Cutting Through the (Digital) Clutter:
Technological Change and Careers of Men and Women in Cultural Markets

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ABSTRACT

How will technological change, and in particular digitization, affect the careers of men and women artists in cultural industries? Digitization has the potential to help women artists by enabling their work to be directly consumed by new audiences. However, digitization is a broad phenomenon that not only affects how creative work is *consumed*, but also shapes how it is *produced*. We isolate the role of digital production technologies in affecting the relative success of men and women artists. We argue that unlike digital consumption technologies that can mitigate gender inequality, digital production technologies have the potential to exacerbate gender inequality. Digital production reduces barriers to entry and creates a crowded marketplace, where artists must self-promote to gatekeepers to get lucrative gigs. Insofar as men as better connected to (men) gatekeepers, they are more likely to succeed in this crowded marketplace. We develop and test this theory using a full-cycle research methodology, combining in-depth interviews with a novel quantitative dataset on the labor market for studio singers in the Hindi film industry. This paper contributes to the study of digitization and its differing effects on men and women artists and explores the implications of technological change for women in the arts.

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Culture is all around us. From the music we listen to, to the books we read, to the art and design we consume, cultural content dominates modern life. Artists who capture project opportunities and build careers in cultural industries enjoy significant material and social rewards. However, capturing such opportunities is easier said than done. Women artists in particular struggle to gain recognition and success in cultural markets as compared to men artists. For instance, women accounted for only 10.4% of Grammy nominees from 2013 to 2019 (Smith et al 2019), and a mere 17.1% of artists on the 2018 Billboard "Hot 100" chart (Epps-Darling, Bouyer and Cramer 2020).

Technological change presents an opportunity for women artists to succeed in cultural markets. For example, the rise of radio allowed a new cadre of women classical musicians, traditionally excluded from performing venues, to find an audience (Weidman 2006). More recently, the forces of digitization have offered renewed opportunities for democratization within creative industries and have improved the career attainment of women artists (Waldfogel 2023, Manuel 1993). In particular, digital platforms enable women artists to reach their fans directly, and can even be explicitly designed to promote their work to new, otherwise unfamiliar fans. By changing how cultural content is consumed, these platforms reduce the power of traditional gatekeepers in curating and promoting talent, thereby allowing women artists to compete on a more level playing field.

However, the impact of digitization is multidimensional; not only does it influence how creative work is consumed, but it also introduces new tools and techniques that fundamentally reshape how creative work is produced. For example, in the field of photography, digitization allows far more individuals to take professional-quality photographs with their smartphone, fix errors with tools like Photoshop, and even generate missing elements through emerging AI

technology like Dall-E or Midjourney. While it is a given that changes to production will dramatically reshape artistic careers, the question of whether and how it will help or hurt women artists remains unanswered. Scholars have considered cultural production to be a distinct phenomenon from cultural consumption and have argued that these two phenomena can have independent effects (Janssen and Peterson 2005). Despite this possibility, the implications of digital production technologies for the relative success of men and women artists in cultural industries remains understudied.

In this study, we argue that unlike digital consumption technologies, which tend to help women artists succeed, digital production technologies on their own have the potential to hurt women artists' ability to garner lucrative gigs in cultural markets. As in the photography example above, we argue that digital production reduces barriers to entry and allows a greater number of artists to produce cultural content. When this increased supply is not accompanied by a rise in opportunities, gatekeepers acquire greater power because they must now 'cut through the clutter' and choose among an ever-expanding list of artists for a limited number of gigs. We show that men artists are more likely to benefit from this change because they tend to have better connections and can self-promote more to key gatekeepers, increasing their chances of getting hired as compared to their women counterparts. In this way, even though digital production technologies democratize entry into creative careers, they can inadvertently hamper the cause of women artists in cultural markets with respect to who gets career-advancing gigs. We further argue that women artists can overcome their limited access to gatekeepers and secure artistic gigs through audience endorsements—via, for example, reality shows and hits.

To investigate our theory, we need to study the distinct role of production technologies separately from consumption technologies. This is challenging for three reasons. First,

digitization typically leads to the adoption of both digital production and consumption tools simultaneously. For example, the rise of livestreaming as a cultural trend was facilitated by affordable webcams on the production side, and platforms like Twitch on the consumption side; it would be difficult to disentangle the impact of one from the other. Second, the use of consumption technologies is easier to observe and track; measuring which technologies are used in the production of culture can be harder to observe. Finally, linking the adoption of new production technologies to broader trends in the labor market can be complicated because such data is not available off-the-shelf.

We investigate our research question in the context of music production for the Indian Hindi film industry ("Bollywood"), which annually produces more movies than any other country's film industry. The majority of these films are musicals, and there is a thriving market for studio singers (women and men) to record songs for soundtracks. In this industry, the music composer acts as a crucial gatekeeper in picking singers. For any given song, the composers (who are almost exclusively men) can pick either a man or woman singer; this is because the audio soundtrack is often recorded before film production begins, and many songs are not associated with a particular actor but instead form part of the background score. In the late 1990s, a rapid adoption of digital recording technology transformed music production in this industry by facilitating multiple takes and allowing for post-hoc error correction in music recording. We examine how the adoption of this digital recording affected the allocation of gigs to men and women studio singers in this cultural market. Note that by allocation of gigs, we mean the likelihood that an active singer receives one of the few 100 singing roles in the top 50 movies in a given year, a marker of career attainment in this industry.

This setting is ideal to isolate the effect of digital production technologies because it helps to overcome the three challenges we laid out before. First, digital music recording completely reshaped how music was produced, but did not directly affect consumption. In particular, the change we study occurred in the mid-late 1990s, over a decade before the introduction of digital streaming services like YouTube, Spotify, Instagram or TikTok. Second, to measure digital adoption, we develop a novel technique to uncover the technology used to produce the soundtrack by analyzing the credits for the music and sound department of a given film. Finally, we build a novel dataset that tracks over 12,000 songs and their respective singers and composers in approximately 1,600 films between 1985 and 2017.[1] By using a fixed-effects regression approach, complemented with an instrumental-variables strategy, we identify the effect of digital recording on the likelihood of a given singer getting a gig in a given film.

Our research process and the organization of this paper adhere to the full-cycle research model (Fine and Elsbach 2000, Chatman and Flynn 2005, Ranganathan 2018). To gain insight into the effects of technological change on the industry in the 1990s and early 2000s, we interviewed 25 music composers, singers, and industry analysts. Analyzing this qualitative data resulted in four hypotheses: two on the entry of new singers and on the success of women singers in the market following the adoption of digital recording, as well as two additional hypotheses delineating the roles of self-promotion to gatekeepers via network connections and of audience endorsements in securing artistic gigs.

Our study makes four contributions to the literature on the artistic careers of men and women. First, while prior work has highlighted the labor market effects of digital *consumption* technologies, we advance the literature on this topic by isolating the role of digital *production*

[1] These data suggest that almost half of all singing gigs were assigned to women singers pre-digitization; our quantitative analysis will examine the extent to which this ratio changes post-digital-recording.

technologies. Second, while prior work largely documents lower gender inequality after the advent of digitization, we show how the adoption of digital production technologies can actually increase the gap between men's and women's success in cultural markets. We unpack how the tendency of these technologies to democratize entry into cultural fields might counterintuitively disadvantage women artists. Third, we show how production technologies can increase the power of gatekeepers as compared to consumption technologies that tend to reduce their power. By creating a cluttered marketplace and intensifying competition among creative talent, digital production technologies allow (largely men) gatekeepers greater leeway to choose artists, often at the expense of women. Finally, our work shows how digital production technologies can affect the dimensions along which cultural producers compete by highlighting the increased value of self-promotion through connections to key gatekeepers post-digital-recording.

It is clear that technological change not only affects cultural consumption, but also cultural production. The overall effects of digitization and technological change are clearly quite complex and will depend on the relative impacts on both sides of the equation. Therefore, our goal is not to claim that new technologies will always increase inequality, but instead to isolate the effects of digital production technologies in shaping gender inequality in cultural industries.

ARTISTIC CAREERS AND GENDER INEQUALITY IN CULTURAL MARKETS

Artistic Careers and Technological Change

Cultural producers hold a significant influence over contemporary society, shaping and reflecting popular culture (Godart, Seong and Phillips 2020). A successful career in the cultural industries offers a tantalizing mix of both financial and status rewards, making it highly sought-after (De Vaan, Stark and Vedres 2015, Becker 1982). However, the reality is that these benefits

are confined to a very small proportion of artists (Rosen 1981, Uzzi and Spiro 2005). The vast majority find it challenging to secure and sustain a career in these industries, with only an elite few attaining the top tier of success and influence (Cattani, Ferriani and Allison 2014, Berg 2022, Menger 2014). This disparity underscores the importance of investigating the factors that shape who succeeds in the arts and the mechanisms behind their attainment.

One important factor with the potential to *reshape* who succeeds in cultural markets is technological change. Specifically, new technologies frequently provide artists confined to the fringes opportunities to ascend into the limelight. A historic instance of this transformative power can be seen in the introduction of microphone technology, which ushered in the era of 'crooners' (Peterson and Anand 2004). This innovation empowered artists with softer vocal styles, such as Bing Crosby and Frank Sinatra, to eclipse their full-voiced operatic counterparts, like Enrico Caruso (Lockheart 2003). Similar changes have been wrought by other historical technological changes, such as the introduction of the radio, the television, and even the printing press (Baumann 2001, Peterson 1990, Dittmar 2011). These examples underscore the profound potential of technology to redefine the landscape of cultural markets and artistic careers.

Among the many waves of technological change, digitization stands out as one of the most pervasive and influential in recent times (Askin and Mol 2018, Hesmondhalgh 2018, Greenstein, Lerner and Stern 2010). The emergence of auto-tune, for instance, has leveled the playing field for artists, allowing those without perfect pitch to achieve musical excellence (Peterson and Ryan 2004). Platforms like YouTube attract a wider range of content, produced by an increasingly diverse set of creators, in comparison to traditional platforms (Qu, Hesmondhalgh and Xiao 2023). Thus, technological change, and digitization in particular, can have serious implications for who succeeds and who falls behind in cultural markets. As the next

section demonstrates, women artists have traditionally lagged behind their men counterparts in diverse cultural fields, making it particularly relevant to understand if, and how, digitization differentially affects the careers of men and women artists.

Gender Inequality and Gatekeepers in Cultural Markets

A particularly striking trend in artistic markets is the noticeable lack of success attained by women artists, despite evidence of their talent and potential. This discrepancy is clearly illustrated through various measures of recognition and achievement across multiple industries. Consider the realm of film, where only three women have won the Academy Award for Best Director as of 2023 and women actors receive consistently fewer gigs as compared to similar men.[2][3] Meanwhile, in the world of visual arts, a 2019 report by Artnet found that over the past decade, only 2% of global art auction spending was on works by women.[4] Similar examples abound in a variety of other cultural domains, such as literature, fashion etc (Stokes 2015, Childress, Rawlings and Moeran 2017). This consistent gender gap in the recognition and success of women artists suggests an array of complex and intersecting obstacles that women face.

One of the most significant barriers for women artists stems from the pivotal role of gatekeepers in cultural markets (Erigha 2021, Berkers, Janssen and Verboord 2014). These include music producers, film directors, and literary agents who wield significant influence over who is afforded prime opportunities in their respective industries (Bourdieu 1984, Hirsch 1972, Rossman, Esparza and Bonacich 2010, Seong and Godart 2018, Smits 2016, Sorenson and Waguespack 2006). Consequently, the ability to connect with and self-promote to gatekeepers is

[2] https://variety.com/2023/awards/awards/no-women-directors-nominated-oscars-1235496819/
[3] https://time.com/4062700/hollywood-gender-gap/
[4] https://news.artnet.com/womens-place-in-the-art-world/female-artists-represent-just-2-percent-market-heres-can-change-1654954

paramount for new artists seeking opportunities to establish themselves (Bielby and Bielby 1999; Cattani and Ferriani 2008; Faulkner 1983; Faulkner and Anderson 1987; Jones 1996). Unfortunately, women often lack the necessary social capital – i.e., the established networks among high-status artists that facilitate opportunities and career progression – to navigate creative industries (Christopherson 2009, Grugulis and Stoyanova 2012, Askin et al 2019, Lutter 2015). Most gatekeepers are men, and many high-status networks are gendered such that men naturally spend more time with and make stronger connections with other men than with women (Brass 1985, Ibarra 1992, 1993, van Emmerik 2006). Across industries, women receive less helpful information from their networks because they do not include as many of the higher-status (usually men) contacts (McDonald 2011, Petersen, Saporta and Seidel 2000, Stainback 2008). All in all, lack of access to self-promote to key gatekeepers is an important reason driving the differential success of men and women artists in cultural industries. While gatekeepers play a powerful role in preventing women artists from succeeding at a similar rate as men artists, the forces of digitization have a key role to play in moderating the power of gatekeepers, as the next section describes.

When Digitization Improves Outcomes for Women Artists

Digitization-led democratization has significant implications for success of women artists in the arts. Preliminary evidence suggests that the rise of digital platforms is aiding women artists in establishing successful careers in cultural markets (Erigha 2015, Waldfogel 2023). One of the transformative ways in which digitization improves outcomes for women artists is by minimizing the role of traditional gatekeepers (Ryan and Peterson 1993, Toop 1995, Erigha 2021). By restructuring the dynamics of artistic markets, digital technologies allow for more direct interaction between artists and audiences, often bypassing the gatekeepers altogether.

This circumvention of gatekeepers materializes in two essential ways. Firstly, digital platforms provide audiences a direct connection to artists, significantly influencing their career trajectory. Fan support, for example, through early reviews on platforms such as Goodreads and Producthunt, has been shown to provide early traction for women artists, allowing them to establish a foothold in their respective industries (Verboord 2011, Cao, Koning and Nanda 2021). In addition, fans have increasingly become sources of financial support and resources through platforms like Kickstarter and Indiegogo, often making significant contributions to the success of their favorite artists, including women creators (Greenberg and Mollick 2017, Greenberg 2019, Gorbatai and Nelson 2015). Moreover, dedicated fanbases may form protective communities around women creators, for example by providing a supportive environment in the wake of the #MeToo movement (Luo and Zhang 2022, Wang, Ramaprasad and Gopal 2022, Vitulli 2017).

The second way digital platforms assist in circumventing traditional gatekeepers is by consciously promoting the work of women artists. Digital platforms can actively curate and spotlight the work of women artists, increasing their visibility in a typically crowded marketplace (Aguiar, Waldfogel and Waldfogel 2021, Aguiar and Waldfogel 2021). Platforms can redesign their algorithms to recommend the work of women artists to new audiences, thus expanding their reach and influence (Epps-Darling, Bouyer and Cramer 2020, Holtz et al 2023). Further, major music platforms have employed human "programmers" to curate and popularize music stations and playlists dedicated to women artists such as "Women in Country" (Pandora) and "Women of Pop" (Spotify). While this is not to claim perfection – as digital platforms can introduce a new form of algorithmic gatekeeping subject to its own biases (Shakespeare et al 2020) – the

environment fostered by these digital platforms does appear more favorable for women artists compared to the landscape dominated by traditional (men) gatekeepers.

Across these two channels, scholars have investigated how digitization affects women artists by predominantly focusing on how their work is consumed via a plethora of digital platforms. When looking at the effect of digitization through this consumption channel, it is clear that it largely helps women artists gain success in cultural markets. However, this leaves open the question of whether (and how) these effects may vary when focusing on the impact of digitization on cultural production.

Gap: Digital Production Technologies and their Implications for Gender Inequality

In parallel with the transformative impact on *consumption*, digitization also ushers in innovative tools and technologies that fundamentally alter the *production* of cultural content. For instance, architects and designers now routinely utilize 3D modeling software to bring their visions to life, while visual artists can employ applications like Procreate to craft masterpieces in the digital realm. These advancements are not limited to any one field, but permeate across the spectrum of creative industries, reshaping the way cultural content is generated.

There are three significant ways in which these digital production technologies alter the creative process. Firstly, they affect how creative content is *represented*, transforming it from analog to digital representation. Tools such as digital cameras and ProTools allow cheaper and easier digital representation of content. Secondly, digitization makes it easy to *correct* errors in the creative process, using tools such as Photoshop (graphic design and photography) and Grammarly (writing). Lastly, in the realm of *generating* new content, groundbreaking AI technologies like DallE and ChatGPT enable the creation of original content with minimal human input.

