Formula 1 Grands Prix demand across different distribution channels

Abstract

Rationale: Over the last two decades, sports economists and management scholars alike have increasingly begun modeling the tv demand for professional sports, most notably association football. However, there as yet exists no empirical study on whether the observed mechanisms are robust across different distribution channels.

Design/methodology/approach: In this study, we add to this still-emerging literature stream by analyzing the robustness of otherwise well-explored determinants of tv demand across different distribution channels (free-to-air and pay-tv), also distinguishing between male and female tv audiences.

Findings/research contribution: Interestingly, exploring the German tv demand for F1 racing at two different tv channels holding non-exclusive media rights between 2011 and 2017, we note that the effects of most (e.g., the starting time, weather), though not all, determinants are robust across the two different channels and the two audience groups.

Practical implications: Our results thus suggest that media right holders interested in maximizing television audience demand for a sport broadcast are well-advised to add nuance to their communication efforts.

Keywords: FIA, Motorsports, television

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Introduction

Over the last two decades, the question of what factors might shape the fan interest in live sports broadcasts has increasingly gained attention, primarily from (sports) economists and management scholars (c.f., van Reeth, 2021). Testing Rottenberg's (1956) much-debated uncertainty of outcome hypothesis (UOH), Forrest et al. (2005) were among the first authors to model such tv audience demand in English Premier League (EPL) football, arguing that analyzing such data was potentially superior to exploiting publicly available attendance data, among others. Since then, many other authors have explored not only the English (e.g., Alavy et al., 2010; Buraimo, 2008; Cox, 2015) but also competing European football markets (e.g., Denmark: Johnson & Solvoll, 2007; Germany: Schreyer et al., 2018a; Italy: Caruso et al., 2019; Norway: Solberg & Hammervold, 2004; Spain: Buraimo & Simmons, 2009), increasingly attempting to model the tv demand for mega sports events such as the Union des associations européennes de football (UEFA) European Championship (e.g., Nüesch & Franck, 2009) and the Fédération Internationale de Football Association (FIFA) World cup (e.g., Schreyer et al., 2017; Uribe et al., 2021; van Reeth & Osokin, 2020) as well. It is, therefore, perhaps, not surprising that today, there already exist somewhat more than 50 empirical studies, a fair share of which have modeled the tv demand for US sports (e.g., American football: Paul & Weinbach, 2007; Major League Baseball: Mills et al., 2016; National Basketball Association: Mongeon & Winfree, 2012), and, to a lesser degree, individual sports, including boxing (Meier et al., 2018), cycling (e.g., van Reeth, 2019), mixed martial arts (e.g., Tainsky et al., 2013), tennis (e.g., Konjer et al., 2017), and stock car racing (Berkowitz et al., 2011).[1]

[1] In addition, there also exist somewhat related, complementary literature streams from authors exploiting survey data, for instance, to understand better consumer's willingness to pay for sports broadcasts (e.g., Hammervold & Solberg, 2006).

While this growing tendency to model consumer interest in sports broadcasts may have several plausible reasons, including a general increase in the availability of reliable tv data, it first and foremost, mirrors the media right holder's increasing dependency on generating sufficient media income for their many stakeholders. For instance, in Germany, the relative share of German Bundesliga matchday and media income was about 16 and 32 percent, respectively, in the season 2003-04. Since then, the resulting difference has gradually grown to roughly 24 percent in the more recent season 2018-19 (c.f., DFL, 2006; 2020), i.e., the last season before the current pandemic hit the European football landscape. Somewhat similarly, Europe's top-selling football clubs, the twenty members of the so-called Deloitte Football Money League, typically generate about 45 percent of their annual income through collectively selling their media rights (Deloitte, 2021). Hence, a better understanding of what shapes the consumer's interest in live broadcasts is essential to successfully market a sports product to audiences not only in the European tv market.

