular advertising platforms worldwide [61]. Facebook offers the ability to advertise across multiple platforms and gathers valuable data from its vast audiences, generating a comprehensive reach database that enables advertisers to target the most relevant audiences for their products and campaigns. It is worth noting that Facebook's primary source of revenue is advertising, with over 98% of its revenue coming from this avenue. Therefore, the platform is committed to providing advertisers with the most effective means of reaching their target audience. Achieving this goal necessitates Facebook collecting data on users' interests, demographics, behavior, and interactions across multiple platforms[62].

Facebook has an extensive range of products and services, including Facebook, Instagram, Messenger, WhatsApp, and Oculus VR. Each platform gathers data on users' activities and preferences, which Facebook can leverage to produce an all-encompassing profile of each user. This profile encompasses age, gender, location, interests, behavior, user interactions, and content [63]. In addition, Facebook utilizes various tools and technologies to monitor users' activities and behavior across various platforms, including cookies, pixels, and SDKs. By doing so, Facebook can compile information on users' browsing history, app usage, and device details, enabling the platform to enhance its ad-targeting capabilities [64]. Advertisers on Facebook have access to a range of targeting options based on user's interests, demographics, behaviors, and interactions. These options include custom and lookalike audiences, as well as interest targeting. Facebook gathers data from users across multiple platforms to create these targeting options. However, Facebook has faced regulatory scrutiny and controversies over its data practices, such as the Cambridge Analytica scandal[65] and Apple's privacy changes in iOS 14.5[66]. These events have brought attention to the extent of Facebook's data collection and usage and its potential risks. Although Facebook has improved its privacy and data protection practices, its advertising revenue still depends on collecting and using user data. In light of the substantial impact that advertising has on human behavior and the market for online ads, it

is worth considering whether equal opportunities are provided for individuals of different genders in online advertisement ecosystems. Such an inquiry may help ensure these systems are fair and equitable and contribute positively to the broader social and economic landscape.

3.2 Retrieving data from Facebook

Facebook's marketing platform allows advertisers to customize their ad campaigns to reach specific target audiences based on location, gender, age, and interests. Once an advertiser sets their target audience criteria, Facebook showcases the ads to match the audiences. The advertiser also has the option to set a daily budget for their ads, which can be used to gain clicks. To sell user profiles, Facebook employs a sophisticated auction process. When users log in, Facebook utilizes their profile information to match them with relevant ad campaigns and then runs an auction to determine which ad will ultimately be displayed. While the exact algorithm used in the auction is undisclosed, factors such as the advertiser's bid and overall budget are considered.

Advertisers must track the success of their ad campaign using key performance indicators (KPIs) such as Cost Per Mille (CPM) and Cost Per Click (CPC). CPM indicates the cost of showing 1,000 impressions of the ad, while CPC measures the cost of acquiring a click on the ad. To assist in making informed budget decisions, Facebook's marketing API offers an endpoint that calculates the daily budget required to target a specific audience. This estimate is based on recent auction results for ad placement with that particular audience. Additionally, Facebook provides price estimation curves for a given audience based on 15 data points. Such tools enable an advertiser to optimize ad spend and achieve maximum ROI.

Advertisers can select the desired curve type by specifying a parameter when utilizing the API query. For example, selecting the *optimization=IMPRESSIONS* parameter will yield a curve displaying the budget on the x-axis and the number of impressions on the y-axis. Advertisers can accurately estimate the CPM by dividing the y-axis value by the x-axis value at a given point on this curve. However, if they choose the *optimization=LINK CLICKS* parameter, the curve will display the budget on the x-axis and the number of clicks on the y-axis. Dividing the y-axis value by the x-axis at a given point on this curve will provide an accurate CPC estimate. Figure 1 visually represents these price estimation curves. This valuable information enables advertisers to confidently make informed decisions regarding expected CPM and CPC for a specific audience.

Figure 1 Sample price curve provided by Facebook

Through our detailed investigation of price estimation curves, we have found that CPM(CPC) values are not uniform across the curves. Our analysis has revealed that the initial points on the curves, which correspond to lower budgets, show significantly different CPM(CPC) values compared to the remaining points.