Despite the potential of these technologies to reshape artistic careers, existing scholarship has largely overlooked their possible implications for gender inequality. Theories of digitization have recognized the importance and potential impact of these digital production technologies (Adner, Puranam and Zhu 2019); scholars in the sociology of culture have similarly underscored the distinction between cultural production and consumption, asserting that each can independently affect industry outcomes (Janssen and Peterson 2005). Given these considerations, it is plausible to speculate that the influence of technology on gender inequality with respect to cultural production may differ substantially from its effects with respect to consumption.

This consideration leads us to the central research question of our study: *How do digital production technologies influence the success of men and women in creative industries?* Addressing this question is not only essential for a comprehensive understanding of the effects of digitization, but is also crucial for informing strategies to promote gender equality in creative careers.

SETTING: BOLLYWOOD PLAYBACK SINGING

To investigate our theory, we need access to a setting where digitization affects production but leaves consumption relatively untouched, where the use and adoption of production technologies can be tracked, and finally where we can link technological adoption to broader labor market outcomes. We focus on music production in India's Hindi-language film industry, which satisfies all three of these criteria. Based in Mumbai, this industry (which is often pejoratively called "Bollywood;" we use the term *the Hindi film industry)* is among the world's largest producers of film content. Other industries in India also produce films, but the Hindi film

industry accounts for almost half of total revenues attributed to films produced in India.[5] Its films dominate Indian culture and attract billions of viewers, including a large fanbase in North America, the United Kingdom, the Middle East and Africa.[6]

A distinctive feature of movies produced by the Hindi film industry is their use of music; almost every film produced by the industry can be considered a musical with an original soundtrack (Booth 2008). Unlike in the United States, where the market share of film music is small compared to that of independent music, popular music in India consists largely of film soundtracks with broad appeal across the nation. Each soundtrack consists of multiple songs sung by professional "playback" singers. Both men and women singers can compete for the same gigs. The number and gender of singers hired can vary independently of the actors on screen because the audio soundtrack is often recorded before film production begins and many songs are not associated with a particular actor but instead form part of the background score.

We study playback singing, or studio singing, in the Hindi film industry. In this labor market, film-production houses typically hire professional "music directors" (composers) to create the soundtrack, recruit singers, and produce the music for a film. In this way, composers act as the key gatekeepers controlling labor market opportunities in our setting. Being hired to sing in a major motion picture film is perhaps the pinnacle of a singer's career and is very consequential in terms of both financial and status rewards. For instance, singers can be paid up to 2–2.5 million Indian rupees per song (about $33,000), though this figure varies and there is no systematic data on compensation. Singing a film song usually generates other labor-market

[5] https://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media-telecommunications/in-tmt-economic-contribution-of-motion-picture-and-television-industry-noexp.pdf

[6] https://web.archive.org/web/20181124213649/http://filmfed.org/IFF2017.HTML

opportunities, notably live shows, and confers status (DiCola 2013); popular film songs are prominent in the prevailing cultural conversation about music in India.

Technological Shift: From Analog to Digital Recording

Our study focuses on a decisive technological shift in the production of film music. Prior to the mid-1990s, music composers typically used analog recording technology, which required singers to sing "live" alongside an orchestra in massive, dedicated recording studios. Such performances were recorded on tape; this meant a song had to be performed in one cut, and errors could not be corrected. Thus, singers had to perform in pitch and in rhythm, without errors, start to finish, in coordination with other musicians.

The late 1990s and early 2000s witnessed the rapid adoption of digital technologies in the Hindi film industry in the form of DAWs, which up-ended the status quo in four key ways. First, a separate track could be recorded for each musician. Thus, singers were now independent of the orchestra and each other; they didn't have to "get it right" together or worry that their mistakes would impact the other musicians. Second, whereas tape had been costly, digital recording allowed for unlimited retakes; singers could keep at it until they got it right. Third, digital recording's cut/copy/paste functionalities made it possible to correct mistakes word by word, rather than having to start from scratch. Finally, post-hoc error-correction technology enabled auto-tuning; thus, a singer's errors in pitch or rhythm could be digitally corrected after the fact.[7] Given the low cost and reduced space requirements of digital recording, new studios cropped up in Mumbai outfitted with DAWs. A new breed of technicians and sound professionals skilled in using DAW technology emerged using titles like "sound mixer", "sound designer" etc. A film's

[7] Note that digital recording technologies did not, by design, favor men over women.

credits in the music and sound department would usually credit these individuals using these new titles created for the digital age.

This is an ideal setting to study our research question because DAWs had a major impact on how music was produced in the industry, while leaving the consumption side relatively untouched. Audiences still consumed music in traditional ways - movie theaters, TV and cassettes/CDs - and digital production did not directly affect the consumption experience.[8] Second, even though a listener might be unaware of the technology used to produce a song, we can measure digital adoption by looking at a film's credits (especially the sound and music department) and tracking the hiring of professionals associated with DAWs (Goehring, Mezzanotti and Ravid 2023). Finally, data on singers hired to sing certain songs is public, allowing us to estimate the effect of digital adoption on the relative likelihood of hiring men or women singers.

Animated by our unique setting that allows us to isolate the labor market implications of a new digital production technology, in this paper we ask how the shift to digital recording has affected the assignment of Hindi film songs to men and women studio singers.

FULL-CYCLE RESEARCH METHODS

We adopted a full-cycle research approach, which combines inductive and deductive methodologies (Cialdini 1980, Fine and Elsbach 2000, Ranganathan 2018). We first conducted semi-structured interviews, which generated our theory and hypotheses. We then tested those hypotheses using a unique dataset consisting of songs performed in the Hindi film industry's top

[8] https://www.forbes.com/sites/cheriehu/2017/09/23/how-india-the-global-music-industrys-sleeping-giant-is-finally-waking-up/?sh=752abbaa30bf

50 films each year between 1985 and 2017, their singers, and information on whether the songs were recorded using analog or digital recording technology.

Qualitative Methods

We conducted 25 semi-structured interviews with 6 women singers, 5 men singers, 5 composers, 4 sound programmers, 3 industry insiders, and 2 critics between January and July 2021. We contacted 45 potential interviewees via phone, WhatsApp, or email based on contact information that we obtained from an unofficial industry directory.[9] We tried to interview a diverse set of individuals with a focus on recruiting (a) a mix of men and women artists, (b) individuals who had experienced varying levels of success, and (c) those who had witnessed the technology transition. In requesting interviews, we stated our position as academic researchers interested in studying the evolution of music production in the Hindi film industry. Given that many artists were not working actively during the COVID pandemic, our final sample of interviewees matched our desired mix in terms of gender and experience.

Interviewees were eager to speak with us because the interviews offered them an opportunity to reflect on how the changing nature of music production had impacted their careers. As Indian nationals and long-time listeners of Hindi film music, we were able to build rapport with our interviewees; however, we also had no direct connections to the Hindi film industry, thus creating a safe space for interviewees to be transparent and open with us. Interviews averaged an hour in length; they were conducted in English or Hindi by one of the paper's authors along with a research assistant, via video on Zoom or WhatsApp, and were recorded (see Appendix A for a discussion of advantages and disadvantages of this virtual interview format). The interviews followed a protocol and focused on respondents' experiences

[9] www.bollywoodhelpline.com

recording for analog and digital films, the characteristics valued in singers for both kinds of films, how the shift to digital has affected experienced singers and newcomers, the process of assigning singers to songs, and the differential experiences of men and women singers. The interviews were transcribed and analyzed using Atlas.ti to track common themes and patterns across the data.

QUALITATIVE FINDINGS AND HYPOTHESES

Adoption of Digital Recording and the Labor Market for Studio Singers

As a first step, the interviews elucidated how recordings were conducted using analog technology. As one singer (I04, man) explained:

> In the old days, when it was the analog system, when we used to record on tape, there used to be a lot of rehearsals. So, everybody used to be in . . . a huge recording room. Right from all the musicians to all the backing vocalists to the solo artists, there used to be two or three days' rehearsal for one song. And if anybody made a mistake in between, [we all] had to go back and then re-record. So we were recording on quarter-inch tapes. . . . So those things, you could not punch in [repair after the fact]…So everybody had to know their parts inside out, you know—like, absolutely clear with no doubt.

In short, "singing used to be a real difficult, tough task back in the days" (I01, man composer). Everyone involved had to be "absolutely prepared," and that no one could "afford to make a single mistake. . . . Because when the conductor announces 1, 2, 3, 4, and the orchestra starts, when the tape is rolling, . . it has to be 100% correct" (I01). Singers also described the pressure to perform and to deliver a good take. A singer (I10, woman) described a recording session when she struggled to maintain her pitch, provoking an ultimatum from the composer:

> I'm in the haloed Mehboob Studio . . . and I was a little off-pitch. There was no sympathy for me. . . . I'm in this tiny room looking out at these 300 musicians. . . . You have to understand, in those musicians there must have been people like Louis Banks [a famous pianist] and Hariprasad Chaurasia [a famous flutist]. . . . The composer comes to me and in his hand he's got a stick. In his other hand, he's got a box of sweets. He says, "Do you want the stick or sweets? You are pitchy. . . . Every time you make one mistake, 400

> musicians need to do the song again. Studio time is very costly. If you sing it well, I'll give you the sweets, but if you don't you'll get the stick."

Given this extremely high bar, the labor market for studio singers was tight; a small pool of singers sang most of the music produced. One singer (I02, woman) reminisced: "The industry then was a very small place. I mean, there were just three studios, and if any good singer came, or if there was any good recording, you know, the word got around very fast." Another singer (I07, man) concurred: "So, well, there was Lata *ji*, there was Asha *ji*. Those were the singers, you know. In reality, there was hardly anybody else in the foreground. And they were known for their ability to sing a song. And I think they were composers' singers: they sang the song according to how the composer wanted." A third singer (I11, woman) remarked, "In a country of crores and crores [millions and millions] of people, it was amazing, isn't it, that there were 5–6 singers to talk about? There were, yeah, 6 singers to talk about: Lata Mangeshkar, Asha Bhosle, Kishore Kumar, Mohammad Rafi, Manna Dey, Mukesh, and you could probably say Gita Dutt, OK? But . . . at that time, . . . there was a pie, and there were 5, 6 people to eat that pie.[10]"

Then, in the late 1990s, a slow technological shift from analog to digital technology began to transform how music was recorded, and thereby the labor market for singers. With digital technology, as one composer explained, recording "just becomes easier, you know. And it's fabulous, the technology that's available now, the kinds of things that you can do, the kinds of magic that technology has created. It's just amazing" (I09, man). Another composer (I01, man) elaborated:

> Now, when it went digital, now we sat at home [in Mumbai], and we made our own mini-studio with our monitors, and interface, and Beyerdynamic headphones, and all those things. So now it's become easier, I feel, because we've downloaded Logic; we're comfortable with it. Some people do it on Pro Tools, some people do it on Cakewalk, and whatever. . . . Studio sizes have been cut down tremendously. You need just a 5-by-5 room,

[10] Note that the specific numbers quoted by the interviewee are perhaps an exaggeration; Figure 1 illustrates the number of unique singers in the labor market.

> where I'm sitting now, and you can record a song. So it's no more 125 musicians and all that. . . . And, of course, then you do it shift-wise. You call the violinists, dub them, leave them. If you have to call 10 rhythm people, you call them, dub them, leave them. Then you call the singer.

The new recording technology made the job of the singer much easier. A singer (I07, man) explained: "Now you could just sing a line at a time. And then came the 2000s, where autotune came in, and, later on, Melodyne. And then you could sing a line at a time. And even if that was out of tune, 'Don't worry, we'll fix it.'" Others agreed that the ability to make post-hoc error corrections was a game-changer: "If there's some error in the pitch, OK. You just put it on Antares, or any software, or whatever suits you; it will be back in pitch. If there's some problem with the tempo, you quantize it. So, there's a vast, vast, vast difference" (I01, man composer). The digital technology also offered copy-and-paste functionalities, which reduced pressures on singers for precision and consistency. A singer (I08, man) explained: "If there is a song to be recorded, first you sing the *Mukhda*, and then the *Antara*. So, if you sang the *Mukhda* right, he sung OK, it is saved, and you can put it anywhere you want in the song. You don't need to sing it again. The same para, same line, will be pasted wherever you want. So you don't need to sing the whole song."

The result was that anyone could be a singer, "because the technology can do so much for you," as a critic explained. "For example, if Asha [famous singer] had to—do you know what throwing the voice means? It is basically, like, suddenly . . . raising a pitch and belting out a thing and then coming back. If Asha had to throw her voice, she really had to throw her voice, because there was nothing to help her. Today a singer can throw her voice with the aid of technology" (I03, man). A singer (I07, man) explained: "What is not really required anymore is to sing in tune. Earlier it was like, if you can't sing a tune, then you definitely cannot do the

recording. Now that's not true anymore. . . . There are so many out there who are not really singing in tune, but they're fixed in the mix."

The lowering of the bar for singers opened up the labor market: there was room for more singers, and the doors were now open to new entrants. A composer (I24, man) explained: "What happened is, slowly, post-90s, music composers use singers just like an instrument, like another sound. So it helped in more singers getting jobs." A critic (I03, man) agreed: "Voices have become a little more interchangeable. . . . Because, for a certain tonality, a composer might use technology and adjust that singer's voice, which was impossible in those days—because, you know, you could not do anything." Many interviewees agreed that "now, after 2005, you will find a lot of other new voices coming in" (I01, man composer). A singer quoted earlier (I11, woman) contrasted the digital era to the analog era by reverting to her earlier analogy to a pie: "So, as I said, remember the pie? There was a pie, there were only five people or six people or seven people, eight maximum, to eat from that. But now that's the same pie, it's the same Bollywood music, but there are thousands of singers." A composer (I09, man) summarized: "This is a time when, you know, there is a plethora of singers, talent, and they're all coming out with stuff. And it's such an amazing time to be, to see, so much talent coming out."

All of this testimony suggests that the prior barriers to becoming a studio singer for a Hindi-language film have been dramatically lowered, facilitating entry and thus increasing the number of active singers in the labor market. For all these reasons, we predict that:

H1: Digital cultural production facilitates the entry of new singers into the labor market.

Digital Cultural Production and Careers of Men and Women Singers

More singers are operating in the industry after the advent of digital recording, as the previous subsection suggests; however, they are not all necessarily building careers in the industry. Many interviewees alluded to "one-hit wonders" (I05, woman singer) who "just sing one song and disappear" (I01, man composer). And given the increased ease of entry, composers are likely to have a surfeit of singers to choose among. "You now have multiple choices for singers, where you can choose from multiple platforms," one composer (I01, man) declared. "And reality shows are too many—and real good talent, also, you get to see." A singer (I08, man) agreed: "Now the competition is very tough, because . . . there are so many singers, and so talented, and they are all available. So the competition is very tough."

Women singers, in particular, seem to lose out. A composer (I09, man) described this phenomenon:

> Women get less songs today. . . . It's very, very sad to see that importance is not given to women singers today. . . . Even when a [duet] song comes, only in the second stanza barely two lines will be given to the female. . . . I am also shocked and very sad to see this trend that is happening. . . . I really don't know why; I really don't know why. Because it's so sad; it's a sad fact.

A critic (I03, man) who had observed this phenomenon commented: "I do feel bad. I don't know. We do have a lot of female singers, but they aren't getting work." A singer (I07, man) expressed bafflement: "This thing about only men singing, I am also equally disturbed. I'm also equally amazed as to why this is happening. It's a sad thing about our country." A composer (I24, man) admitted to complicity in the phenomenon but justified his actions:

> I don't know. I do know that there's a lot of talent out there; there is a lot of talent out there. And some of these, the guys . . . the boys are really, really singing beautifully. I haven't actually in a long time heard somebody, a female singer, who was actually giving me a sleepless night, to be honest. . . . So I'm working more with male voices. . . . See, it's very competitive now.

Women singers acknowledged the phenomenon. One (I05) lamented that "women often don't get a lot of solo songs today." Another (I11) said: "You know, it's a strange phenomenon. And I'm not able to really put my finger on it. . . . [To hire a woman], they have to wait for a situation. When I say *they*, I mean the music producer or the director. They have to wait for a situation where they will try out a new female voice. . . . That's not the case for male voices."