Against this background it is surprising that these previous authors have not yet addressed the related question of whether the determinants that shape the consumer interest in professional sports are robust across different distribution channels. In fact, there already exists a significant body of empirical tv demand studies suggesting that the tv demand for a sporting product is, to some degree, also depending on broadcaster effects (e.g., Konjer et al., 2017; Schreyer et al., 2017; van Reeth, 2019).[2] However, as these broadcasters might cater to very different audiences, developing a more nuanced understanding of the underlying mechanisms at hand seems important, not least for the top management's many stakeholders. For instance, for those broadcasters investing vast amounts in media rights, such a better understanding might

[2] As one reviewer has pointed out, our empirical research, therefore, also touches upon the somewhat related question of whether simultaneous broadcasts, for instance, two distinct different FIFA World Cup matches scheduled in parallel, affect the consumer's demand for each other. In this context, Van Reeth and Osokin (2019) note that perhaps unsurprisingly, such simultaneous broadcasts did negatively affect Russian TV demand for international football. Evidently, this finding seems robust across various tv markets, including the German market (e.g., Schreyer et al., 2017).

help activating their audience through more effective program framing, which, in turn, is crucial for them to break even in the long run.

In this article, we attempt to answer this previously unexplored research question by exploring the German tv demand for Formula 1 (F1) Grands Prix, i.e., a sport which is largely absent from the still-emerging economic literature (c.f., Schreyer & Torgler, 2018).[3] More specifically, we exploit tv data from 2011 to 2017, during which F1 racing was broadcasted in parallel by two different rights holders; free-to-air television channel RTL, i.e., the largest private network in Germany, and pay-tv channel sky. As such, we not only attempt to add to our limited knowledge on the robustness of the determinants for F1 racing across two different and competing distribution channels but also hope to shed some light on the increasingly important question of whether these competing product offerings, which basically only differ in tone (e.g., due to different anchors, editors, and pundits), can be considered substitutes for each other. Finally, by separately modeling the tv demand of female and male audiences, we also add to the only slowly emerging literature on potential gender differences in sports consumption (e.g., Meier & Leinwather, 2012).

Below, we proceed as follows. First, primarily to document an existing gap in the empirical literature on sports broadcast demand, we provide a brief synthesis of the empirical literature on motorsports in general and F1 racing in particular. Second, to make our subsequent analysis as understandable as possible, we then provide an overview of the data and our empirical strategy, thereby also reporting the summary statistics of our key variables. Third, we report and discuss our empirical results, contrasting them, to the best of our knowledge, to those

[3] As these F1 Grands Prix take place worldwide, our empirical setting is conceptionally somewhat different from other empirical studies exploring, for instance, tv audiences' demand for a sporting product produced in (1) the same market (e.g., Alavy et al., 2010; Scelles, 2017: Tainsky, 2010), (2) the same market but without any local contenders (e.g., Tainsky & McEvoy, 2012) or (3) in different market (e.g., Schreyer et al., 2018b). Further, we also refrain from exploring regional demand, i.e., regional tv audiences' demand for a sporting product produced in the same domestic market (e.g., Gasparetto & Barajas; 2018).

few extant studies on F1 tv demand. Fourth, we conclude our article, also providing a brief outlook on what we think should be addressed in future research.

A brief synthesis of the empirical literature on F1 racing

Despite the sports' global appeal, the empirical literature on F1 racing is relatively sparse, particularly when it comes to modeling consumer (tv) interest. More precisely, despite the existence of a handful of empirical studies assessing the competitive balance, and therefore an integral aspect of Rottenberg's (1956) original demand equation, in F1 racing (e.g., Budzinski and Feddersen, 2020; Judde et al., 2013; Mastromarco & Runkel, 2009), none of these studies also explored an association with consumer demand. Similarly, Rockerbie and Easton (2021), although interested in estimating the specific driver effects in F1 racing, limit their analysis to an evaluation of sporting performances, as have others (e.g., Bell et al., 2016; Eichenberger & Stadelmann, 2009; Philips, 2014). In contrast, various authors have exploited F1 racing data, using the sporting environment as a lab, to analyze a firm's response to regulatory changes (Marino et al., 2015), the evolution of technological trajectories (Jenkins & Floyd, 2001), the effect of aging on productivity (Castellucci et al., 2011), sponsorship prioritization (e.g., Cobbs et al., 2017), and sports event tourism (e.g., Henderson et al., 2010), among others. In sports management,

Consequently, to the best of our knowledge, there as yet only exist five empirical studies modeling the (tv) demand for motorsports, four of which center on F1 racing at least to some degree. Among these few authors, Kipker (2003) was the first to analyze F1 racing demand. Exploiting German tv data generated during 88 European F1 races scheduled between 1992 and 2000, Kipker (2003), primarily interested in the relationship between competitive balance and the resulting race outcome uncertainty (ROU) and tv demand, observes neither support for Rottenberg's (1956) UOH nor a robust superstar effect. In contrast, Kipker's (2003) initial

descriptive analysis suggests that German tv demand was highly dependent on the race's starting time, which explains the subsequent focus on European races.