The final points correspond to the most commonly used budget values and are evaluated using sufficient points. Therefore, we used the final point of the curve to achieve robust results.

4 Methodology

The main purpose of this paper is to investigate the existence of a *digital marketing pink tax*. This refers to a situation where advertisers pay a systematically higher price CPM(CPC) to target female audiences than male audiences. We use the *Facebook marketing platform*, which Facebook made publicly available and we described in the previous section, to conduct our research. This approach is consistent with previous studies using the *Facebook marketing platform API* to extract marketing data from social media websites (OSNs)[67–74]. We created a software library that automatically queries the *Facebook marketing platform API*. The software calculates each audience's CPM and CPC estimation curves based on the price estimation curves obtained for thousands of audiences. The following characteristics define our audiences:

- *Gender*: Our approach to evaluating marketing expenses for different target groups relies on Facebook's three gender classifications: Male, Female, and All (encompassing both genders). This enables us to identify any potential *digital marketing pink tax* and compare the CPM(CPC) expenditure for marketing to male versus female audiences.
- *Location (Country)*: We thoroughly researched the connection between the *digital marketing pink tax* and location by gathering data from Facebook users across multiple countries. Our investigation centered on the user's home location, a dependable indicator of their permanent residency. Facebook employs IP addresses and profile information to precisely determine a user's home location.
- *Interests*: Our dataset for research is designed to be comprehensive and impartial, covering a diverse range of interest topics. To achieve this, we have utilized a meticulous audience collection process that involves a detailed list of 10,000 interests ranked based on their level of masculinity,

as previously outlined in our research [46]. In our dataset, we have ranked interests on a scale from +5,000 for the most masculine to -5,000 for the most feminine.

We have created a metric to analyze the presence of the *digital marketing pink tax*. This metric enables us to compare the bias of prices CPC(CPM) for a particular audience based on their gender parameter.

$$DMPT = \frac{price_f - price_m}{price_{all}} \times 100$$

The variables, $price_f$ and $price_m$, signify the advertising cost for females and males, respectively, either through ad display (CPM) or obtaining a click (CPC). The overall advertising expense without specifying gender is represented by $price_{all}$. The DMPT sign denotes which gender has a higher advertising cost. A positive (negative) DMPT number suggests that females (males) are more expensive. The DMPT's absolute value represents a relative measurement of the audience's gender bias. For example, a DMPT of 20% implies that advertising to females is 20% costlier than advertising to males, compared to the benchmark price of the same audience, without considering gender ($price_{all}$).

Our research examines the DMPT value of numerous audiences, providing us with significant data to ascertain whether the *digital marketing pink tax* is a sporadic occurrence or a systemic issue. Additionally, we evaluated the impact of economic and industry-related factors on the *digital marketing pink tax* by analyzing the data across various targeted consumer aspects. The upcoming section will discuss the marketing data collected to analyze the pink tax phenomenon in marketing.

4.1 Dataset

Our dataset includes DMPT values for over 7 million unique audiences, created through the combination of 227 countries, three gender groups (male, female, and all), and 10,000 interests marked with a masculinity score obtained from literature[46]. Our dataset primarily contains one DMPT value per audience on different dates, and we calculate the CPM of the 15th point on the estimation curve based on 43 samples taken between 16-Nov-2022 and 19-Jan-2023. To investigate the digital marketing pink tax across different price types and determine if calculating the pink tax using different points on the curve impacts the results, we compute multiple DMPT values associated with different points (all 15 points) of the price estimation

Table 1 The specifications of the dataset

Dataset Name	Specifications
samples	43
countries	227
interests	10000
period	16/11/2022 - 19/12/2022 and 17/1/2023 - 25/1/2022
sampled curve points	1 (16/11/2022 - 19/12/2022) 15 (17/1/2023 - 25/1/2022)

curves, as well as the median CPM and CPC values between 17-Jan-2023 and 25-Jan-2023. Overall, we gathered over 97 million data points in our dataset for analyzing the presence of DMPT in different countries and industries.