These patterns suggest that while digital cultural production has enlarged the pool of singers now able to garner top gigs, it has not benefited women singers at the same rate as it has men singers. Ironically, even though the market appears to be more democratized, our qualitative data suggests that it is also more unequal in terms of gender. These patterns lead us to hypothesize:

H2: Digital cultural production reduces the likelihood of women being hired for top gigs.

Mechanism: Self-Promotion to Gatekeepers

We discovered in our interviews that music composers are the primary gatekeepers of singing roles and can make or break a singer's career. Music composers, who are almost exclusively men, choose which singers they will use for any given song. One singer (I04, man) reflected on the freedom that music composers enjoy in choosing singers, saying:

> When the music director is writing a song, he is in a particular thinking zone. …when he thinks about that particular tune,… he's also thinking about who can sing this song and who can do justice to this song. Not only tonality wise, style of singing, emote, emotive, emotiveness also. So, all these aspects, it's going on in his head. So finally, when that song is almost in its completion, or maybe close to completion, he's already zeroed in on who he wants… Yes, composers definitely are very much into casting and they're very particular as to who you know, is going to be singing their song, their composition. So that's important for them.

Another singer (I07, man) corroborated that "music composers …are the masters of voice casting."

In the analog era, music composers already had this power to choose singers, but they were constrained in their choices by the need for singers who could sing a song perfectly, with live backing musicians, in a single take. Few singers are capable of performing perfectly and reliably in this way, and so the few that could received a consistent flow of work based on their skill. In the analog era, in-person auditions were particularly common in choosing singers. As one singer (I08, man) recalled, "In my time, in spite of singing in many films, I had to give auditions to each and every music composer before I sang a song. Like the song I sang for S.D. Burman *sahab*, <name of song>, I had to go in and give an audition. He said that first I will listen to your voice and then I will decide." Not only did this mean that a small number of singers were active in the labor market, but also that a significant number of these singers were women. In fact, as our quantitative data will show, women singers were hired to sing at almost the same rate as their men counterparts.

Post-digital-recording, the need for perfect singing declined. If there was a mistake in a singer's line, the music composer could cut that line and replace it with a retake (i.e. "punch it in.") Now, music composers had a lot more power and leeway to choose among a much larger pool of singers and they no longer needed to rely on in-person auditions. One music composer (I01, man) explained, "So basically, I feel it's very easy for people to choose singers today…you have multiple choices…If somebody sends you a demo, even a demo is enough." A singer (I08, man) concurred, "Now, there are all these new voices…so, they [music composers] look at these singers whoever are new and among them, they try to find out the one who justifies the song."

Our data suggest that this increased choice in the hands of the music composers introduced gender inequality in the selection of singers for gigs. First, because of the rising number of available singers and the declining skill level required to record a successful song,

music composers and singers agreed that networking and promoting oneself to music composers were especially important for singers to get gigs in a crowded marketplace. One singer (I07, man) reflected on the time and energy singers have to put into their self-promotion efforts today in addition to singing, saying that today "the way of getting your gig has changed… the singer has to start making his own connections directly….Your PR skills are very important today. In the earlier days, you didn't need to do PR. . . . I'm just saying that you need to do that today, where the artist, the singer himself or herself, needs to promote themselves in their current situation, in their work areas." A composer (I24, man) went on to say that the choice of singer can now hinge on the music composer's personal interactions with the singer: "music composers choose singers who are, who they're comfortable with. Okay, if the world's best singer comes to me, … there is a 50-50% chance that I will use the singer I'm comfortable with at the cost of the world's best singer." A singer (I04, man) also emphasized the relative importance of self-promotion versus talent, saying:

> To get a break into the industry is very tough, it's not that simple…. there are a lot of people who don't know who to contact. I get so many people through FB, Instagram asking me, 'Sir can you please help me?' When I hear their demo, they're so good, so good, but they just don't get that chance.

There appeared to be a consensus that singers had "to be pushy" (I01, man composer) and "keep promoting themselves" (I20, woman singer) to succeed post-digital-recording. But making these meaningful connections and self-promoting to music composers is easier for men as compared to women singers. A man singer (I08), for whom this was easy, said:

> We meet all the music directors very regularly. Even if there is no song, still we'll go, you know regularly to keep in contact so that we stay in their mind. For that, we go there very regularly. And that clearly has pros. Sometimes, if they are composing some songs and, and you go there and sit there and then they would have that in mind that let's try and get it sung by them, you know. So, that kind of benefit is always there.

In contrast, one woman singer (I05) recalled how difficult it was for her to connect with music composers: “I won the Grand Prix. I thought it was going to be a cakewalk in the industry. I won the Grand Prix and I'm in the front page of every newspaper as the Indian singer wins the Grand Prix. But it didn’t matter at all. I was walking out of studios and walking out of studios, I was meeting all the wrong people.”

Women struggled to connect with and promote themselves to composers because they lacked opportunities to socialize with key gatekeepers. A man (I09) we interviewed said, “we used to have all kinds of musicians come, play, jam through the night and music sessions happening. And, and, you know, some friends of mine, they were like, very, very already reputed musicians like Fazal Qureshi who was Ustad Zakir Hussain’s brother. And when Fazal heard me sing multiple times,…there was an opportunity when you know he invited me to his house and Zakir Hussain Ji was at home and it led to a gig.” We rarely heard any such stories from the women singers we interviewed.

Self-promoting through parties and through one-on-one meetings with (men) composers in positions of authority was also difficult because it blurred professional and personal boundaries in a way that made women singers uncomfortable. As one woman singer (I10) said:

> I'm not there to date anybody. I'm not there to turn anybody on. I am not there to go hee hee hoo hoo. And none of that. You pay me, I'll stand for my work, and I will get into my car, I'll go home. And I have always had a no nonsense response, which is also as my family says, the reason why I'm not like this, I'm not like a mega mega superstar with 50,000 hits. Because you know, a lot of shit comes with the territory. You got to know the right people. You've got to be hobnobbing at parties. Nothing wrong with that. Let me, let me let, you have your methodology. I have mine. I, I don't do that. I am not interested. Call me. Tell me there's a song. Tell me there's a project. By god, I'll sing the pants off that song. But go round about with, how to get the song go and sit over there, go and hang around. See I cannot do all that.

The women singers who have successfully obtained gigs in the digital age have often had some prior connection to a prominent music composer. The connection might be that the singer

and composer are from the same home region, or that they share network ties through family or friends. A very successful woman singer (I20) described how she got work: "I know Vishal-Shekhar [composer duo]; they have been my dear friends for a long time" and another successful woman singer (I02) described, "well my husband used to work with S.D. Burman. And, you know, he used to generally have me sing on a rough recording at home. So, when Burman Dada happened to hear that, he called me. He said, why not record the song in her voice?" Another singer (I04, man) we interviewed explained that being from the same region as a music composer helped them to get an important gig:

> So, basically that movie was shot in Goa. And I'm a Goan. Yeah, so that's my native place. So, the song included a lot of Konkani lyrics, that's my mother tongue, Konkani. So, obviously there I was chosen because of my fluency of the language and also my friend had suggested me to Sanjay Leela Bhansali ji.

Being born in the industry's home region of Mumbai also appeared to help singers gain professional opportunities, while being an outsider was seen as challenging. One woman singer (I10) said, "I arrived in Bombay [Mumbai] as a teenager with a little dream in my heart, didn't know anybody. That made it harder."

In summary, digital recording has given gatekeepers greater choice of singers and increased their power to pick who gets gigs in a crowded marketplace. Insofar as composers have closer ties to men singers through their personal and professional networks, then men are more likely to self-promote and get gigs, contributing to the gender inequality we observe in Hindi film singing gigs.[11] Thus, our third hypothesis is:

H3: Digital cultural production hurts women because they have less access and opportunities to self-promote to gatekeepers.

[11] To be clear, our hypothesis is driven by the increasing importance of self-promotion to gatekeepers post-digital-recording, not that women singers are less able to self-promote after the advent of digital recording.

The Importance of Audience Endorsements for Women Singers

Our data suggested that audience endorsements might help to compensate for the disadvantage that women singers experience in promoting themselves to music composers. When audiences publicly endorse a singer—such as by making a song a hit or voting for her on a reality TV show—they are also promoting her to composers. Pointing out the role of audience endorsements, one critic (I03, man) said:

> Just like with actors, just like with filmmakers, . . . cults build up around stars. . . . I'm talking about fans and other things, then there is this perception, that composers might get, that "Oh, look how many people are talking about Arijit all the time; let's just hire him." So it might become a bit of a self-perpetuating, fan-driven thing as well.

Our interviews revealed that success on reality shows and having a hit song were effective at mitigating the negative effect of digital recording technology on women singers' careers. Both types of endorsement gave women singers the boost they needed to stay in the mix; men singers also benefited, but less.

Singers confirmed that the support of reality shows' audiences helped bring them to composers' attention.[12] One man (I08) said:

> You know either it may be *Indian Idol* or it may be *Saregama* or whatever shows people use to hear you—even the music directors, they too every night listen to these programs, and they find out that . . . which is the singer who would be good for them, who would sing a good song for them. They get to know immediately. So they don't need to give an audition; they are called directly.

Another man (I04) corroborated that such shows, though they might appear to be mere entertainment, draw attention to particular singers:

> Yes, it is for entertainment. Yes, a lot of people like to see dance, singing, in these shows. There's a lot of positive response. The TRPs (television rating points) are hitting the roof. Yes, it's good for singers to do this . . . getting that airtime on television. Yes, there are

[12] Note that getting into a musical reality show, unlike getting a singing gig, is relatively easy since these shows tend to travel across India recruiting participants.

> quite a few composers who have promised singers work based on the shows. And I think most of them have kept to their promise and given them a break in their songs, in their movies.

Agreement appeared to be widespread that women singers in particular benefited from reality shows as a platform to showcase their work. One composer (I09, man) said:

> I think reality shows is the best thing that has happened for women singers, because, if you look at it, . . . she's extremely talented, [but] she would not know where to go; coming to Mumbai itself is a big project. Forget about meeting the music composer or trying to meet a music company or trying to get her stuff out. Where do I put this stuff? How do I make somebody listen to my song? . . . How am I going to reach out to people? But when these reality shows are there, at least there is a focal point here: "Hey, I want to be part of *Saregama*, I want to be part of *Indian Idol*. I want to be part of *Rising Star*. So there are various shows which showcase talent like this."

The same composer (I09) added:

> I must have made [hired] about 23 or 24 singers from reality shows. . . . It's not about the winner. . . . It is that super-talented girl you see who's got an X factor which will contribute to a particular song in your film. . . . Look at our country's number-one [female] singer, Shreya Ghoshal; she's a product of a reality show.

A critic (I03, man) also mentioned Shreya Ghoshal, who gained prominence from a reality show:

> I'm pretty sure that there are 100 women voices that are at least as good as Shreya Ghoshal, if not better, that are out there. But they are struggling because they simply don't know how to get close to a music composer . . . because Shreya herself, like I said, she was chosen by entering this show. Because Bhansali heard her singing in *Super Singer* [a reality show] or something, and said, "that's the voice." . . . And imagine [what] that involves: you're singing in a competition, hoping that something happens. And this music director who's known for working on these big films is watching that very show. And then he decides to make you *the* voice.

Like reality shows, hit songs benefited women singers by demonstrating audience approval. One woman (I10) described how a hit song had catapulting her into a career:

> I sang a song. . . . I then went back to my life as an ad trainee, earning Rs.300 [because I wasn't getting work]. Three months later, you will not believe it, I get a call and [the song's composer] said, "You know the song you sang? You have created fire in the country. The song has won an award; London is screaming for you." That song—people went mad, they went berserk, they loved it. Everything happened very fast after that. And that, my dear, is how my career started. . . . The public just loved me; they couldn't get enough. . . . Then I realized, I'm onto a good thing.

Another woman (I20) reported that her first song didn't generate more work in films because it created no buzz. Her second song became a hit and made all the difference:

> My first song [song #1] . . . it was a beautiful song, really, though it's a sad thing nobody knows about it. The film [in which the song was featured] was a very good film but didn't really do well in the box office. Soon after that, . . . I think in a couple of years, [song #2] happened. So, actually, people know me because of [song #2] more than [song #1]. And that's how my career started.

Hit songs benefited men singers too, but seemed to matter less. One man (I06) said:

> Whatever songs I sing, they become associated with me and become larger than life. For me, whichever composer calls me, those songs become special [whether or not they become hits]. And how many ever songs I've sung, for whichever composer, each song has its own appeal. . . . Even before [my first hit song], my voice was being talked about in the industry, and I was getting work.

Our evidence points to a unique role for audience endorsements, via reality shows and hit songs, in promoting the work of women singers to composers and helping them achieve success. Thus, we hypothesize:

H4: Digital cultural production's negative impact on women is less severe among singers who receive audience endorsements.

QUANTITATIVE DATA AND MEASURES

Having derived four testable hypotheses from our interviews, we now turn to explaining the quantitative data we collected to test these hypotheses.

Building Our Dataset

No single database offered all the information we needed; we therefore built a unique dataset that captures (a) a population of songs recorded in a sample of major films in the Hindi film industry, including their genres and the names and gender of their singers; (b) whether the music was recorded digitally; (c) control variables at the song- and film-level, including song

genre, the size of the film's cast, the gender of each cast member, the name of the composer etc.; (d) measures of gatekeepers connection to singers (based on hometown locations); and (e) singers' participation in reality-TV music shows and ratings of their songs.

We sampled films by relying primarily on the *Hindustan Times*' lists of the 50 top-grossing films each year between 1985 and 2017, totaling about 1,600 films. Though far more films are produced, this sample captures most of the industry's culturally and commercially important films allowing us to focus on the top echelons of success in the film industry (cf. Sorenson and Waguespack 2006). These are the gigs that really matter for financial and status rewards. For each film in the *Hindustan Times* database, we relied on the *Hindi Geetmala (HGM)*, an online catalogue of Hindi film music that provides information on each song in a soundtrack, including the names of the singers and composer. We disambiguated the list manually, classifying singers as men or women based on their first names. HGM also allows users to rate songs, providing a crowdsourced measure of their popularity.

Whether a film's soundtrack is digital or analog is not publicly disclosed. Interviews with industry veterans, including composers, suggested that digital technicians are identified in film credits with titles like *sound designer* and *sound programmer*, and that these technologies were introduced in the late 1990s and diffused rapidly in the early 2000s. For example, while discussing "*Hum Dil De Chuke Sanam*" (one of the first Hindi film soundtracks to be digitally recorded), an interviewee (I15) who studies the history of Indian cinema informed us:

> My experience in this business is that . . . you just spent a lot time watching movies, or watching the credits. . . . For quite a while I was really into the credits, because you learn a lot. . . . You look; you watch the credits. There's a separate background-music credit, I believe, a guy from Kolkata, and there might even be a sound-design credit.

Accordingly, our third data source was IMDb, which catalogues films' credits, including the names of those responsible for the sound and music of every film in our database. To incorporate

this rich credits information, we develop a machine-learning-based text classifier that determines whether a given soundtrack was recorded digitally. Our algorithm can automatically associate credits such as *sound designer* and *sound programmer* with digital production and achieves 98.4% test accuracy when evaluated on a 20% test sample. See Appendix B for more detail on the classification process. IMDb's lists of films' casts also enabled us to determine the genders of the on-screen actors and thus of the corresponding singers.

We supplemented the HGM and IMDb data with variables collected from an array of sources. To understand the influence of gatekeepers, we needed to develop measures of connections between composers and singers. Since regions in India vary significantly in terms of language and culture, coming from the same region can often tie different participants from the industry together. Therefore, we collected data on the hometowns of both singers and composers to see if they share the same region of birth. Further, this data also allows us to mark singers who are "insiders" (born in Mumbai, the home of the industry) as compared to those who were born outside.

To understand singers' participation in reality shows, we had a research assistant manually search the internet (including Wikipedia) for biographies of a sample of singers in our database. This process revealed whether a singer had participated in at least one reality show (typically before breaking into the industry). Finally, to identify a song's genre, we purchased song-level information from MySwar, a database of Indian film music based on expert classification of songs on an array of characteristics, including genre.