Focusing on the role of ROU in shaping the tv demand for F1 races, Kipker's (2003) pioneering work has motivated two subsequent studies, both of which also analyze German tv data. Taking a slightly different empirical approach than Kipker (2003), Krauskopf et al. (2010), quantifying ROU using an otherwise well-established concentration index of championship points, i.e., the Gini coefficient, observe a more nuanced association between ROU and German F1 tv demand during 1992 and 2009. On the one hand, German tv audiences, favoring races featuring Michael Schumacher, were not necessarily interested in evenly balanced competition. On the other hand, the same audiences preferred those races with an – ex-ante – close contest between the race series' top title contenders. Consequently, Schreyer and Torgler (2018), essentially questioning the effectiveness of an ROU-proxy based on the championship standing, were the first to exploit differences in the qualifying times of top contenders to capture ROU. Analyzing 400 F1 broadcasts over the period between 1993 and 2014, i.e., a period of 20 years, Schreyer and Torgler (2018) note a significant relationship between ROU, approximated by the summed difference between qualifying time of starting Grids 1–3 (DQT3), and, once more, German tv demand. In addition, Schreyer and Torgler (2018) also observe a significant role of product quality aspects relating to patriotism and, seasonal progress, among others, and the opportunity costs that might arise from watching a sports broadcast live (e.g., scheduling and weather effects).

In addition, we believe that two more studies relate reasonably well to our research question. First, analyzing the role of ROU in National Association for Stock Car Auto Racing (NASCAR) racing between 2007 and 2009, Berkowitz et al. (2011) observe that US tv demand was positively associated with a more balanced competition, among others. Second, Garcia-del-Barrio and Reade (2021), capturing varying consumer interest using Google Trends, note that interest in F1 racing decreases once the Championship is decided. Interestingly, this finding

is, to some degree, reflective of the results from not only Schreyer and Torgler (2018) but also Krauskopf et al. (2010).

Taken together, the scarce empirical literature on F1 racing tv demand can certainly be best described as focused, anchoring on the much-debated question whether, and if so, by how much, competitive balance is necessary to generate consumer interest. Further, somewhat surprisingly, all three previous studies were conducted in the German tv market, more specifically by modelling the tv demand for F1 racing on a free-to-air channel, RTL, despite the existence of an alternative program offer from the pay-tv channel sky, which broadcasted F1 racing since 1996.[4] Therefore, the otherwise interesting question on whether the determinants of F1 racing tv demand are robust across these two different channels has not yet been addressed in the empirical literature. Similarly, as previous F1 studies have exclusively focused on analyzing a homogenous consumer group, i.e., German audiences, there also remains the question of whether the observed effects are robust across gender. Interestingly, most previous research suggests that such gender differences are relatively modest in the German market (e.g., Ansari & Schreyer, 2023; Schreyer et al., 2018a; 2018b), even though there seem to exist differences across products. More specifically, Meier and Leinwather (2012), analyzing German tv demand for men's and women's international football, document no notable gender differences in the determinants that shape the tv demand for the men's matches. However, this uniformity did not fully carry over to the women's football product, where men's and women's responses to a match's quality aspects, in particular, differed to some degree.[5] Below, we explain how we attempt to answer both of these questions.

[4] However, as Schreyer and Torgler (2018) note, official rating data on Sky broadcasts are only available starting from 2011. This is also why our sky data only contains 136 races, while our RTL data includes 137 races, i.e., one race more.

[5] Broadening the perspective beyond the German market, most previous empirical research modeling the tv demand for sports broadcasts similarly suggest that such gender differences are modest (e.g., Tainsky & Xu, 2019; Tainsky et al., 2014), although, perhaps, they seem to be somewhat more nuanced in survey research (e.g., Clark et al., 2009)