5 Results and discussion

In this study, we have conducted an analysis of the digital marketing pink tax across various audiences. We aim to delve deeper into this phenomenon and determine whether the hypotheses we have developed based on the theoretical discussion in section 2 are substantiated by evidence. Our findings will be presented in the following sections.

5.1 Is digital marketing pink tax a systemic phenomenon?

To Answer this question, we computed the DMPT distribution for the more than 7M audiences in our dataset for both the CPM and CPC. In particular, figure 2 and figure 3 present the CDFs of the DMPT associated with CPM and CPC, considering the 15th point of the price curves, respectively. Note that the figure 3 presents the 9 days DMPT distributions in our dataset between 17-Jan-2023 and 25-Jan-2023 and figure 2 presents the 32-days DMPT distributions in our dataset between 16-Nov-2023 and 25-Jan-2023

Figure 2 Cumulative distribution of DMPT using CPM between 16/11/2022 and 25/1/2023

Figure 3 Cumulative distribution of DMPT using CPC between 11/1/2023 and 25/1/2023

The results show the existence of a systemic *digital marketing pink tax* for CPM. More specifically, we found that 75% of all our dataset's audiences shows a *digital marketing pink tax*. Furthermore, advertisers must pay a median extra of 17 % (i.e., the median value of DMPT) to show ads to females compared to males (H1).

However, we did not find digital marketing pink tax in CPC in our dataset. This means that advertising cost per click is almost equal for both genders. We can explain this observation using the formula for calculating *click-through ratio*(CTR) using CPM and CPC. CTR is the portion of the audience that clicks on the ads shown to the audiences. Higher values of CTR mean that a high percentage of people who see an ad on a website also click on it.

$$CPC = \frac{Cost}{Clicks}$$

$$CPM = \frac{Cost}{impressions} \times 1000$$

$$CTR = \frac{Clicks}{impressions}$$

Therefore, we can calculate CTR given CPM and CPC as follows:

$$CTR = \frac{CPM}{CPC} \times 0.001$$

Given that CPM is typically higher for females, and CPC is almost equivalent for both genders, it can be deduced that the click-through rate (CTR) is higher for females than males. This suggests that advertisers can obtain more clicks from females while exhibiting the same number of ads to both genders. Moreover, prior literature on gender variances in response to advertisements has demonstrated that females tend to assimilate more cues when making judgments than males, implying that they are more likely to require supplementary information for decision-making [75]. This need for information may result in more clicks, leading to a greater number of clicks from female audiences than males. Additionally, research has found that more women than men click on ads [76]. Therefore, our findings align with previous studies on audience behavior regarding gender.

Nevertheless, CPC is a complex metric that involves factors beyond advertisers' willingness to attain their objectives, such as the attractiveness of the ad banner, the psychological factors behind the topic's appeal, the quality and reliability of the ad's placement, and more. Consequently, CPC is not a reliable metric for analyzing the pink tax marketing phenomenon. Hence, the following subsections use CPM as our metric to investigate the pink tax in various countries and industries.

Once we have proven *digital marketing pink tax* for CPM is a systemic phenomenon in the Facebook advertising ecosystem, we want to make some analyses

to understand important factors that may be linked to the *digital marketing pink tax*. Therefore, in the remainder of the section, we study how three factors relate to the *digital marketing pink tax* phenomenon. In particular, we study 1) *digital marketing pink tax* in different countries, 2) the *digital marketing pink tax* across different country locations, and 3) the *digital marketing pink tax* that exists in different industries.

Figure 4 Culimative distribution of DMPT for points 2 to 15 on the CPM estimated price curve for all the audiences

Figure 5 Culimative distribution of DMPT for points 2 to 15 on the CPC estimated price curve for all the audiences

5.2 Digital marketing pink tax in different countries

The literature on the pink tax reveals that domestic policy choices that shape globalization can disadvantage females in their role as consumers[77]. While trade policy largely ignores consumer interests [78], political inequalities among consumers leave a clear imprint. Complementing existing work on gender differences in trade preferences [79] [80]. As we discussed before, the *digital marketing pink tax* affects the end user price discrimination resulting in a consumer pink tax. We analyzed our dataset to see whether the *digital marketing pink tax* behaves differently worldwide. We used Tukey pairwise HSD test[81] with the following null hypothesis: The *digital marketing pink tax* vector of 10k dimensions(interests) for different countries are pairwise similar. In 6,108 pairs of countries out of 25,651 combinations, we found strong evidence with criteria of p-value equal to 0.05 to reject the null hypothesis. Therefore, the vector of pink tax for the countries is not similar (H3). The details of the Tukey test are provided in the online repository [82].