In addition to these variables that help us test our main hypotheses, we also collected a whole host of additional variables that helped us further test our mechanisms and rule out

alternate explanations. For the sake of brevity, we will expand on these sources as we discuss these results.

Jointly, HGM, the *Hindustan Times*, IMDb film credits, MySwar, singer and composer birthplace data, ratings and reality-show participation provide a rich overview of the Hindi film music industry's labor market and technological evolution of over the last thirty years.

Sample Construction, Research Design, and Variables

Sample Construction

The goal of our quantitative analysis is to understand the labor-market allocation process for highly sought-after music gigs in the Hindi film industry. In other words, we aim to explain why a particular gig was allocated to a particular singer. A gig is defined here as a role in singing a given song, which may have many singers.[13] We strive to avoid selecting on the dependent variable, which we would be doing if we only considered cases in which a given singer was awarded a given gig. Instead, for every calendar year we identify both a "risk set" of singers who could have been chosen for a particular gig and a list of all gigs in that year. Singers were considered active in a given year if they had been awarded at least one gig in the previous or next five years. We then created an observation for every gig-singer combination, and defined a dummy variable as equal to one if a particular singer was assigned a particular gig, and zero otherwise. We can then ask whether links—combinations of singer and song—were more likely to materialize given certain characteristics of a singer (e.g., gender) and certain characteristics of a song (e.g., digital production), while accounting for all possible linkages [associations of singer and song] that could have occurred in the market in a given calendar year. Constructing the

[13] Note that our interviews indicate that singers almost never turn down gigs that they have been offered; even established singers rarely sing more than 10 songs in a year.

dataset in this way avoids selecting on success, thus allowing us to measure the impact of digital recording in an unbiased manner (Salganik, Dodds and Watts 2006).

Appendix C illustrates this process in action. In 1994, we found 417 active singers in consideration for 374 gigs, for a total of 155,958 observations. For each observation, we recorded a link if a given singer sang a given song: for instance, Kumar Sanu and Alka Yagnik sang "Tum mile . . . ."; all other singers were recorded as having missed out on that opportunity. Panel B shows how this process produced our dataset. Repeating it for every calendar year, we collected a total of 8,557,956 observations between 1985 and 2017.

Variables and Summary Statistics

Dependent Variable. Our key dependent variable is a dummy variable, *GotGig*, which we define as a positive link between a singer and a gig in our overall sample. In other words, if a singer was allocated a particular gig, *GotGig* is set to one; otherwise, it is set to zero. We will examine whether a particular singer was more likely to be assigned a particular gig by determining whether *GotGig* is more likely to be set to 1 under certain conditions (such as a song having been recorded digitally or a singer's gender). Because the likelihood of a particular singer-gig combination is quite low, we multiply this index by 100. Thus, the variable *GotGig* can be read as the probability that a given singer is assigned a given gig.

Independent Variables. Our key independent variable is *Digital*, which is set to one for films recorded digitally and zero otherwise.[14] We define *Woman* as a dummy variable set to one for women singers and zero otherwise; we define *Debut* as a dummy variable set to one for the first year a singer was active in the labor market and zero otherwise. We will use the *Debut* variable to examine H1 and the *Woman* variable to examine H2.

[14] Note that this variable does not vary within film because all the songs in a film were either recording using analog or digital technology.

Controls. Because digital films are likely to be more recent than analog films, we record the *Year* in which a gig was recorded as a key control. This control helps to account for any broad patterns affecting the industry, such as changes in the popularity of different film genres, changes in audience tastes, the globalization of film production and consumption etc. Similarly, *Composer* IDs can be used to account for time-invariant differences across composers. We also use our IMDb data to determine the number of men and women cast members in a given film and control for the baseline likelihood of men or women singers being chosen for a given gig. Finally, we specify a categorical variable, *Genre*, depending on a song's classification (e.g. pop, folk, classical) in the MySwar database. This control accounts for the possibility that certain genres are more likely to favor men or women singers.

Mechanism Variables. To measure the role of gatekeepers, we need indicators for whether singers have access to gatekeepers. If our proposed mechanism is important, women singers who are connected to composers are less likely to suffer post-digital-recording. To test this idea, we collect data on two measures of access to composers. First, using data on singer and composer birth regions, we create a variable "Same Region" that indicates whether a singer and composer were born in the same region, where regions are defined as one of the 7 main regions we see in the data (e.g. Mumbai, Maharashtra, North, South etc). Appendix G describes this variable in more detail. Further, we also create an indicator for whether a singer was born in Mumbai, where the industry is located. Given the manual nature of data collection for this variable, we collect this data only for those singers with more than 4 songs in our data, i.e., for 328 men and 195 women singers. These variables will help us test H3.

Finally, to test H4, we measure singers' participation in reality shows using *Reality Show,* a dummy variable that equals one if a singer has done so, and *High Rated*, a dummy

variable that equals one if the singer's musical output has averaged more than four stars on HGM. Note that reality shows pre-date the arrival of digital recording, which means this variable measures the impact of audience endorsements separately from any independent role that digitization might play.[15] While we can measure *High Rated* for all singers, the *Reality Show* measure is calculated only for those singers with four or more songs as before, and we exclude the other singers from our analysis.

Summary Statistics. Table 1 provides summary statistics. Panel A presents the data at the singer-gig level summarized above. Of the 8,557,956 possible singer-gig links, the mean value of *GotGig* is 0.24, signifying a 0.24% probability that a given singer would be assigned a given gig. About 36% of active singers are women; about 59% of gigs are digital. The average film in the sample features 19.6 men and 7.7 women actors. About 19% of the time, singers and composers come from the same region of birth.

Panel B describes the labor markets for men and women singers respectively. A total of 956 men sang at least one song in a film; only 547 women did so, a pattern that suggests some bias in this market. Participants in reality shows represented 16% of men and 21% of women; their songs' average crowdsourced ratings on HGM are similar at about 3.5 stars out of 5, suggesting no difference in audience preferences between men and women singers. 32% of men singers and 35% of women singers were born in Mumbai, even though this data is available only for a subset of singers in the data.

INSERT TABLE 1 HERE

[15] As Appendix J shows, reality shows have a relatively equal distribution of men and women participants, validating our hypothesis that they do not tend to be influenced by any pre-existing differences in the ability to self-promote between men and women singers.

Figure 1 documents the diffusion of digital recording technology in the Hindi film industry. Lighter-colored bars represent songs (not gigs) recorded with analog technology; darker bars represent songs recorded digitally. The total number of songs hovers between 350 and 450 in 1995–2017; digital recording began being adopted slowly in the mid-1990s and then exploded in popularity: over 90% of songs were digitally recorded by 2010. These trends match the qualitative data we collected from industry participants, validating our method of classifying songs as digital or analog.

INSERT FIGURE 1 HERE

Research Design

How can we use the change depicted in Figure 1, and the sample and variables described in Table 1, to understand the effect of digital production on labor-market outcomes? Simply comparing films featuring digitally produced music to those with analog music is likely to lead to biased results; the two sets of films differ substantially in other ways, notably in terms of the year when they were produced and the genre, cast, and composer employed. Our core estimation strategy therefore relies on a series of fixed effects to account for these concerns. Specifically, we ask whether in a given calendar year *GotGig* is more likely to be one [a realized singer-song link] depending on the characteristics of the song (e.g., its digital status) and the singer (e.g., gender or debut year). We include year fixed effects that essentially wipe out intertemporal comparisons, allowing us to compare outcomes between digital and analog films in a given year. We include composer FEs to account for composer-specific tastes that might correlate with choosing men singers over women singers and we also control for song genre. We explicitly control for the gender composition of the film's cast for additional robustness. Such a

specification can be used to examine entry (H1), gender allocation of gigs (H2), and the roles of gatekeepers (H3) and audience endorsements (H4).

Our baseline FE specification can help to reliably estimate the effect of digital cultural production on labor-market outcomes for studio singers in the Hindi film industry. However, the possibility remains that, even within a given year, and even after accounting for composer FEs and other controls, digitally produced music differs from analog music in a way that also changes the demographic composition of hired singers. To test for this possibility, we make use of an instrument that affected a composer's likelihood of digital adoption without directly affecting the types of singers hired for a given song. In the analog era, composers relied heavily on a few large studios to record their music. Four of these studios (Mehboob, Sunny, Western Digital, and Sahara) accidentally caught fire in different years between 2000 and 2003. Because composers could not go back to these permanently closed analog studios, we argue that composers previously dependent on them were more likely to exogenously adopt digital recording technology. Since the fires are unlikely to have directly affected the demographic composition of the singers chosen, this strategy suggests an instrumental variables (IV) research design that we can employ to provide additional robustness for our baseline hypotheses.

QUANTITATIVE RESULTS

Digital Cultural Production and Labor Market Entry

We hypothesized that digital cultural production increases entry into the market by facilitating the debuts of new entrants. Figure 2 offers a look at descriptive trends in the data. This figure presents stacked bar charts showing the total number of unique singers who worked at least one gig in a given year (Panel A) and the total number of unique singers who debuted in

a given calendar year (Panel B). In both panels, a singer is assigned to the digital category if more than 50% of their gigs in a given year were digitally produced. As sound recording shifted to digital production, the number of active singers in the labor market more than doubled, from about 100 in the year 2000 to over 225 by 2015 (Panel A). Panel B makes this point more starkly: the number of newcomers in the industry hovered around 15–20 in the analog era and then more than tripled to over 60 by 2010. These patterns document a general trend that accompanied digital cultural production: a greater number of active singers and a greater number of newcomers. Note that the total number of songs in this time period remained quite constant at around 400; thus, this expansion of the labor market resulted in a near-constant number of opportunities being distributed among a growing number of singers.

INSERT FIGURE 2 HERE

The patterns in Figure 2 are striking, but they leave unresolved whether expanded entry ought to be attributed to digital production or to other broad trends (such as expansion, professionalization and globalization of the film industry, and the emergence of the internet). To test this question formally, we examine whether digital cultural production is linked to more debuts in a given calendar year in a regression framework using the fixed-effects research design described above. Specifically, we estimate regressions of the form:

$$GotGig_{sgt} = \alpha + \beta_1 \cdot Digital_g + \beta_2 \cdot Debut_{st} + \gamma \cdot Digital_g \times Debut_{st} + \delta_t + \eta_g + \sigma \cdot X_g + \epsilon_{sgt}$$

for singer s and gig g in year t, where $Digital_g$ is a dummy variable that equals one if the gig is digitally produced and where $Debut_{st}$ is set to one for singer s's first performance in their first active year t, δ_t represents year fixed effects, η_g represents composer fixed effects, and X_g controls for gig characteristics, including number of men and women cast members and genre of the gig. Standard errors are clustered at the level of the individual film, since the treatment

(digital recording) varies at this level; that is, because all gigs in a film have the same treatment status, it is important to adjust for serial correlation within film (Abadie et al 2017).

The estimates from this specification appear in Table 2. Column (1) includes only year fixed effects, column (2) adds actor/genre controls, and column (3) presents the full model with all fixed effects and controls (including composer fixed effects). The results are consistent across all models and confirm the finding that a newcomer is more likely to be hired for a digital film than an analog film during their debut year. The coefficient of .223 represents a nearly 100% greater chance of being hired than the mean of .24 reported in Table 1. Jointly, Figure 2 and Table 2 confirm H1's prediction that digital cultural production facilitates entry and thus expands the market for studio singers.

INSERT TABLE 2 HERE

Digital Cultural Production and Opportunities for Women Singers

We next examine whether the trend toward digital cultural production has affected men and women singers differently. Figure 3 is a stacked bar chart illustrating the number of gigs allocated to men singers (light-blue bars) and women singers (dark-blue bars) in analog (Panel A) and digital soundtracks (Panel B). In analog films, women singers were assigned 47% of all gigs, while women win only 34% of all singing gigs in digitally recorded films. In other words, though the market for singers was quite limited in the analog era, the shares of women singers and men singers were quite similar. As digital recording began to expand the labor market, gigs were increasingly allocated to men singers at the expense of women singers.

INSERT FIGURE 3 HERE

Table 3 tests this idea formally by estimating regressions of the form:

$$GotGig_{sgt} = \alpha + \beta_1 \cdot Digital_g + \beta_2 \cdot Debut_{st} + +\beta_3 \cdot Woman_s + \gamma \cdot Digital_g \times Woman_s + \delta_t + \eta_g + \sigma \cdot X_g + \epsilon_{sgt}$$

The key dependent variable is the interaction $Digital_g \times Woman_s$ which compares the impact of digital cultural production on women and men singers' likelihood of getting gigs. We also add a dummy for $Debut_{st}$ which accounts for the fact that a singer, by definition, is more likely to get a gig in the first year in which they are hired. The estimates for this interaction in Table 3 are negative and significant. For example, in the fully specified third column the coefficient is -0.09, which can be interpreted as an approximately 37% lower likelihood of a woman singer getting a gig in a digital film when compared to the mean of about 0.24 reported in Table 1 for *GotGig*. Note that, even though the main co-efficient on *Woman* is positive and significant, this cannot be interpreted as a causal estimate; it is simply a function of the fact that there are far fewer active women singers in any given year, and so, the chance of any random woman getting a gig is higher than that of a randomly chosen man.

The first three columns present estimates from the baseline fixed-effects specification; column 4 provides estimates in line with the instrumental-variable strategy described earlier. Specifically, we consider fires that occurred at four prominent analog recording studios and calculate each composer's prior reliance on those four studios as a percentage of their total recordings. Of the four studios, we identify the one that each composer relied most on. If a composer's reliance on each of the four studios was less than 5%, we code the composer as reliant on none of the four. We then code a dummy variable, $AfterFire_{gt}$, which equals one if the composer of a given song worked on it during the year after a fire at the focal studio. For example, before 2003, the composer Viju Shah had recorded 53% of his songs at Western Digital Studio, which caught fire in 2003. We thus code the instrument equal to 1 for all songs recorded by Viju Shah after 2003.

In the baseline specification, we instrument $Digital_g$ with $AfterFire_{gt}$ and $Digital_g \times Woman_s$ with $AfterFire_{gt} \times Woman_s$ while keeping the other controls unchanged. The results appear in Table 3, column 4; the coefficient on the instrumented interaction effect remains negative and significant though the coefficient is about twice as large as the $Digital_g \times Woman_s$ estimate in column 3, suggesting that the local effect of digital cultural production on the treated composers is quite large.

INSERT TABLE 3 HERE

Robustness of Baseline Results

The results in Table 3, while compelling, raise three sets of questions. First, we are assuming that men and women singers are competing for the same gigs. We base this assumption on the idea that singers are often chosen before a song is picturized i.e., they are not associated with a given actor and so the singer gender can be different that the gender of the actor on screen. Is this the right assumption, or might the choice of singer gender mechanically reflect changes in gender composition on screen? While we do control for actor gender in our regressions, in Appendix D, we examine this assumption in more detail. First, in Figure D1, we plot the share of women cast members in the films in our sample by calendar year. This plot shows that the ratio of women cast members to men in major Hindi language films is constant or somewhat increasing from a level of about 25-30% before the year 2000 to almost 50% post 2000. Therefore, if anything, we should see an increase in women singers, not a decrease. Further, using HGM, which lists actors for a given song, we collected the list of songs for which no actors were listed, assuming these to be "background" songs.[16] Then in Table D1 we examine our baseline hypothesis by restricting

[16] Figure D2 shows that the usage of such background songs in Bollywood films remains relatively constant over time.

our analysis to women-dominant films (i.e. a high proportion[17] of actors on screen are women) and to background songs only. As columns 3 and 6 of Table D1 show, the triple interactions are small in magnitude and not significant, suggesting that there is no difference in our baseline estimates when we consider women-dominant films and background songs. This is reassuring – the patterns we document are not driven by any particular kind of film or song, suggesting that screen presence of actors is not a first order consideration in our setting.

A second concern with our baseline results is that even though we document a decrease in women singers getting gigs post-digital-recording, might it be that these "lost" gigs are precisely the ones that they are not interested in? In other words, might women singers be choosing to sing a smaller number of high-paying and more prestigious gigs rather than a larger number of low-paying, less prestigious gigs? Note that our sample already considers a set of high-paying prestigious gigs in that it is restricted to songs in the top 50 movies. Further our interviews suggest that singers are usually not capacity constrained (i.e., they do not turn down these top gigs because they are "too busy"). Despite this, it might still be interesting to examine whether our baseline results change when considering additional measures of "gig quality."