Background, data, and empirical strategy

To answer our research question of whether the determinants of F1 racing tv demand are robust across two different channels, i.e., a free-to-air and a pay-tv channel, we exploit a convenient data set that contains detailed information on all 137 Fédération Internationale de l'Automobile (FIA) F1 World Championship Grand Prix (GP) broadcasts in the period between 2011 and 2017, i.e., seven seasons. Although choosing this specific period may seem random at first glance, it is particularly interesting to us because for these seven seasons two unrelated German broadcasters, RTL and sky, held the right to broadcast F1 races in parallel in Germany. In fact, the two years 2011 and 2017, are natural starting and endpoints respectively. Before April 2011, Gesellschaft für Konsumgüterforschung (GfK), the official provider of television usage data in Germany, did not collect any sky ratings (DWDL, 2011). After the 2017 season, Sky Germany gave up their broadcasting rights for 2018 and 2019 before repurchasing them for the 2020 season onwards. Quite to the contrast, after 30 years of F1 coverage, in 2020, RTL announced that it would no longer broadcast F1 races by the end of the 2020 season.

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In Figure 1 and Table 1, we provide an overview of the development of German F1 demand by distribution channel over time and the summary statistics of our data set, respectively. As can be seen from this table, German F1 demand was, on average, 5.22 million viewers,[6] most of whom were watching F1 races on RTL, one of Germany's largest free-to-air television stations. However, as can be seen from Figure 1, this demand has gradually declined over time. In contrast, tv demand for F1 racing broadcast on Sky, in general significantly lower

[6] As many colleagues did before (e.g., Schreyer et al., 2017), we purchased the TV data exploited here from the Gesellschaft für Konsumforschung (GfK), which conducts representative TV ratings for the entire German TV industry. The data is/are generated from a representative sample of a minimum of currently 5,400 households, including about 11,000 individuals. As Schreyer et al. (2018a) explain, this data represent(s) individual spectator rather than aggregated household decisions because each resident has to sign in or out by pressing a particular button.

than on RTL, has increased continuously. Further, we note that absolute demand was significantly stronger among male (M = 3.47, SD = 0.51) than female (M = 1.64, SD = 0.76) audiences. Noticeably, this gender information is only available for audiences aged 14 and older, which, however, constitute the majority of the German audiences. Exploiting four different dependent variables per tv channel, we estimate a total of four demand specifications each. More specifically, in line with most previous research modeling tv demand for sports broadcasts, in Table 2, we present ordinary least square (OLS) regression results with Huber–White corrected standard errors robust to heteroskedasticity. Further, we log-transformed all four dependent variables relating to RTL, though not to sky, to obtain normally distributed residuals.

In all eight specifications, we apply an identical set of potential explanatory variables, capturing aspects that relate to (1) ROU, (2) the race's scheduling, (3) the race track and conditions, (4) patriotism, (5) the potential opportunity costs that arise from watching an F1 race live, effectively weather effects, and, as a control, (6) season fixed effects. In sum, we, therefore, explore the robustness of twelve different variables, all of which were found to be robust and significant determinants of F1 racing tv demand in the most recent empirical study on German F1 racing demand (c.f., Schreyer & Torgler, 2018).

First, as discussed earlier, analyzing the competitive balance and the resulting ROU are key themes in motorsport demand research and beyond (e.g., Schreyer & Ansari, 2021). Here, following the approach by Schreyer and Torgler, (2018), we exploit two different variables to capture such uncertainty on two different temporal dimensions. First, to capture short-term ROU, we add DQT3, i.e., the summed differences between qualifying times of the top three drivers into account.[7] Second, to account for long-term Championship uncertainty, we add a

[7] While focusing on the top three drivers seems arbitrary, Schreyer and Torgler (2018) argue that according to their data, about 9 out of ten Grand Prix winners have started from the Grids one (ca. 50 percent), two (25 percent), or three (12.5 percent). Similarly, though perhaps unsurprising, Wesselbaum and Owen (2021) find that pole sitters, in particular, have a significant advantage over the remaining drivers.

dummy (SEASONAL) that takes the value of 1, if the F1 Driver's World Champion has already been decided, and a value of 0 otherwise. In line with previous research, most notably Schreyer and Torgler (2018), we expect a negative relationship between DQT3 and F1 tv demand, indicating that consumer interest decreases if the difference in the qualifying result of the most likely race winners increases. Similarly, we expect demand to decrease if the World Cup has already been decided (c.f., Garcia-del-Barrio & Reade, 2021).