The literature on the pink tax also found a relation between the human development indices and the consumer pink tax[77]. The literature on the pink tax found, for instance, strong evidence of the positive correlation between *Gross Domestic Product (GDP) per capita* and the pink tax on apparel imports [77]. This indicates that the pink tax is a more severe problem for economically developed countries. To test this hypothesis, we calculate the median pink tax for all the interests to find the pink tax level per country. Figure 6 illustrates our dataset's *digital marketing pink tax* geographic distribution in 227 countries. In addition, we have plotted the countries where Facebook does not operate (e.g., Russia, Iran, and Cuba) using black

color. This figure demonstrates the existence of a clear digital marketing pink tax in most of the world (88% of the 227 countries existing in our database).

Figure 6 Variation of the average Facebook digital marketing pink tax across countries

To further analyze the relationship between the country's development with the *digital marketing pink tax*, we use the classification of countries according to their Human Development Index (HDI). The HDI summarizes the average achievement in key dimensions of human development: a long and healthy life, knowledge, and decent living standards. The HDI is the geometric mean of normalized indices for each of the three dimensions [83]. We calculated the median of the pink tax value across 10k interests for each country in our dataset. It is worth mentioning that the *digital marketing pink tax* for each interest is calculated using the 15th point in the associated CPM curve. Pearson's correlation between *digital marketing pink tax* and HDI is 0.35**, which shows a non-negligible (statistically significant) positive correlation between DMPT and HDI. Table 2 shows the variation of the *digital marketing pink tax* across the countries grouped by their HDI value. The criteria for this categorization is defined by the United Nations Development Program (UNDP) [84].

As it comes from the results, human development is correlated positively with the *digital marketing pink tax*. Higher developed countries are expected to deal with a higher *digital marketing pink tax*. Furthermore, as indicated in table 2, a greater percentage of countries with high levels of development are dealing with the *digital marketing pink tax*. Notably, the *digital marketing pink tax* has been observed in 92% of the most developed countries. Conversely, only 52% of less developed countries are impacted by this phenomenon, underscoring the fact that the *digital marketing pink tax* is a more pressing concern in highly developed countries. One possible explanation could be that the existing direction for economic development leads to gender inequality. Therefore policymakers should consider that in the absence of solid regulation in the online advertisement ecosystem, the country's development may lead to a higher gender gap.

5.3 Digital marketing pink tax in different industries

The existing literature reported the existence of the consumer pink tax in various industries/categories, including vehicles, personal care, and real estate [33, 33, 34, 34, 36–41, 85]. This indicates that females must pay

Table 2 Median value of the marketing pink for countries categorized by their human development

HDI category	DMPT	HDI	pct positive DMPT
Low	1.10	0.49	52%
Medium	3.21	0.62	54%
High	9.77	0.75	83%
Very high	18.62	0.88	92%

more for similar items and services than males. In this section, we delve more into the data and analyze the pink tax that marketers in different industries should pay. More specifically, we analyzed the pink tax in the classical 24 industries specified by IAB Tier1 taxonomy [86], the reference standard used in the online advertising industry.

We have already calculated the *digital marketing pink tax* for 10,000 interests. Next, we must identify which industry the interests fall under to investigate the *digital marketing pink tax* for each industry. We used two alternative methods to classify the interests into different industries:

- 1 We used GPT API to map Facebook interests to 24 distinct IAB version 2.2 standard tier 1 interest categories [86]. Note that IAB defines the reference categories' standard used in the advertising industry. Since the GPT API returns more accurate results when sending queries with less text length, we broke the list of 10k interests into 500 batches of 20 interests. Then we pragmatically sent requests using GPT API, asking each time the following question:
Map topics in list1 to the topics in list2, writing the results in CSV format,
list2=<LIST OF 20 INTERESTS IN THE BATCH>
list2=<LIST OF IAB TIER1 CATEGORIES>
e.g., Toyota, Automotive;
We cleaned up the responses to have one table per batch, which we combined to produce a single table mapping all the interests to their corresponding IAB Tier 1 category. The appendix contains a sample GPT API answer, while the entire dataset [87] and the code is provided in the article's online repository [88].
- 2 We utilized a categorization method introduced in academic literature [46] to classify interests. This approach uses Facebook's Graph API to map each interest in our dataset to one of the 14 root categories defined in the Facebook marketing platform.

Our first technique enabled us to accurately categorize 8,976 interests into the standard IAB Tier 1 categories, whereas the second approach could classify only 3,348 interests into the 14 root Facebook categories. Since the first approach is able to map a significantly major fraction of interests into categories,

we opted to use it to analyze different industries. We utilized the second categorization method to analyze the robustness of our findings. In particular, we select the common categories between the 24 IAB Tier 1 and the 14 Facebook root categories, e.g., Sports or Education. We assess the coherence of our two categorization methods in mapping interests by analyzing the overlapping categories.

Based on our first approach, the entire mapping table for each interest into a category can be found in this article's online repository [89]. Moreover, Table 3 shows (1) the 24 IAB tier 1 categories (2) the pink tax value of each category is computed as the median pink tax value of the interests mapped into such a category; (3) The masculinity ranking of the category is again computed as the median masculinity ranking of each interest mapped in the category.

Table 4 shows the same metrics for the 14 Facebook parent categories using our second categorization approach.

As introduced above, to assess the robustness of our categorization, we computed the relative difference of the DMPT value for the 6 categories present in both classification methods (See Tables 3 and 4). These categories are Sports, travel, food and drink, technology, business, and education, presenting a relative difference of the DMPT value of 2%, 1%, 6%, 7%, 7%, and 8%, respectively. Therefore the difference is in all cases, smaller than 10%. This high correlation in the results offered by two independent categorization methods guarantees the correctness of our categorization exercise.

Since our first methodology offers a larger coverage and given that IAB is the industry's categorization standard, we follow our analysis using the results from our first categorization method present in 3.

Our first general observation is that the pink tax is present in all IAB industries/categories, with DMPT values ranging between 9,9 *Real Estate* and 16,2 *Hobbies and Interests*. There are two important takeaways from these results. Conversely, the median overprices paid by advertisers to attract women's attention (compared to men) is roughly superior to 10% regardless of the category. On the other hand, there is a significant variation in the overprice assumed by advertisers depending on the category. For instance, the median overprices to target a woman based on interest related to *Hobbies and Interests* is 60% higher than interests falling in the *Real Estate* category. We hypothesize that this significant difference in the median overprices across categories may be related to the gender- (male- or female-) bias of the different categories.

Table 3 Digital marketing pink tax in different industries/categories

IAB Tier1 category	Masculinity	DMPT	count
Automotive	2,572	12.2	635
Sports	2,180	13.9	727
Technology & Computing	2,054	11.5	577
Personal Finance	1,742	12.5	70
Law Government & Politics	1,132	13.3	415
Business	975	12.3	338
Real Estate	444	9.9	30
News	229	13.0	176
Illegal Content	98	12.6	45
Careers	92	12.4	143
Arts & Entertainment	-158	13.0	1955
Education	-194	13.5	228
Science	-227	12.9	306
Hobbies & Interests	-393	16.2	175
Travel	-505	14.7	663
Society	-712	12.9	197
Home & Garden	-817	14.3	273
Religion & Spirituality	-1,875	13.7	198
Shopping	-1,931	14.4	263
Food & Drink	-1,937	13.7	480
Health & Fitness	-1,945	13.8	327
Pets	-2,274	14.7	120
Style & Fashion	-2,423	15.3	506
Family & Parenting	-2,850	12.5	129

To assess the correctness of our hypothesis, we have analyzed the correlation between the masculinity (i.e., gender bias) of a category and the median DMPT value of the category. Each of the 10k interests in our dataset is assigned a masculinity rank ranging between +5,000 for the most masculine categories to -5,000 for the most feminine (i.e., least masculine) category. The Masculinity column in Table 3 provides for each IAB category the median masculinity rank across the interests included in such category.