Our results in Appendix Table E1 suggest that concerns around gig quality are unlikely to be a major issue in our setting. First, we introduce a fixed effect for the production company of a movie – the assumption is that high quality gigs are likely to come from well-known production houses, and so we would like to check if our results hold even within a production house. Second, we use our data on song ratings and examine whether our results hold when considering highly rated compositions; these are ones that became "hits" and to which a singer might be especially attracted to. Third and fourth, we develop two measures of song quality based on other

[17] We operationalize women-dominant films to be those with greater than the median (41.1%) ratio of women to men actors.

singers hired in the movie and box office returns. We term a gig as high quality if a top singer[18] was hired on the album. The assumption is that if the album has a top singer, the quality of the movie and therefore the gig is likely to be quite high. Similarly, we collect data on box office returns from two sources IBOS and Box Office India and examine differential effects for high versus low grossing movies; gigs in higher grossing movies could be considered higher quality to the extent that they have a wider audience. Finally, our interviews suggested that solo performances are especially valuable for singers because they do not share singing time with another singer. Accordingly, we examined the differential effect of solo gigs relative to gigs with more than one singer.

As Table E1 shows, the effects are consistent when we control for the production house (column 1). Further, there seem to be no differential effects for highly rated songs, for high grossing movies, and for solo songs (columns 2, 4 and 5). The coefficient in column 3 is negative and significant, suggesting that the negative effect of digitization on women singers is especially driven by albums that have top singers. Assuming that these gigs signify high quality opportunities, this result rules out the possibility that the overall negative effect of digitization on women singers is driven by a reduction in low-quality gigs being allocated to women. Overall, the results in Table E1 suggest that women are losing out on meaningful gigs, which is likely to have a serious impact on their professional success and income in the industry post-digital-recording.

Finally, our theoretical argument claims to isolate the effect of a production technology on the career success of men and women artists; this theory relies on no major changes wrought by digitization on the consumption side. We exclude gigs post-2010 when this assumption is less

[18] We define a "top singer" as one that ranks in the top 100 of our sample based on the number of lifetime gigs.

likely to hold true given the rise of digital streaming platforms and notably YouTube. The results are robust to this exclusion (Appendix F).

The Role of Promoting to Gatekeepers

Having found support for our first two hypotheses, we turn to evaluating H3: that digital cultural production harms women because they are less connected to gatekeepers. To test this idea, we examine data on singer/composer birthplaces to determine whether being from the same region as the composer or from Mumbai mitigates the negative impact of digitization for women singers. In Appendix G we provide some brief descriptives of these variables.

Specifically, we estimate regressions in which we introduce two indicators: $Same\ Region_s$ which indicates gigs where the singer and the composer share a home region, and $From\ Mumbai_s$ which is an indicator for whether a singer's hometown is Mumbai. Using these variables, we examine the effect of digital cultural production on women singers via (a) a split-sample analysis and (b) a triple interaction framework in which the two indicator variables are interacted with the $Digital_g \times Woman_s$ term.

Table 4 presents estimates from this analysis. The first set of results examines the effect of being from the same region as the composer and the second set examines the effect of being from Mumbai. As is clear in columns 1 and 2, the negative effect of digital cultural production pertains only to women singers who are not connected to gatekeepers via their home region. When considering the triple interaction (column 3), women singers with the same home region as the gig's composer do not suffer as much of a penalty as compared to those who do not share a hometown; the triple interaction is positive (0.164) and statistically significant. In other words, the negative effect of digital cultural production is much smaller for women singers who have connections to gatekeepers.

The next three columns tell a similar story – but using only the singer's hometown instead of connections to composers. Here we see in column 4 that when women singers are not born in Mumbai, they suffer post-digital-recording; when they are (column 5), there is no negative effect. Aligned with these patterns, the coefficient in the triple interaction term in column 6 is positive and statistically significant. Collectively, Table 4 suggests that when women singers can access (and implicitly promote themselves) to gatekeepers, they are largely shielded from the negative effects of increased competition post-digital-recording. Women singers lacking these ties are the ones who bear the brunt, validating our hypothesis that difficulties in self-promoting and accessing gatekeepers is a key reason for the reduced opportunities for women singers post-digital-recording.

One alternate explanation for the mechanism of gatekeeper access is a story based on audience preferences and biases (Kuppuswamy and Younkin 2020). In this account, once digital recording increases the pool of qualified singers, women singers are neglected not because they cannot access gatekeepers, but because gatekeepers are responding to audiences' demands for more men voices. While our finding that connections between singers and gatekeepers matter validates our theory to some extent, we test this alternative mechanism more directly in Appendix H. We argue that if a demand side story is at play, then we would expect the effects we document to be more severe in movies and songs that are more commercially oriented; for these gigs, composers might be particularly sensitive to audience demands. Accordingly, we examine the heterogeneous effects of digital recording for sequels (which are arguably the prototypical example of a commercially oriented movie) and for the "pop" genre, which usually represents songs composed for a more popular audience. As Table H1 shows, if anything, digitization has a positive effect on the hiring of women singers for these commercial movies

and songs – not a negative one (see triple interaction in columns 3 and 6). In other words, when a movie or song is more commercially oriented, women singers in digital films are more likely to get picked, suggesting that audiences are demanding women's voices. The demand side story, therefore, seems to be inconsistent with the patterns in Table H1, further corroborating our proposed mechanism.

Combined with our qualitative data, these quantitative analyses suggests that limited connection to gatekeepers has an important role to play in explaining women singers' lost opportunities when music is digitally recorded.

INSERT TABLE 4 HERE

The Value of Audience Endorsements for Women

H4 proposes that the negative impact on women of digital cultural production is lessened by audience endorsements via reality shows and hit songs. We use a framework similar to that of Table 4 to examine the role of being (a) highly rated and (b) a reality-show participant. The results appear in Table 5. The first three columns show no negative effects of digital cultural production on women singers whose bodies of work elicited high audience ratings. This result is robust and statistically significant when we consider the triple interaction term in column 3. As column 2 shows, digital cultural production has been harmful only for singers without high audience ratings.

The effects of reality-show participation appear in columns 4, 5, and 6. These results demonstrate that appearances on reality shows help women outperform men in digital films. Indeed, unlike those without reality-show experience (column 4), the effects of digital cultural production for artists with reality-show experience (column 5) are actually positive and

significant; the difference between those with and without experience is therefore also positive and significant (column 6).[19]

These results strongly confirm H4, which asserts that the negative effects on women singers of digital cultural production are mitigated when they elicit audience endorsements. Reality-show participation in particular helps women exceed mere parity to outperform men in terms of employment opportunities.

INSERT TABLE 5 HERE

DISCUSSION

This paper examines the effect of digital recording technology on the likelihood that women singers will be hired to record music for Hindi film soundtracks. Drawing on in-depth interviews with composers and singers, we hypothesized that digital recording would (1) expand the market for singers but (2) restrict opportunities for women singers. We attributed this effect to (3) women singers' inability to access and self-promote to gatekeepers in a newly crowded marketplace, and hypothesized that the negative effect could be mitigated when (4) women garner audience endorsements via reality shows and hit songs. Exploiting a hand-collected dataset on musical recordings used in major films between 1985 and 2017, in conjunction with a fixed-effects empirical strategy, we found support for all four hypotheses. Digital production has led to an approximately 20% increase in the likelihood of a newcomer to the industry being assigned a gig, but has reduced that likelihood for a woman singer by about 9%. Women artists who either share a home region with a gig's composer or are born in Mumbai - where the

[19] In Appendix I, we provide estimates as in Table 5 but using a sample that excludes those singers born in the composer's hometown (Table I1) or Mumbai (Table I2) to examine if the effects of audience endorsements are relevant to those without connections to gatekeepers. The results are robust to this test.

industry is located - are able to mitigate the negative effects of digitization, presumably because they are able to effectively access and promote to gatekeepers. Further, those who win audience endorsements through hit songs or reality-TV shows are also able to obtain more gigs. Our results suggest that digital production technologies can create new forms of gender inequality by cluttering the marketplace with new talent and increasing the power of gatekeepers to decide which artists get lucrative gigs.

Contributions to Scholarship on Artistic Careers in Cultural Industries

Our study makes four contributions to the literature on artistic careers. First, while prior work has highlighted the labor market effects of digital *consumption* technologies, we advance the literature on this topic by isolating the role of digital *production* technologies. Prior scholarship has conflated the two, grouping them both under the umbrella of "technological change." Even as the literature on these technological changes has grown, scholars have referred to production and consumption technologies as though they are interchangeable (Menger 1999, de Laat 2017, Kim, Toh and Baik 2022, Hirsch and Bajpai 2018). For example, in Peterson and Anand's (2004) influential review of the literature, they bounce seamlessly between references to production technology, such as autotune and microphone technology, and consumption technology, such as radio and digital communication media, without making a distinction between the two. Distinguishing between technological change in the production and the consumption of cultural goods is crucial because each kind of technology is likely to operate according to a distinct logic and have independent consequences.

Our second contribution is to show how the adoption of digital production technologies can actually increase the gap between men and women artists' career success in cultural markets. These findings contrast with the bulk of the literature, which largely finds lower gender

inequality after the advent of digitization (Aguiar, Waldfogel and Waldfogel 2021, Mollick and Greenberg 2017, Erigha 2015). However, most papers that have found a positive, equalizing effect of digitization have focused on technological changes in *consumption*, which have enabled artists to get their products directly to their audiences. We do not dispute these findings, but show that the effects of digitization of *production* can be in the opposite direction. Our results show that digitization lowers barriers to entry and attracts a flood of new talent into the industry; our theory asserts that, ironically, this very process serves to promote gender inequality.

Third, we show how production technologies can increase the power of gatekeepers as compared to consumption technologies that tend to reduce their power. Previous work has shown that digitization of consumption technology has weakened the influence of gatekeepers by providing creators with direct channels to their audiences, from social media, to YouTube, to streaming services like Spotify (Ryan and Peterson 1993, Toop 1995, Erigha 2021). Where gatekeepers have less power, women artists are more likely to succeed (Verboord 2011, Cao, Koning and Nanda 2021, Greenberg and Mollick 2017, Greenberg 2019, Gorbatai and Nelson 2015). In contrast, we suggest that by creating a cluttered marketplace and intensifying competition among creative talent, digital production technologies allow gatekeepers greater leeway to distribute gigs, through which gender inequality might increase. Because the gatekeepers in the Hindi film industry (music composers) are almost exclusively men in gendered networks, men artists benefit from the increase in music composer control over awarding of gigs. We have always known that gatekeepers have the power to affect who succeeds in a creative field because they have control over the distribution of opportunities to artists (Hirsch 1972). However, the literature has not previously shown that certain technological developments can inadvertently solidify gatekeeper power and increase inequality.

Fourth, our work shows how digital production technologies can affect the dimensions along which cultural producers compete by showing the increased value of self-promotion through connections to key gatekeepers post-digital-recording. Scholars have long been interested in understanding the drivers of competition in creative markets and have pointed to the role of experience, networks, and skill among others (Menger 1999, Caves 2000, Gross 2020). Our work shows how digital production technologies can intensify competition and change the relative importance of different dimensions of competition. In our setting, while vocal ability was prized pre-digitization, technological change increased the returns to self-promotion and made differences in vocal ability less important. These results echo other findings in the literature that show how the importance of status signals can increase when evaluators have limited attention (Simcoe and Waguespack 2011).

Finally, this paper also addresses the role of audiences in helping women artists overcome disadvantage. Even if women artists face barriers in network access and self-promoting, fans and followers can act on their behalf to promote their abilities to gatekeepers. Our interview data documents how women musicians can leverage audience endorsements generated by reality-show participation and hit songs. Reality shows have been criticized in sociological work (for example, Grazian 2010) as profit-maximizing endeavors whose participants work long hours for paltry wages. We do not dispute this argument, but do call attention to the benefits of exposure (Younkin and Kashkooli 2020) on such shows for marginalized groups, like women, who might otherwise be hard-pressed to promote themselves. Similarly, prior work has investigated the production of hits in cultural markets (Salganik, Dodds and Watts 2006, Hsu 2006, Kovacs and Sharkey 2014); we point out that hit songs can propel women's careers by showcasing their talent and raising their salience to composers.

Generalizability

The Hindi film industry, based in Mumbai, India, is the world's leading producer of films, releasing over twice as many films per year as Hollywood does. The industry is also the global leader in viewership and number of tickets sold, producing almost three-quarters of all recorded music sold in India.[20] Our results examine the impact of new technology in music production on the industry's labor market, thereby contributing to a literature that has largely focused on English-language cultural markets in the western (especially US) context.

Because the labor market in the Hindi film music industry largely consists of studio singers rather than artists who release album-based music, thoughtful readers might question whether our results generalize to other cultural markets, such as the American and European recorded-music industries. We believe our results to be pertinent to those markets since the advent of the digital recording technology we study is a global phenomenon. In fact, most of the technology in use in the Hindi film industry was developed in the west. Thus, we expect the effects of digital recording that we identified to be a widespread phenomenon.

Although some scholars have argued that technology's impact on labor market dynamics is only apparent in the recorded music industry rather than in the broader music market (Rogers 2013), we believe that cultural producers of all artistic media are likely to be affected by technological changes in production. Gatekeepers are also prevalent in such other cultural markets as art (e.g., gallery owners), film (film producers and directors), and fashion (editors and buyers). Thus, if digital technology attracts much larger pools of talent into those arenas, we might expect growing inequality in their labor markets as well.

[20] https://www.businesstoday.in/latest/economy-politics/story/india-recorded-music-industry-can-rival-europe-in-10-years-imi-study-293251-2021-04-12

Readers might also assume that India is unique in the starkness of its gender norms. It is useful to keep in mind, however, that women singers' share of the labor market was near-equal to men's prior to the introduction of digital technology; thus, the patterns we trace are due more to the impact of technological change than to more pervasive gender norms. Should we therefore expect technological change to harm women cultural producers always and everywhere? More research is needed, but there are compelling reasons to expect this finding to generalize as long as women artists are subject to more severe constraints in promoting to gatekeepers.

Finally, our work has implications for understanding the labor market consequences of a new generation of production technologies including generative AI. For example, the growth of ChatGPT lowers the skill levels required for film and television writers. If any amateur writer can claim to generate a first draft of a sitcom, for example, then television studios only need professional quality writers to come in for rewrites, thus reducing the qualifications for television writing gigs. Consequently, with more writers able to perform the work, studios can choose writers from a larger pool based on who they know. No matter the context, as long as women face difficulties in accessing (men) gatekeepers who have the power to distribute opportunities, a more digital creative market will operate to their detriment.

In conclusion, the overall effects of digitization on gender equality in the arts are clearly quite complex and will depend on the relative strength of the impact of digitization of consumption versus production. Therefore, our goal is not to say that new technologies will always increase inequality. More modestly, by isolating the labor market effects of digital production technologies, we hope to shed new light on an underexplored channel through which new production technologies shape the labor market for cultural industries.