Second, in terms of scheduling, we exploit three variables. First, we add a dummy variable that takes the value of 1 if a race was hosted in Germany. As Schreyer and Torgler (2018) found, tv demand is likely to increase for such home Grands Prix, namely the European GP (Nürburgring; 2 races) and the German GP (Hockenheim; 3). Similarly, we also expect a positive effect of seasonal progress, and a non-linear start time effect. More specifically, with about roughly every second F1 Grands Prix scheduled for a convenient start at 14:00 (or 2:00 pm), it is likely that demand is significantly weaker before and after this slot. In fact, in the German market, such non-linear effects are not uncommon (e.g., Schreyer et al., 2017), though most previous research seem to rely on less nuanced, typically significant, access/prime time-dummies (e.g., Artero & Bandrés, 2018; Bergmann & Schreyer, 2019; Meier et al., 2019).

Third, we also explore whether track condition affect German tv demand. More specifically, we add the GP track distance (in km) as well as a rain dummy. The second variable, in particular, is often associated with an exciting, often spectacular race (c.f., Schreyer & Torgler, 2018). For instance, although purely anecdotal, in Germany in particular, many fans might remember Michael Schumacher's first win at the Belgian GP, in a wet race at Spa, or, his exceptional race to win the same GP in 1995 in pouring rain, starting from grid 16. As such, as rain is likely to significantly alter race track conditions during a GP (Gutiérrez & Lozano, 2020), audiences might turn on their television set expecting to witness more nuanced driving skills or, perhaps, quite the opposite, more accidents. Somewhat differently, as the length of a

race track in F1 racing determines the number of laps,[8] a short race track automatically also means more laps and, therefore, repetition, which might help audiences to become familiar with the specifics of a particular race track. Intrinsically, it is not necessarily surprising that previous research has indicated a negative relationship between race track length and German F1 racing tv demand (Schreyer & Torgler, 2018).

Fourth, circling back to our earlier point, we add two factors that proxy a form of patriotism, which might positively affect tv demand. Here, specifically, we add a Michael Schumacher dummy,[9] as well as a variable that captures the number of German GP starter. Interestingly, while both Krauskopf et al. (2010) and Schreyer and Torgler (2018) note a positive Schumacher effect, robustness is not necessarily a given (c.f., Kipker, 2003).

Fifth, and finally, we also add three different weather variables. More specifically, we explore whether the opportunity costs that may arise from watching a GP broadcast live on tv affect consumer demand. For instance, tv demand may decrease as sunshine or the temperature increases because audiences decide to spend their time outside of their home. In contrast, pouring rain might increase the demand to watch tv at home in general and F1 Grands Prix in particular because such uncomfortable weather conditions are typically associated with a decrease in mood. In this specific context, watching an entertaining broadcast (e.g., a top-tier sports event) may help repair such a lower mood (e.g., Eisinga et al., 2011).

Results

In Table 2, we report the regression results. Intriguingly, our empirical results suggest that most of the determinants, though not all, were robust across not only the two different channels but also the two different audience groups, i.e., male and female audiences. Further, and perhaps

[8] In F1 racing, the distance of all races is typically equal to the least number of complete laps that exceed 305 km (c.f., FIA, 2022).

[9] As one reviewer noted, Schumacher, who returned from career retirement in 2010, was somewhat more successful in season 2011 (ranked 8th) than in 2012 (13th). Nevertheless, the presented results are robust to adding a more nuanced variable.

somewhat unexpected, we note significant differences when comparing our results to the earlier work by Schreyer and Torgler (2018), most likely due to the alternative period of observation.

As is evident from Table 2, roughly half of our explanatory variables are robust across both the two different distribution channels and as gender,[10] despite alternating signs. However, somewhat surprisingly, only two of them – the GP start time and the temperature – are also significant and, thus, in line with the previous results from Schreyer and Torgler (2018), who exploited data from the same market, though over a different, also earlier period. More specifically, we observe a significant, non-linear relationship between a race's starting time and German F1 tv demand, with an estimated turning point at about 16:00 (or 4:00 pm), largely reflecting a strong consumer preference for Grands Prix scheduled at 14:00 or later, as well as a negative association with the temperature.[11] While the former effect is not necessarily in line with the broader sports tv demand literature, where authors tend to rely on categorical data (e.g., Feddersen & Rott, 2011), often even exploiting mere dummies (e.g., Meier et al., 2018; Tainsky et al., 2014), primarily because demand is often, tough not always, expected to peak during prime time, it is, nevertheless, reflective of the few previous F1 demand studies in the German market (e.g., Kipker, 2003). As such, more specifically, after adjusting for all other predictors in our empirical model, German tv demand for F1 Grands Prix on the pay-tv channel sky is roughly 0.21, 0.40, and 0.35 million TV viewers for a race that starts 06:00 a.m. (e.g., 2015 Australian GP), 02:00 p.m. (e.g., 2015 Italian GP), and 09:00 p.m. (e.g., 2017 United States GP), respectively. Intriguingly, this finding, to some degree capturing the potential opportunity costs from watching an early/late race, is also reflected in the negative association with temperature. Put differently, as the temperature rises, consumers might increasingly opt for