Our analysis uses Spearman's correlation considering the masculinity ranking and the DMPT value of each of the 22 IAB categories. The analysis revealed a moderate negative correlation between the two variables (Spearman's correlation=-0.47, $p=0.0879$). However, it is important to note that the observed correlation was statistically significant at the 0.1 level. The moderately high negative value of Spearman's correlation indicates that the *digital marketing pink tax* is higher in those categories presenting a feminine gender bias. In other words, advertisers are willing to pay a higher overprice to attract females' attention in industries with a bias toward females.

Finally, to conclude our analysis in this section, we discuss the obtained results in the context of the existing literature for some of the considered categories:

- **Health & Fashion :** The literature on personal care found strong evidence of the presence of a pink tax in the price of lotion (37%) and deodorants (16%) [33]. Similar observations were reported by Gend et al. [34] by finding strong evidence for a 20% pink tax on deodorants. An expla-

nation would be that the fashion industry is more directed towards luxury goods [90]. In most markets and product categories, female luxury brands are much more expensive than similar male products. According to the available literature, these discrepancies may be due to a larger perceived symbolic and social significance of such luxury brands, which have traditionally been more important for females than males [91]. This discussion confirms our findings that marketers pay a median pink tax value of 13.8% to advertise their health products (within the *Health and Fitness* category) to females. Furthermore, our findings indicate marketers should pay slightly more (15.3%) to advertise *Style and Fashion products*.

- **Sports:** Our results show relatively high *digital marketing pink tax* (14%) for the Sports category. Commercialization has infiltrated all levels of sports, from community sport participation to elite professional sports. Due to the audience and media exposure of professional sport, sponsorship in this context is best suited to satisfying commercially driven objectives [92]. Despite growing commercialization and professionalization, females' sport as a standalone product has received minimal attention. However, exponential growth in the professionalism and associated commercial opportunities of female sports started to grow in 2017, [93].
- **Education:** Global organizations like UNESCO are following different strategies to reduce the gender gap in education [94]. Our results show that despite these efforts, we can still observe a relatively high value of the pink marketing tax in the education (13.5%) category. Furthermore, the literature raises the concern about masculinity and the social norms for careers related to STEM [95]. Our results show a 12.4% and 12.9% *digital marketing pink tax* in the Careers and Science categories, respectively. The existing literature explains how advertisements affect social norms and expectations [96]. This finding is coherent with the existing literature on the gender gap in online social network advertisements. Men were exposed to 20% more impressions related to STEM than women [97]. Therefore, global organizations and policymakers should consider the critical role of monetary incentives and the digital marketing pink tax in their strategy to reduce this gap.

5.4 Robustness analysis

We comprehensively analyzed the pink tax phenomenon by repeating the same analysis on all the price estimation curve points. We aimed to determine

whether the digital marketing pink tax only exists in a specific budget range or can be observed in all budgets. The outcomes are shown in figure 4 and figure 5, which show the DMPT curves for CPM and CPC, respectively. The data includes the DMPT value for nine days from January 11th to January 25th, 2023. While the initial points on the curve may be more erratic for lower budgets, we can still see evidence of the pink tax when calculating the DMPT value using estimated prices for all 15 points on the price estimation curve. This robustness analysis supports that the *digital marketing pink tax* is a systemic phenomenon in the whole spectrum of advertising budget reported by Facebook's price curves for the CPM. Instead, there is no *digital marketing pink tax* in the case of CPC.

6 Conclusion and future works

This research shows how social media marketing data that is publicly available can be used to understand social trends. The paper introduces the *marketing pink tax* concept using existing theoretical frameworks and borrowing from the previously studied *Consumer Pink Tax*. Additionally, a new method was introduced that uses online social networks to measure the Marketing Pink Tax in more than 200 countries. This technique is cost-effective, accessible, and scalable. We used this approach to determine whether advertisers must pay more to deliver Facebook ads to females or males. We found that over 70% of the audience is exposed to Pink Tax marketing, which means advertisers must pay more to deliver ads to females than males in 70% of the audiences. This result suggests that the existence of the marketing pink tax is a systemic phenomenon.