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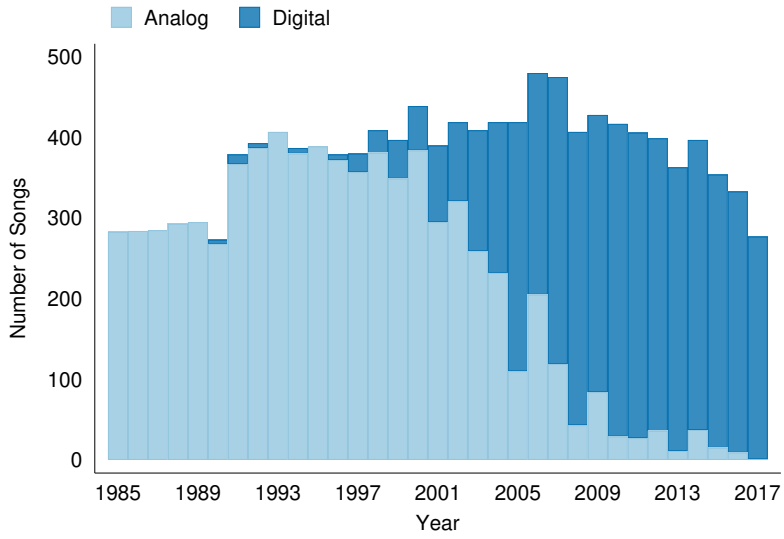
Figures and Tables

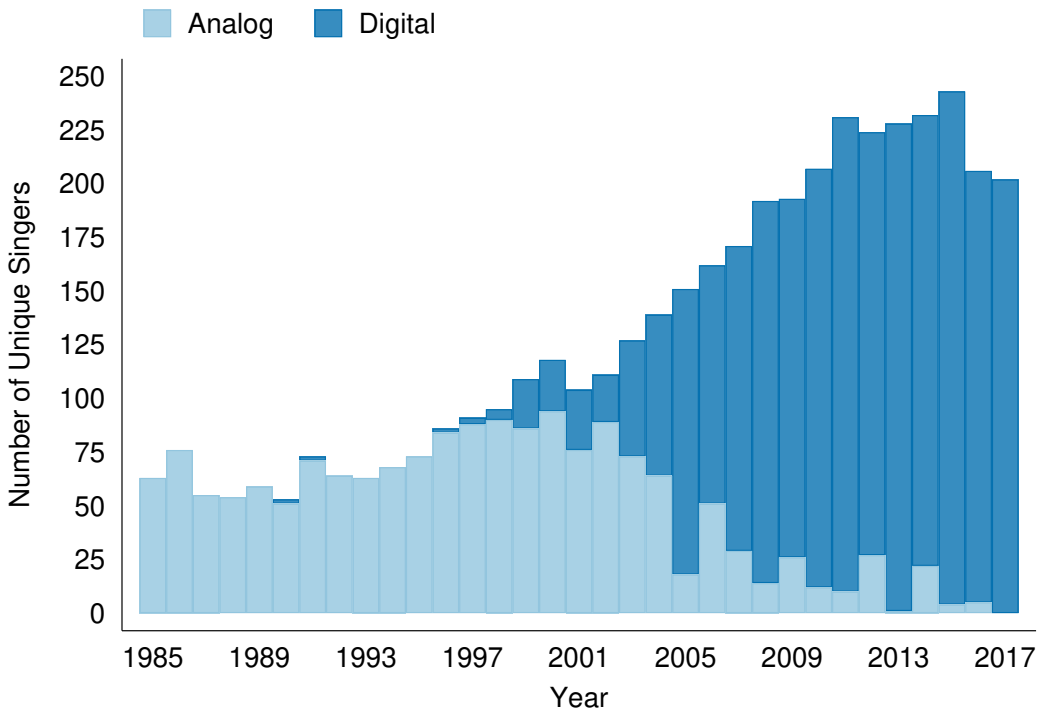
Figure 1: Share of Songs Recorded Using Digital Technologies, 1985-2017



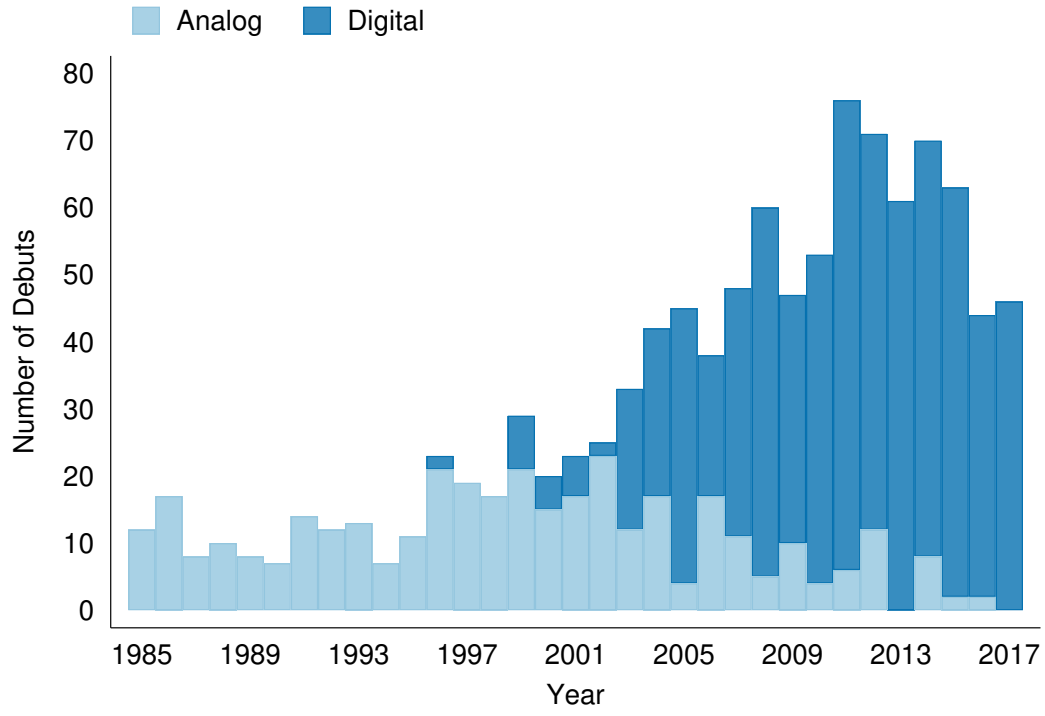
Note: This figure explores the diffusion of digital recording technology over time. For each year, we calculate the number of songs recorded using analog technology and digital technology. Light-blue bars represent analog songs; dark-blue bars represent digital songs. Because the data are stacked, the total height of a given bar indicates the total number of songs recorded using both technologies in a given year.

Figure 2: Singer Entry in Analog and Digital Film Songs

Panel A. Unique Singers



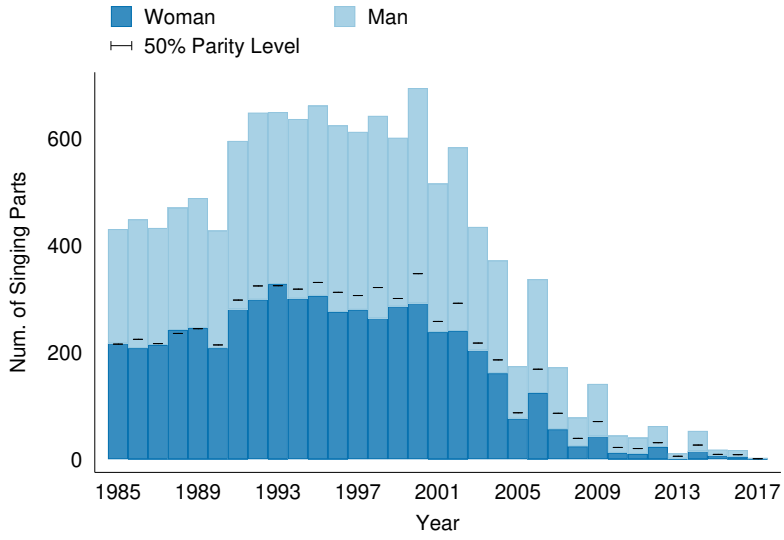
Panel B. Debuts



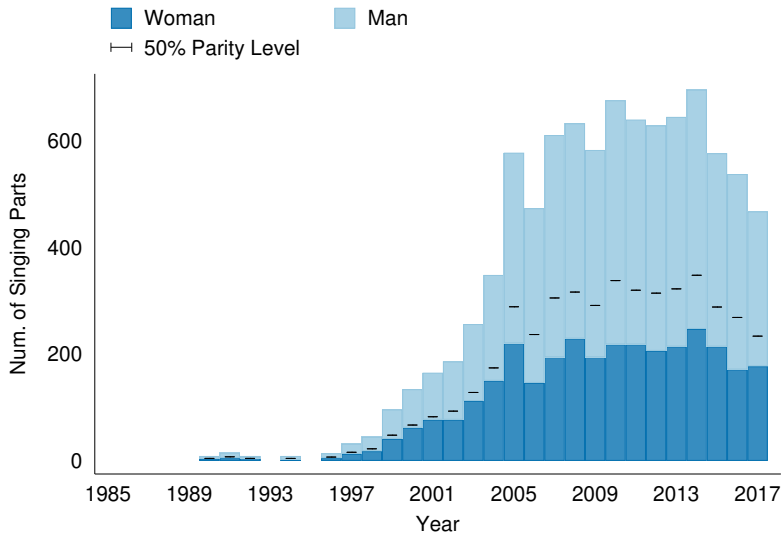
Note: This figure shows patterns of entry into the labor market for studio singers in the Hindi film industry over time. Panel A plots the number of unique singers who performed in analog and digital films in a given year; singers are assigned to one category or the other if more than 50% of their gigs in that year belong in that category. Panel B includes only newcomers in each category.

Figure 3: Distribution of Singing Gigs for Men and Women

Panel A. Analog ($\mu = 0.47$)



Panel B. Digital ($\mu = 0.34$)



Note: This figure explores the share of gigs assigned to men and to women for analog songs and digitally recorded songs. For every calendar year, we calculate the number of analog gigs assigned to women and to men; Panel A presents this data as a stacked bar chart. Light-blue bars indicate gigs assigned to men; dark-blue bars indicate gigs assigned to women. Horizontal black lines indicate the 50% level, given the total number of gigs in a given year (the combined height of both bars). Panel B presents the same information for digitally recorded songs.

Table 1: Summary Statistics

Panel A: Overall Statistics (N=8,557,956)

	Mean	Std. Dev.	Median	Min	Max
Year	2005.23	8.06	2007.00	1985	2017
Digital	0.59	0.49	1.00	0	1
GotGig	0.24	4.90	0.00	0	100
Woman	0.36	0.48	0.00	0	1
Number of Men Actors	19.60	14.74	16.00	1	206
Number of Women Actors	7.74	6.64	6.00	0	76
Same Region	0.19	0.40	0.00	0	1

Panel B: Singer-Level Statistics

Men Singers (N=956)

	Mean	Std. Dev.	Median	Min	Max
Debut Year	2001.64	15.64	2007.00	1936	2017
Final Year	2011.08	7.81	2013.00	1985	2019
Reality Show	0.16	0.36	0.00	0	1
Avg. Rating	3.57	0.70	3.68	1	5
From Mumbai	0.32	0.47	0.00	0	1

Women Singers (N=547)

	Mean	Std. Dev.	Median	Min	Max
Debut Year	2000.08	16.75	2006.00	1939	2017
Final Year	2010.12	8.41	2013.00	1985	2019
Reality Show	0.21	0.41	0.00	0	1
Avg. Rating	3.53	0.66	3.61	1	5
From Mumbai	0.35	0.48	0.00	0	1

Note: The table in Panel A provides overall summary statistics of the main dataset. *GotGig*, *Digital*, *Woman*, *Pop* are dummy variables that range from 0 to 1. The mean of the *GotGig* variable indicates the probability that a random active singer is hired for a random song in a calendar year. *Same Region* indicates if the singer and the music director come from the same region, which is coded for singers who sing more than 4 songs and for music directors with more than 2 songs (N = 3,899,067). Panel B provides summary statistics by the singers' gender. *Average rating* was computed for each singer based on the crowd-sourced rating of their songs. *Debut Year* and *Final Year* indicate the first and last year a singer appear in our data as active and *Reality Show* is set to one if a singer has ever participated in a televised reality show. *From Mumbai* indicates if the singer comes from Mumbai, which is coded for 328 men and 195 women who sing more than 4 songs.

Table 2: Digital Cultural Production and Labor Market Entry

	Likelihood of Getting Gig		
	(1)	(2)	(3)
Digital	-0.00449	-0.00460	-0.00153
	(0.00516)	(0.00508)	(0.00542)
Debut	-0.0498*	-0.0498*	-0.0498*
	(0.0223)	(0.0223)	(0.0223)
Digital x Debut	0.223***	0.223***	0.223***
	(0.0285)	(0.0285)	(0.0285)
Year FE	Yes	Yes	Yes
Composer FE	No	No	Yes
Actor/Genre Controls	No	Yes	Yes
N	8557956	8557956	8557956

Note: This table provides OLS estimates of the likelihood that a newcomer will be hired for a digital or an analog gig. Data are at the singer-gig level, with one observation for every active singer-gig combination by calendar year. The outcome variable is *GotGig*; *Digital* and *Debut* are dummy variables if the focal gig is for a digital soundtrack or if the singer is making a debut in that year. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$

Table 3: Digital Cultural Production and Allocation of Gigs to Women Singers

	Likelihood of Getting Gig			IV
	(1)	(2)	(3)	(4)
Digital	0.0411***	0.0410***	0.0440***	-0.0563
	(0.00568)	(0.00560)	(0.00592)	(0.0888)
Woman	0.0944***	0.0946***	0.0946***	0.170***
	(0.00586)	(0.00585)	(0.00586)	(0.0399)
Digital x Woman	-0.0905***	-0.0906***	-0.0906***	-0.219**
	(0.00734)	(0.00734)	(0.00734)	(0.0675)
Debut		0.0942***	0.0942***	0.0943***
		(0.0141)	(0.0141)	(0.0141)
Year FE	Yes	Yes	Yes	Yes
Composer FE	No	No	Yes	No
Actor/Genre Controls	No	Yes	Yes	Yes
N	8557956	8557956	8557956	8557956

Note: This table provides OLS (1-3) and IV (4) estimates of the likelihood that a woman singer will be hired for a singing gig after digital cultural production. The sample is at the singer-gig level, by calendar year; the main outcome variable is *GotGig*. *Digital* and *Woman* are dummy variables that equal one if either the gig is for a digital soundtrack or the singer is a woman. *Debut* indicates the first year a singer becomes active. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Column 4 provides IV estimates where *Digital* is instrumented with *AfterFire* and *Digital* x *Woman* is instrumented with *AfterFire* x *Woman*. *AfterFire* is set to one for composers after the analog studio they relied on is affected by a fire. Standard errors are clustered at the film level. $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$

Table 4: The Effects of Access to Gatekeepers on Allocation of Opportunities to Women Artists

	Same Region			From Mumbai		
	No	Yes	All	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)
Digital	0.103***	0.101**	0.0427**	0.119***	0.0369	-0.00255
	(0.0144)	(0.0385)	(0.0138)	(0.0161)	(0.0193)	(0.0149)
Woman	0.268***	-0.139***	0.268***	0.310***	-0.0305	0.314***
	(0.0161)	(0.0329)	(0.0161)	(0.0190)	(0.0194)	(0.0190)
Digital x Woman	-0.245***	-0.0829	-0.245***	-0.319***	0.0103	-0.322***
	(0.0189)	(0.0454)	(0.0189)	(0.0230)	(0.0257)	(0.0230)
Indicator			-0.00607			-0.436***
			(0.0327)			(0.0195)
Digital x Indicator			0.303***			0.278***
			(0.0448)			(0.0254)
Woman x Indicator			-0.425***			-0.368***
			(0.0407)			(0.0303)
Digital x Woman x Indicator			0.164**			0.357***
			(0.0536)			(0.0376)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	3141630	757437	3899067	2510690	1206361	3717051

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on whether the singer and music director come from the same region and whether the singer comes from Mumbai. The sample is at the singer-gig level by year; the main outcome variable is *GotGig*. The sample size is smaller than the baseline because we only code the birthplace for singers who sing more than 4 songs and for music directors with more than 2 songs. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. *Indicator* is set to one in col (3) when the singer and music director come from the same region and is set to one in col (6) for singers who come from Mumbai. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \, p < 0.05$, $* * \ p < 0.01$, $* * * \, p < 0.001$

Table 5: Audience Endorsements and the Effects of Digital Cultural Production for Women

	Rating			Reality Show Participant		
	Low	High	All	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)
Digital	0.0482***	0.00923	0.00344	0.103***	-0.110**	0.0696***
	(0.00739)	(0.00750)	(0.00664)	(0.0124)	(0.0387)	(0.0120)
Woman	0.101***	0.00590	0.104***	0.228***	-0.247***	0.228***
	(0.00712)	(0.00676)	(0.00709)	(0.0127)	(0.0484)	(0.0126)
Digital x Woman	-0.0985***	-0.00368	-0.101***	-0.240***	0.275***	-0.240***
	(0.00907)	(0.00899)	(0.00905)	(0.0163)	(0.0547)	(0.0163)
Indicator			-0.335***			-0.00960
			(0.00795)			(0.0394)
Digital x Indicator			0.179***			0.0208
			(0.00997)			(0.0441)
Woman x Indicator			-0.103***			-0.463***
			(0.0101)			(0.0549)
Digital x Woman x Indicator			0.102***			0.511***
			(0.0134)			(0.0622)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	6733377	1824579	8557956	3516410	561416	4077826

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on audience ratings of their music and their participation in musical reality shows. The sample is at the singer-gig level by year; the main outcome variable is *GotGig*. The sample for columns 4–6 is smaller than the baseline sample because it includes only singers for whom we found reality-show participation. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. *High* is set to one in col (3) for singers with ratings of 4 stars or above for their music and is set to one in col (6) for singers who had participated in a reality show. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \, p < 0.05$, $** \, p < 0.01$, $*** \, p < 0.001$

Appendix A: Virtual Qualitative Methods

Our qualitative data collection was conducted during the height of the COVID-19 pandemic and, as such, it was not possible for members of the research team to travel to Mumbai and interview key participants in person. Given this restriction, the interviews for this project were conducted virtually, on video, using technologies such as Zoom or WhatsApp by the US-based research team. This section provides some additional context on the benefits and challenges of this approach, with the hope that it will be useful to other qualitative researchers interested in adopting similar methods.