[10] Noticeably, this second observation, that is a certain robustness across genders, is mostly in line with the previous research in both the German (e.g., Schreyer et al., 2018a) and the US (e.g., Tainsky & Xu, 2019) tv market.
[11] Interestingly, results from additional estimations exploiting only these two variables indicate that these two variables already explain about half of the of the variance in German F1 tv demand at RTL, and about 20 percent at sky.

outdoor leisure activities rather than watching sports – a finding mostly in line with the broader literature (e.g., Feddersen & Rott, 2011; van Reeth, 2019).

Although still robust across both the two distribution channels and gender, we neither note a significant effect of home GPs nor seasonal progress, track conditions, and domestic rainfall. As such, also given the relative importance of the GP start time in explaining the variance in demand, these findings seem, to some degree, to suggest that F1 GPs seem to attract a relatively loyal fan base across both distribution channels. Intriguingly, this also becomes evident when only looking at those GPs that start at 02:00 p.m., i.e., the quasi-reference point for most German F1 audiences, where the coefficient of variation, i.e., the size of the standard deviation in relation to its mean, is relatively modest (RTL: 0.178; sky: 0.232). For media right holders, emphasizing the varying track conditions or generating additional media buzz in the run-up of a home GP, a factor often associated with generating additional tv demand (e.g., Feddersen & Rott, 2011), seems not helpful in attracting consumers.

However, we also observe notable differences. For instance, regarding (race) outcome uncertainty, undoubtedly, the most heavily debated potential determinant in the still-emerging empirical literature on sports tv demand (e.g., Nalbantis & Pawlowski, 2016), we note some differences between not only the two distribution channels but also across gender. That is, while we observe an insignificant association between ROU and German F1 tv demand at RTL, largely contradicting the previous evidence (Schreyer & Torgler, 2018), we note a positive, but relatively small, and significant association at sky that seems to be driven by female audiences. Interestingly, these female audiences, unlike their male counterparts, however, seem not to value seasonal uncertainty, as we only observe insignificant associations. Insofar, our results are largely reflective of earlier findings generated in the same tv market (c.f., Meier & Leinwather, 2012; Schreyer et al., 2018a; 2018b) and indicate that these variations in responses to ROU may ultimately constitute one of only a few differences across gender. Further, as the perceived importance of ROU might change over time (e.g., Schreyer et al., 2018a), it is not

surprising, per se, that our results deviate, to some degree, from earlier results generated in the same market (c.f., Schreyer & Torgler, 2018).

Similar to ROU, we only find limited support for an important role of German starters in general and Michael Schumacher in particular. In fact, while insignificant at RTL, we even observe a robust, and surprising, negative relationship between the appearance of Schumacher, who, having already retired from F1 racing in 2006 only to return to the Mercedes GP Petronas F1 Team in 2010, only raced to the podium once between 2010 and 2012. In contrast, we observe a positive relationship between the total number of German starters at sky, which is, however, not robust across gender.[12] Besides, when once more returning to potential weather effects, we find some weak support for a positive association between sunshine and F1 tv demand at RTL.

Conclusions

Although the empirical literature on the determinants of sport broadcasts demand is continuously growing, most of this literature has focused on professional team sports, most notably football, also known as soccer in some parts of the world (c.f., Szymanski & Weineck, 2018), and US sports (c.f., van Reeth, 2021). In contrast, the literature is relatively shy on individual sports and the robustness of demand drivers across both different distribution channels and heterogenous audiences. In this study, we address this notable research gap by analyzing the robustness of otherwise well-explored determinants across different distribution channels, also distinguishing between male and female tv audiences. Interestingly, by exploring the German tv demand for F1 racing at two different tv channels between 2011 and 2017, we note that the effects of most, though not all, of our determinants were robust across not only the two different channels but also the two audience groups.