Our comprehensive analysis shows that the pink tax presents itself differently in various countries and industries. Our investigation of over 10000 interests across 227 countries indicates that the pink tax is prevalent in approximately 88% of the world. Moreover, our study shows that the human development index at the country level, which encompasses economic, educational, and health factors, positively correlates with the occurrence of the pink tax. Specifically, the pink tax is present in 92%, 83%, 54%, and 52% of countries with very high, high, medium, and low development, respectively. Furthermore, in these countries, advertising costs for females are 19%, 10%, 3%, and 1% higher than for males. Thus, the pink tax is arguably an unintended consequence of the advancement of human society, and policymakers should address this issue.

Our analysis shows that the *marketing pink tax* is present across all industries, which supports previous research on the topic. Additionally, we present initial evidence that the overprice advertisers pay to attract

women's attention is higher in categories presenting a feminine gender bias.

Finally, efforts by international organizations to reduce the gender gap in education, our results show that this industry's *marketing pink tax* remains relatively high (13.5%). Our research also highlights concerns about social norms in STEM careers, as we found a *marketing pink tax* of 12.4% and 12.9% in the Career and Science categories, respectively.

This paper introduces a novel approach to examining the pink tax, a prevalent issue in the literature, by considering it from a distinct perspective. The pink tax in marketing refers to the additional expenses advertisers incur to target females, which ultimately contributes to gender inequality and the consumer pink tax. Further investigation is needed to determine the causal connection between the *marketing pink tax* and political and social variables in human development. This remains an open topic for future research.

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Declarations

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests

Authors' contributions

Ruben Cuevas contributed to the design of the paper, the development of the measurement methodology, and the paper writing. Amir Reza Mehrjoo contributed to the design of the paper, the execution of the experiments, and the paper writing. Angel Cuevas contributed to the design of the paper and the development of the measurement methodology, and the paper writing.

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Appendix

The data we gathered for this research is available in the articles' <https://github.com/AmirXmj/PinkTax.git>.

Facebook penetration

To find the validity of our dataset, we defined Facebook penetration by dividing the amount of monthly active Facebook users over the total population of each country. Figure 7 presents the worldwide distribution of Facebook penetration. The regions with relatively higher penetration values are European, North America, Australia, and New Zealand countries. The countries plotted in Red color are the ones where Facebook does not provide any marketing services. The Facebook penetration in developed countries is, on average, 53.3%, and in developing countries is, on average, 40.3%.

Table 4 DMPT in different categories previously defined in the literature [46]

Interest category	Masculinity	DMPT	count
Sports and outdoors	2,072	14.1	540
Technology	2,070	12.3	273
Hobbies and activities	787	13.0	1054
Business and industry	670	13.3	1637
News and entertainment	14	13.4	1674
People	-58	13.0	754
Travel, places and events	-134	14.6	924
No Category	-231	13.6	441
Lifestyle and culture	-512	13.1	452
Education	-610	12.5	169
Food and drink	-1,775	12.9	454
Fitness and wellness	-1,930	12.7	183
Shopping and fashion	-2,532	14.2	376
Family and relationships	-3,945	13.4	45

Gpt4 API response sample

Toyota, Automotive ; Mario Bautista, Arts & Entertainment ; UEFA, Sports ; Basketball, Sports ; FIFA World Cup, Sports ; Cycling, Sports ; Play (telecommunications), Technology & Computing ; BMW M, Automotive ; Linux, Technology & Computing ; Mobile app, Technology & Computing ; Juventus F.C., Sports ; Military, Law Government & Politics ; Coup, Illegal Content ; Sedan (automobile), Automotive ; Ford Motor Company, Automotive ; Team sport, Sports ; Finance, Personal Finance ; Lamborghini, Automotive ; Speed (1994 film), Arts & Entertainment ; Investment, Personal Finance ; Gamer, Arts & Entertainment

Figure 7 Worldwide distribution of monthly active Facebook users divided by the population