Benefits:

There were several benefits of virtual data collections that we experienced. First, we found that virtual interviews offered a level of flexibility in scheduling participants that we have not experienced in past in-person interview-based projects. We found it easier to schedule interviews around the participants' travel and work schedules, including at times when traditional interviews would typically not be possible (e.g. at night or during travel). As a consequence, we were able to find time to interview subjects much sooner than expected. For example, one interviewee described that she had just returned from a trip and was free at that moment to talk, so we ended up conducting a high-quality interview with relative ease.

Second, virtual interviews also saved on travel costs for the research team, which enabled us to conduct a larger number of interviews with a more diverse and geographically dispersed interview sample than expected. Reducing travel was also environmentally beneficial, especially given the long travel distance between the US and India.

Third, we found it easier to record and transcribe virtual interviews. For example, Zoom's feature to "enable recording" allowed us to record all participant interaction in a non-intrusive and natural manner. Participants were not as self-conscious about what they were saying (as compared to having an audio recorder placed near them), and we had both audio and video data for transcription.

Finally, in addition to having benefits for participants, remote interviews were also valuable to the research team. First, note that without the possibility of virtual data collection, projects like this would not have been possible during prolonged periods of disruption such as the COVID-19

lockdowns, especially given the varying and changing rules and regulations across different countries. In addition, insofar as researchers might have their own family constraints (such as childcare responsibilities for young children), remote data collection allows for a more level playing field among researchers with and without family obligations. It is also possible to schedule interviews in a non-concentrated fashion (often not possible when the researcher travels to a given location), and around other constraints such as daycare pickups or school holidays. Further, in instances where interview participants show up late, remote interviews afford researchers the possibility of engaging in other productive tasks at home or at work as they wait for interviewees. Finally, in locations where traveling often poses safety concerns (either for reasons of local violence and conflict or sexual harassment), remote data collection offers a safer environment from which high-quality data can be collected with fewer concerns about personal safety.

Challenges:

While remote data collection has many benefits, there is no doubt that it can compromise on important factors of relevance to qualitative research. Perhaps the most central difference is that the researcher and the interviewee are not co-located during their conversation, which makes it harder to pick up on subtle bodily cues and body language that might guide the interviewer. Further, the interviewer sees the participant through a digital medium and is less attuned to local and environmental factors that might affect the interview (such as the local weather, sounds and smells of the environment etc.). This might make it harder to connect with interviewees and build rapport. Further, virtual interviews rely on a sound technical infrastructure for both the researcher and the participant, including a strong internet connection and accessories such as a working camera and microphone. Given the diversity of contexts of interest to qualitative researchers, such infrastructure might not always be available. Beyond the technology itself, depending on the study population, participants might not be familiar with using technology such as Zoom and might therefore be more reluctant to participate, leading to remote interviews selecting on those with the technical means and know-how to participate. Finally, we noticed that since remote interviews were often conducted in participants' work or home locations, there could be interruptions during the interview. While we did not face a lot of interruptions in our

interviews, we did have cases when participants were, for example, interrupted by a cook asking about dinner plans, or family members (such as children).

In our context, our study sample came from a relatively more affluent stratum of Indian society and had access to a basic technology suite including laptops, cellphones and stable internet connections. Further, the research team was located at a significant distance from the study setting and we collected data during the pandemic, which compounded the benefits of pursuing a digital mode of interviewing our subjects. The fact that our interviewees were quite busy individuals - who found it easier to converse remotely as and when they had time (rather than welcoming us into their workplaces) – helped us achieve a larger and more representative sample than would have otherwise been possible. Finally, key members of the research team had personal family considerations including childcare responsibilities for young kids, and would have exposed themselves to safety threats from doing fieldwork in India. For all these reasons, in our context, a virtual and remote approach to qualitative data collection helped strengthen our study. In other contexts, more thought is needed before a potential researcher chooses between virtual and in-person data collection methodologies.

Appendix B: Classifying Soundtracks as Analog or Digital

We classified 960 films released between 1990 and 2010 using a simple logistic-regression text classifier with L2 regularization. Each film was assigned to one of two classifications: digital (Yes) or analog (No).

Data pre-processing: The data was cleaned via computational techniques like stopword removal as well as manual cleaning. The CountVectorizer function from the scikit-learn python library was used to extract text features. This feature-extraction technique uses one-hot encoding for text data.

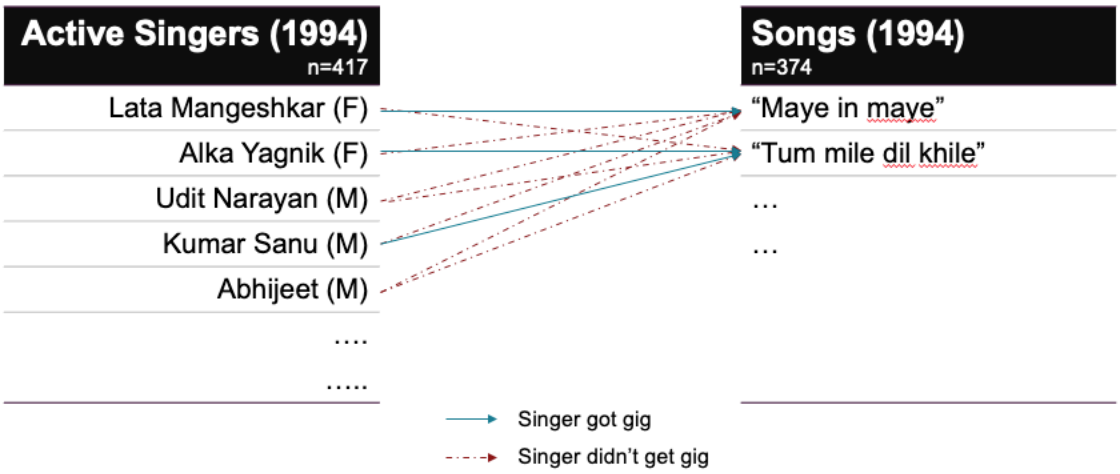
Model building: Films released prior to 1990 were assumed to be non-digital; those released post-2010 were assumed to be digital. This forms the labelled data, used to train and test the model. Eighty percent of this data is used to train the logistic-regression model; 20% is used to test the model predictions. Our model achieves a test accuracy of 98.4%, signifying that for the data on which we tested the model our result was correct 98.4% of the time. The logistic-regression model picks up keywords that correspond to digital processes, such as *ADR* (Automated Dialogue Replacement), *Foley* (reproduction of everyday sound effects that are added to films, videos, and other media in post-production to enhance audio quality), *Designer*, *Producer*, etc. The model predicts that 665 of the films are non-digital (No) and 295 are digital (Yes). In other words, for a film released between 1990 and 2010, there is a 69.27% chance that the model will classify it as non-digital.

Model validation: To validate the model we used the 20% of the labelled data that we designated as test data. We use this data to compute the precision, recall, and F1 score of the Yes and No categories.

Category	**Precision**	**Recall**	**f1-score**	**support**
No	0.96	1.00	0.98	52
Yes	1.00	0.97	0.99	73

Appendix C: Example of Sample Construction

Panel A: Construction of Singer-Song Links

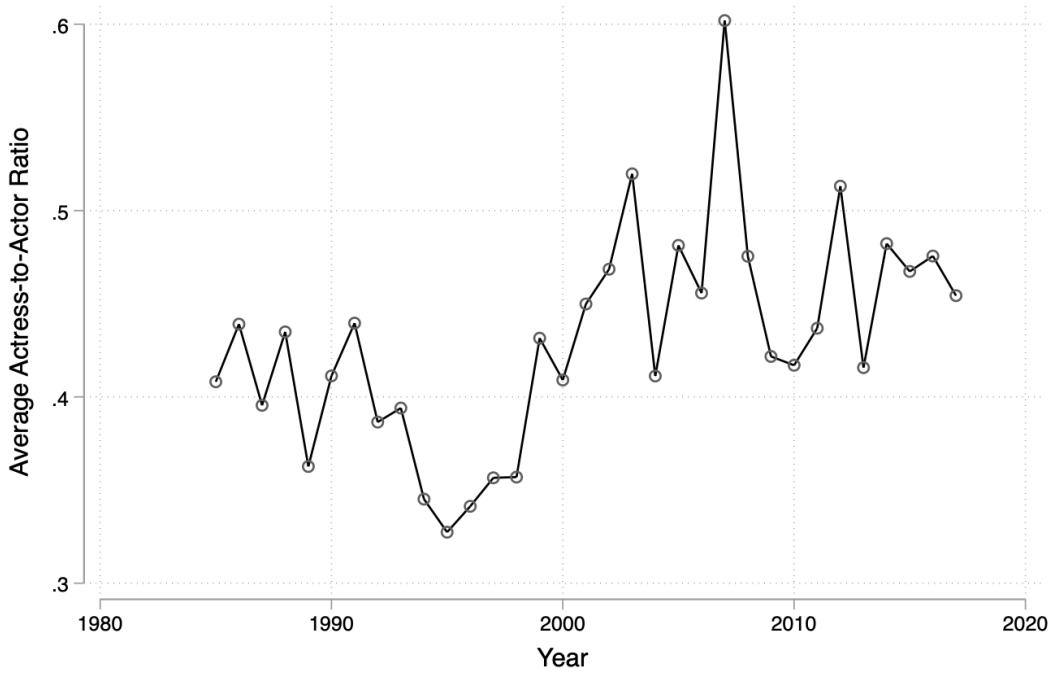


Panel B: Sample Extract

Song	Movie	Year	Digital	Singer	Singer Gender	GotGig
Maye ni maye	**HAHK**	**1994**	**0**	**Lata Mangeshkar**	**F**	**1**
Maye ni maye	HAHK	1994	0	Alka Yagnik	M	0
Maye ni maye	HAHK	1994	0	Udit Narayan	M	0
Maye ni maye	HAHK	1994	0	Kumar Sanu	F	0
Maye ni maye	HAHK	1994	0	Abhijeet	M	0
Tum mile dil khile	Criminal	1994	0	Lata Mangeshkar	F	0
Tum mile dil khile	**Criminal**	**1994**	**0**	**Alka Yagnik**	**F**	**1**
Tum mile dil khile	Criminal	1994	0	Udit Narayan	M	0
Tum mile dil khile	**Criminal**	**1994**	**0**	**Kumar Sanu**	**M**	**1**
Tum mile dil khile	Criminal	1994	0	Abhijeet	M	0

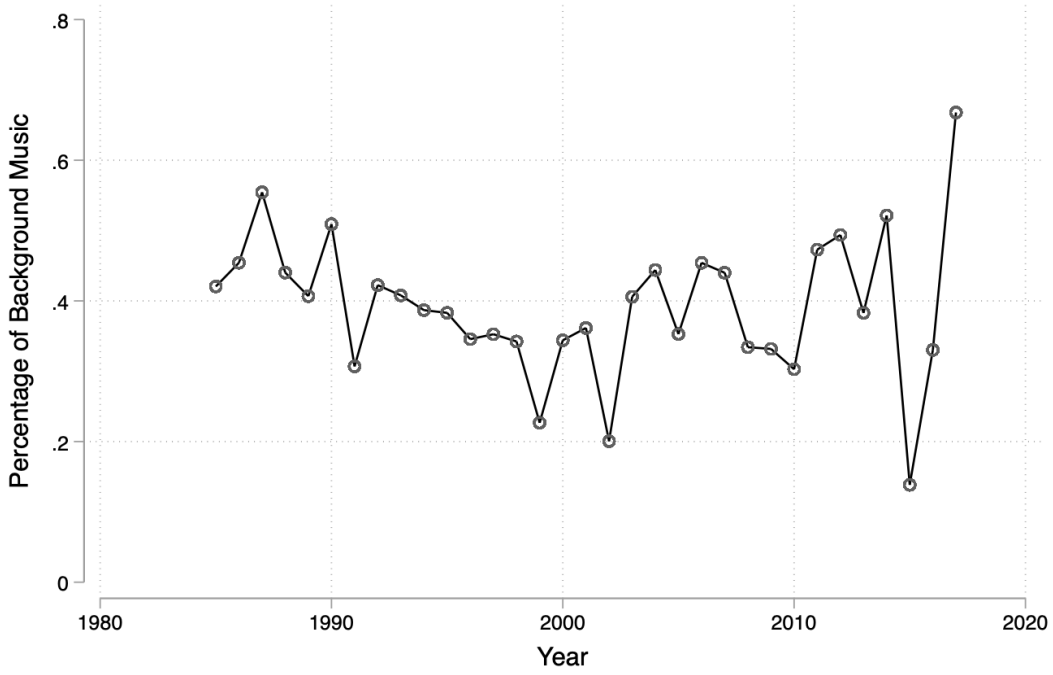
Appendix D: Women Opportunities in Digital Cultural Production

Figure D1: Actress-to-Actor Ratio Over Time



Note: This figure explores the gender composition of movie casts based on manually coded actor gender from IMDb cast data for the sample of movies we analyze. For each movie, we calculate the ratio of actresses and actors, and then we take an average for each year.

Figure D2: Percentage of Background Song Over Time



Note: This figure explores the percentage of songs that is background song over time. For each year, we count the number of background songs. A song counts as a background song if there are no actors/actresses on-screen singing the song when the song is played in the movie.