[12] Insofar, given some broadcaster's tendency to center on local heroes (e.g., MacArthur & Smith, 2021), this finding is certainly surprising.

Naturally, although certainly limited in scope, we believe that our empirical results offer a number of interesting insights for the business practice. For instance, for media rights holders interested in maximizing the demand for a given sports broadcast, our results suggest that adding nuance to their communications efforts before, during, and after a GP might help nurture tv demand. More importantly, though, our results, deviating from earlier results, imply that these rights holders must review these communication efforts continuously, as consumer preferences seem not to be set in stone, despite some notable core support. Further, for sporting associations such as FIA, our results, once more, underline the importance of effective scheduling – certainly a challenge for an association offering a product that it produces around the world and then simultaneously distributes to a truly global audience. Here, as a prioritization of markets seems inevitable, it might be helpful for them to understand that solving the puzzle of how and where to grow the global tv demand might more so depend on effective scheduling rather than on additional media buzz from a home market GP or the number of local heroes. That is if our findings from the potentially already mostly saturated German F1 market are externally valid.

Although we certainly add necessary nuance to the still-emerging body of literature modeling the tv demand for sports, it is, however, worth noting that our empirical study is certainly not without its limitation. In particular, we admit that our sample, only contains information from seven F1 seasons and one previously explored (e.g., Kipker, 2003) tv market; i.e., the German market. Future research might, thus, be well-advised to also explore other relevant tv markets, perhaps most notably, the US market, as well as more traditional F1 markets (e.g., Australia, Italy and the United Kingdom). Similarly, as more and more date becomes available, we believe it would certainly be worthwhile to look into whether the observed effects remain robust across alternative distribution channels and, naturally, also sports. For instance, to the best of our knowledge, as yet there is no research modeling the demand for sports over the top (OTT). Furthermore, we believe it would be interesting to

explore the robustness of our results in an alternative setting, most notably by analyzing race track attendance demand. More specifically, while Gasparetto and his co-authors (2022) have made the first attempt to model such F1 attendances only recently, future research might want to exploit more nuanced attendance data focusing on the weekend's main event (i.e., the race) or, even better, the different events.

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Figure 1 Development of German F1 demand by distribution channel over time

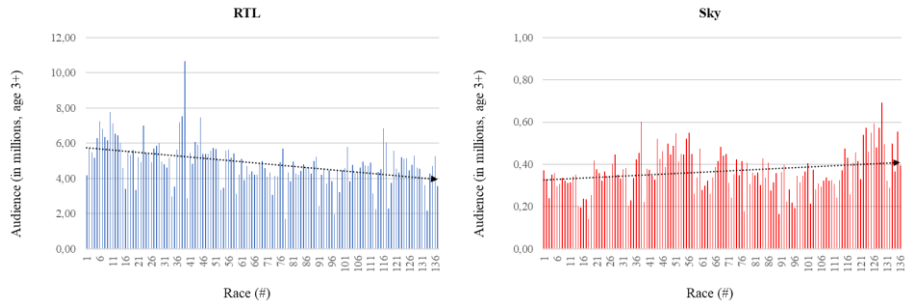

Table 1 Summary statistics

Dependent variable(s)		Sign[3]	M	SD	Min	Max
Audience (RTL)	Audience on channel RTL (in m, age 3+)		4.85	1.24	1.71	10.65
	Audience on channel RTL (in m, age 14+)		4.74	1.20	1.69	10.28
	Audience on channel RTL (in m, age 14+, male)		3.19	0.73	1.27	6.24
	Audience on channel RTL (in m, age 14+, female)		1.55	0.49	0.42	4.03
Audience (sky)	Audience on channel sky (in m, age 3+)		0.37	0.10	0.14	0.69
	Audience on channel sky (in m, age 14+)		0.36	0.10	0.14	0.65
	Audience on channel sky (in m, age 14+, male)		0.28	0.07	0.11	0.48
	Audience on channel sky (in m, age 14+, female)		0.08	0.03	0.02	0.17
Explanatory variables						
Outcome uncertainty						
Race	The summed difference in a qualifying time (in secs)[2]	-	0.59	0.42	0.05	2.43
Seasonal[1]	Driver's Championship is decided (yes = 1; otherwise = 0)	-	0.09	0.29	0.00	1.00
Scheduling						
Home GP[1]	GP is held in Germany (yes = 1; 0)	+	0.04	0.19	0.00	1.00
Begin	GP starting time (as scheduled)	+/-	13.55	3.66	6.00	21.00
Seasonal progress	Relative progress in the Championship (in percentage)	+	0.53	0.29	0.04	1.00
Tracks and conditions						
GP Distance	Track distance (in kilometer)	-	5.19	0.80	3.34	7.00
Rain[1]	Rainy weather (yes = 1; 0)	+	0.07	0.25	0.00	1.00
Patriotism						
German starter	Total number of German drivers participating in race	+	4.06	0.92	2.00	6.00
Schumacher[1]	Michael Schumacher participates (yes = 1; 0)	+	0.28	0.45	0.00	1.00
Weather/opportunity costs						
Temperature	Temperature on race day in Germany (in Celsius)	-	12.89	5.98	-2.30	27.30
Rainy	Rainfall on race day in Germany (in millimeter)	+	2.08	2.99	0.00	12.60
Sunshine	Sunshine on race day in Germany (in hours)	-	5.54	3.49	0.00	14.30

Abbreviations and notes: All figures are rounded; Grand Prix (GP), millions (m); Seconds (secs). [1] Dummy variable; [2] Grids 1–3; [3] Expected relationship (c.f., Schreyer and Torgler (2018)

Table 2 Robustness of determinants across the two different tv channels

	Age 3+		Age 14+		Age 14+, male		Age 14+, female	
	RTL	sky	RTL	sky	RTL	sky	RTL	sky
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome uncertainty								
Race	-0.02	0.03†	-0.02	0.03*	-0.01	0.02	-0.03	0.01*
	0.02	0.02	0.02	0.02	0.02	0.01	0.03	0.01
Seasonal[1]	-0.10	-0.05	-0.10†	-0.04	-0.11†	-0.03	-0.07	-0.01
	0.06	0.03	0.06	0.03	0.06	0.02	0.07	0.01
Scheduling								
Home GP[1]	0.02	-0.01	0.02	-0.02	0.03	-0.01	-0.00	-0.01
	0.05	0.02	0.04	0.02	0.03	0.02	0.07	0.01
Begin	0.25***	0.06***	0.25***	0.06***	0.23***	0.04***	0.31***	0.02***
	0.02	0.01	0.02	0.01	0.02	0.01	0.03	0.00
Begin*Begin	-0.01***	-0.00***	-0.01***	-0.00***	-0.01***	-0.00***	-0.01***	-0.00***
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal progress	-0.04	0.01	-0.03	0.01	-0.01	0.00	-0.07	0.01
	0.06	0.03	0.06	0.03	0.06	0.02	0.08	0.01
Tracks and conditions								
GP Distance	-0.02	-0.00	-0.02	-0.00	-0.02	0.00	-0.02	-0.00
	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.00
Rain[1]	0.06	0.02	0.07	0.02	0.06	0.01	0.09	0.00
	0.04	0.02	0.04	0.02	0.04	0.01	0.05	0.01
Patriotism								
German starter	0.06	0.06*	0.06	0.06*	0.03	0.05**	0.12	0.01
	0.06	0.02	0.06	0.02	0.05	0.02	0.07	0.01
Schumacher[1]	0.14	-0.32***	0.14	-0.32***	0.20	-0.26***	0.04	-0.07*
	0.17	0.07	0.17	0.07	0.16	0.05	0.21	0.03
Weather/opportunity								
Temperature	-0.01**	-0.00*	-0.01**	-0.00*	-0.01*	-0.00*	-0.01**	-0.00†
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sunshine	0.01†	0.00	0.01†	0.00	0.01†	0.00	0.01†	0.00
	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
Season (fixed effects)	YES	YES	YES	YES	YES	YES	YES	YES
N	137	136	137	136	137	136	137	136
R-squared	0.7912	0.6084	0.7953	0.6261	0.7698	0.5777	0.8100	0.4818
Mean VIF	9.51	9.46	9.51	9.46	9.51	9.46	9.51	9.46

Abbreviations and notes: All figures are rounded; Grand Prix (GP); †, ***,**,* indicate significant differences in means between matches with fans and without at 0.1%, 1%, 5% and 10% levels, respectively. Robust standard errors are given in bold. [1] Dummy variable.