Table D1: Women Opportunities in Digital Cultural Production

	Women-Dominant Movies			Background Songs		
	No	Yes	All	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)
Digital	0.0434***	0.0591*	0.0435***	0.0430***	0.0470***	0.0361***
	(0.00592)	(0.0230)	(0.00607)	(0.00682)	(0.00878)	(0.00631)
Woman	0.0895***	0.142***	0.0895***	0.0898***	0.103***	0.0899***
	(0.00607)	(0.0203)	(0.00607)	(0.00635)	(0.0101)	(0.00634)
Digital x Woman	-0.0897***	-0.119***	-0.0897***	-0.0876***	-0.0961***	-0.0876***
	(0.00771)	(0.0233)	(0.00771)	(0.00819)	(0.0120)	(0.00819)
Indicator			-0.0321**			-0.0327***
			(0.0105)			(0.00639)
Digital x Indicator			0.0156			0.0226**
			(0.0121)			(0.00762)
Woman x Indicator			0.0520*			0.0126
			(0.0211)			(0.0110)
Digital x Woman x Indicator			-0.0290			-0.00836
			(0.0245)			(0.0133)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	7322357	1235599	8557956	5404792	3153164	8557956

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on whether the movie is women-oriented and whether the song is a background song. The sample is at the singer-gig level by year; the main outcome variable is *GotGig*. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. *Indicator* is set to one in col (3) when the movie is women-oriented, which is defined by a relatively high proportion of actresses in the movie cast (actresses-to-actor ratio > 0.7), and is set to one in col (6) for songs where there are no actors/actresses on-screen singing the song when the song is played in the movie. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \ p < 0.05$, $* * \ p < 0.01$, $* * * \ p < 0.001$

Appendix E: Gig Quality in Digital Cultural Production

Table E1: The Effect of Digital Cultural Production Accounting for Gig Quality Measures

	(1) Prod FE	(2) Song Rating	(3) Singer Popularity	(4) Box Office	(5) Solo Song
Digital	0.0451***	0.0468***	0.0459***	0.0457***	0.00396
	(0.00592)	(0.00681)	(0.0103)	(0.00730)	(0.00609)
Woman	0.0944***	0.105***	0.0153	0.0982***	0.115***
	(0.00586)	(0.00744)	(0.0181)	(0.00831)	(0.00644)
Digital x Woman	-0.0905***	-0.0943***	-0.0251	-0.0909***	-0.0799***
	(0.00734)	(0.00972)	(0.0194)	(0.0107)	(0.00929)
High		0.00826	0.0374***	0.0215**	-0.215***
		(0.00507)	(0.00944)	(0.00721)	(0.00580)
Digital x High		-0.00607	-0.00675	-0.00973	0.0888***
		(0.00666)	(0.0104)	(0.00911)	(0.00702)
Woman x High		-0.0230*	0.0884***	-0.0103	-0.0505***
		(0.00963)	(0.0189)	(0.0132)	(0.0105)
Digital x Woman x High		0.00945	-0.0669**	0.00945	-0.0135
		(0.0122)	(0.0208)	(0.0163)	(0.0133)
Year FE	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes
Production Corporation FE	Yes	No	No	No	No
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes
N	8557956	8557956	8557956	7319291	8557956

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on some gig quality measures. The sample is at the singer-gig level by year; the main outcome variable is *GotGig*. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. Production Cooperation fixed effects are added in col (1). *High* is set to one in col (2) when the rating of the song is above the median, is set to one in col (3) for there is a singer ranked in the top 100, is set to one in col (4) if the box office returns are ranked in the top 20 in that year, and is set to one in col (5) if the song is a solo. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \ p < 0.05$, $* * \ p < 0.01$, $* * * \ p < 0.001$

Appendix F: Digital Cultural Production and Allocation of Gigs Dropping Post-2010 Movies

Table F1: Digital Cultural Production and Labor Market Entry Dropping Post-2010 Movies

	Likelihood of Getting Gig		
	(1)	(2)	(3)
Digital	-0.00415	-0.00449	-0.00114
	(0.00553)	(0.00539)	(0.00583)
Debut	-0.0671**	-0.0671**	-0.0671**
	(0.0209)	(0.0209)	(0.0209)
Digital x Debut	0.215***	0.215***	0.215***
	(0.0329)	(0.0329)	(0.0329)
Year FE	Yes	Yes	Yes
Composer FE	No	No	Yes
Actor/Genre Controls	No	Yes	Yes
N	5932647	5932647	5932647

Note: This table provides OLS estimates of the likelihood that a newcomer will be hired for a digital or an analog gig. Data are at the singer-gig level, with one observation for every active singer-gig combination by calendar year and excludes movies after 2010. The outcome variable is *GotGig*; *Digital* and *Debut* are dummy variables if the focal gig is for a digital soundtrack or if the singer is making a debut in that year. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$

Table F2: Digital Cultural Production and Allocation of Gigs to Women Singers Dropping Post-2010 Movies

	Likelihood of Getting Gig			IV
	(1)	(2)	(3)	(4)
Digital	0.0407***	0.0403***	0.0437***	0.0303
	(0.00630)	(0.00617)	(0.00656)	(0.0524)
Woman	0.0962***	0.0962***	0.0963***	0.145***
	(0.00595)	(0.00595)	(0.00595)	(0.0227)
Digital x Woman	-0.0903***	-0.0901***	-0.0902***	-0.206***
	(0.00878)	(0.00879)	(0.00878)	(0.0523)
Debut		0.0335*	0.0335*	0.0328*
		(0.0165)	(0.0165)	(0.0165)
Year FE	Yes	Yes	Yes	Yes
Composer FE	No	No	Yes	No
Actor/Genre Controls	No	Yes	Yes	Yes
N	5932647	5932647	5932647	5932647

Note: This table provides OLS (1-3) and IV (4) estimates of the likelihood that a woman singer will be hired for a singing gig after digital cultural production. The sample is at the singer-gig level by calendar year and excludes movies after 2010; the main outcome variable is *GotGig*. *Digital* and *Woman* are dummy variables that equal one if either the gig is for a digital soundtrack or the singer is a woman. *Debut* indicates the first year a singer becomes active. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Column 4 provides IV estimates where *Digital* is instrumented with *AfterFire* and *Digital* x *Woman* is instrumented with *AfterFire* x *Woman*. *AfterFire* is set to one for composers after the analog studio they relied on is affected by a fire. Standard errors are clustered at the film level. $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$

Table F3: Gatekeeper and the Effects of Digital Cultural Production for Women Dropping Post-2010 Movies

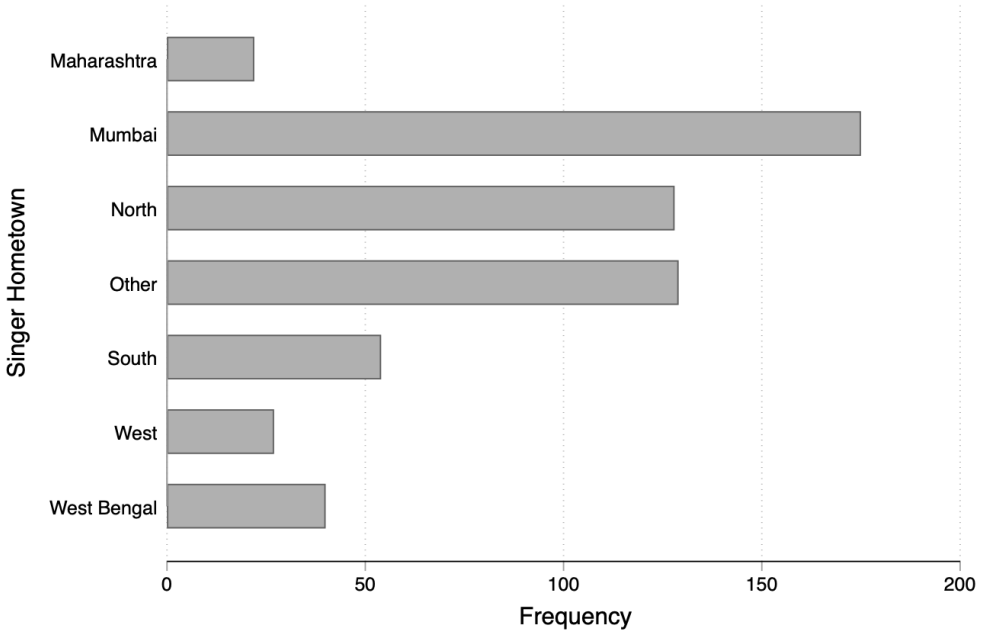
	Same Region			From Mumbai		
	No	Yes	All	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)
Digital	0.103***	0.101**	0.0427**	0.119***	0.0369	-0.00255
	(0.0144)	(0.0385)	(0.0138)	(0.0161)	(0.0193)	(0.0149)
Woman	0.268***	-0.139***	0.268***	0.310***	-0.0305	0.314***
	(0.0161)	(0.0329)	(0.0161)	(0.0190)	(0.0194)	(0.0190)
Digital x Woman	-0.245***	-0.0829	-0.245***	-0.319***	0.0103	-0.322***
	(0.0189)	(0.0454)	(0.0189)	(0.0230)	(0.0257)	(0.0230)
Indicator			-0.00607			-0.436***
			(0.0327)			(0.0195)
Digital x Indicator			0.303***			0.278***
			(0.0448)			(0.0254)
Woman x Indicator			-0.425***			-0.368***
			(0.0407)			(0.0303)
Digital x Woman x Indicator			0.164**			0.357***
			(0.0536)			(0.0376)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	3141630	757437	3899067	2510690	1206361	3717051

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on whether the singer and music director come from the same region and whether the singer comes from Mumbai. The sample is at the singer-gig level by year and excludes movies after 2010; the main outcome variable is *GotGig*. The sample size is smaller than the baseline because we only code the birthplace for singers who sing more than 4 songs and for music directors with more than 2 songs. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. *Indicator* is set to one in col (3) when the singer and music director come from the same region and is set to one in col (6) for singers who come from Mumbai. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \, p < 0.05$, $** \, p < 0.01$, $*** \, p < 0.001$

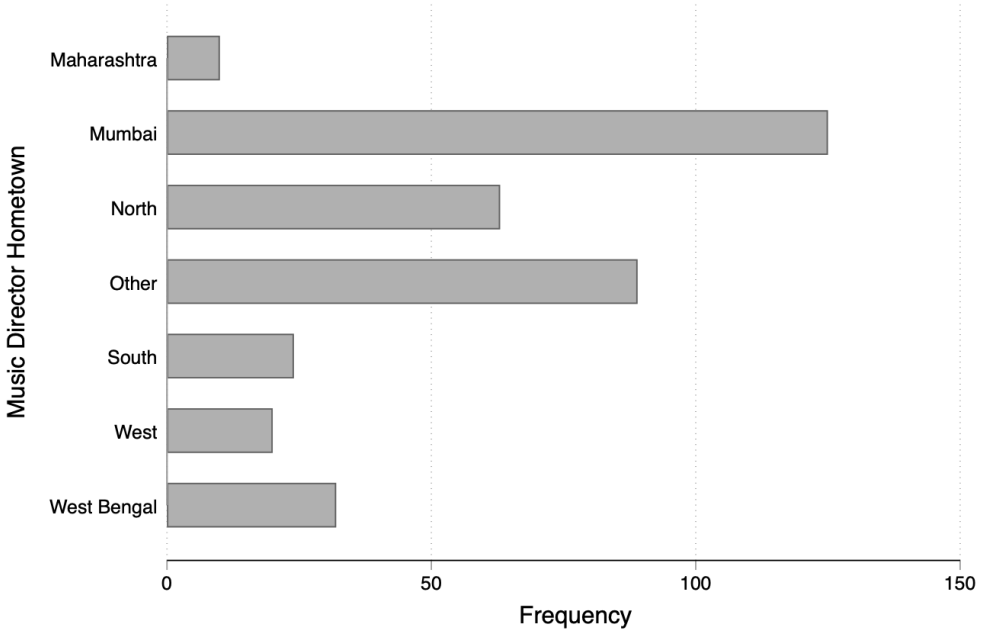
Appendix G: Distribution of Birth Regions

Figure G1: Distribution of Singers' and Music Directors' Hometown

Panel A. Singers

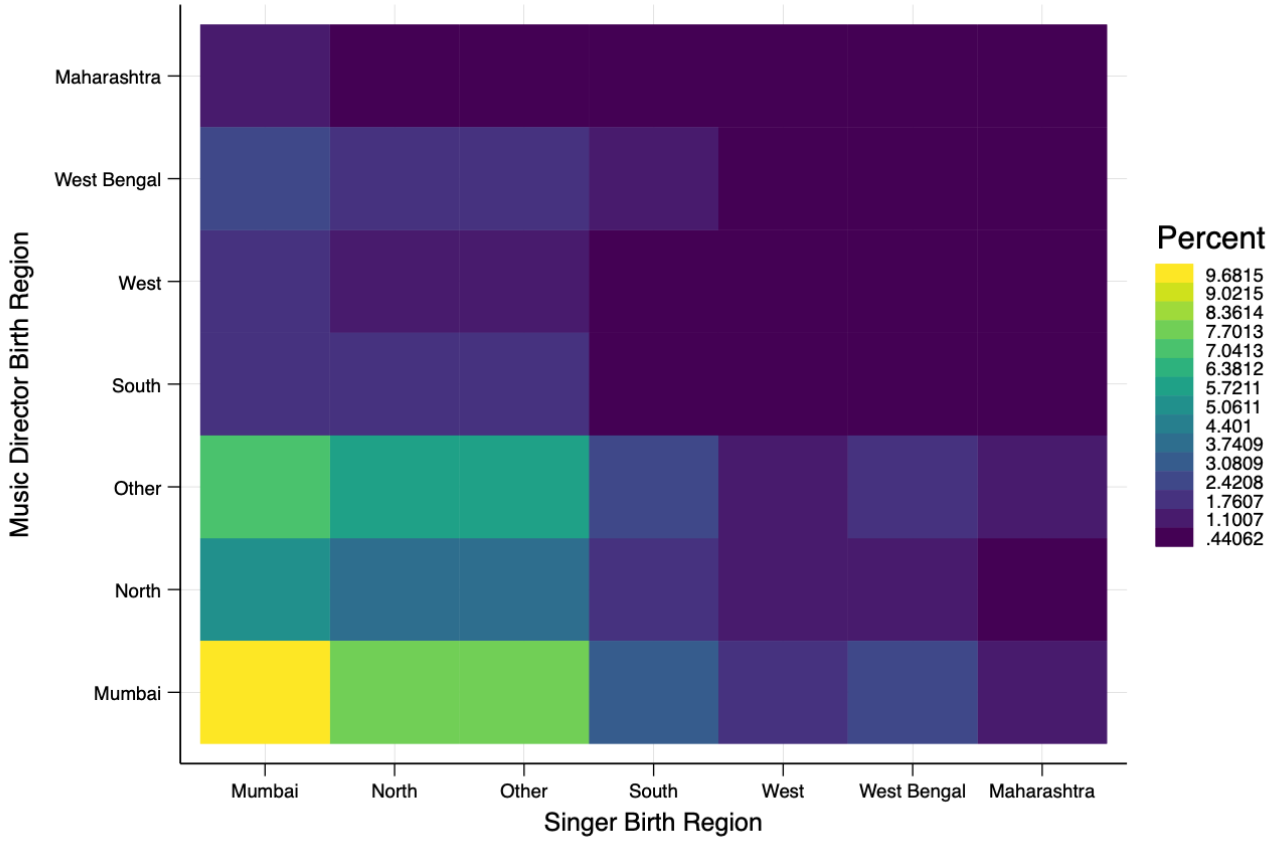


Panel B. Music Directors



Note: This figure explores the distribution of the hometown for singers and music directors. We categorize 7 regions: Mumbai, Maharashtra, West Bengal, North, South, West, and Others. North includes Punjab, Delhi, Uttar Pradesh, Haryana, Sindh, and Uttarakhand. South includes Tamil Nadu, Telangana, Karnataka, Kerala, and Andhra Pradesh. And West includes Gujarat and Rajasthan.

Figure G2: Distribution of Singer-Director Pairs



Note: This figure explores the distribution of singers-music directors birthplace pairs. We categorize 7 regions: Mumbai, Maharashtra, West Bengal, North, South, West, and Others. North includes Punjab, Delhi, Uttar Pradesh, Haryana, Sindh, and Uttarakhand. South includes Tamil Nadu, Telangana, Karnataka, Kerala, and Andhra Pradesh. And West includes Gujarat and Rajasthan.

Appendix H: Commercial Products in Digital Cultural Production

Table H1: The Effects of Digital Cultural Production for Women in Commercial Products

	Sequel			Pop		
	No	Yes	All	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)
Digital	0.0457***	0	0.0449***	0.0549***	0.0125	0.0501***
	(0.00603)	(.)	(0.00596)	(0.00776)	(0.0125)	(0.00728)
Woman	0.0956***	-0.00682	0.0956***	0.101***	0.0580***	0.101***
	(0.00589)	(0.0467)	(0.00589)	(0.00732)	(0.0142)	(0.00732)
Digital x Woman	-0.0926***	0.0227	-0.0926***	-0.0988***	-0.0524**	-0.0988***
	(0.00749)	(0.0489)	(0.00749)	(0.00989)	(0.0167)	(0.00989)
Indicator			0.0480**			0.0216*
			(0.0177)			(0.00918)
Digital x Indicator			-0.0526*			-0.0248*
			(0.0205)			(0.0108)
Woman x Indicator			-0.102*			-0.0440**
			(0.0467)			(0.0159)
Digital x Woman x Indicator			0.115*			0.0471*
			(0.0491)			(0.0191)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	8155997	401959	8557956	3044973	1141578	4186551

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on whether the movie is a sequel and whether the song is a pop song. The sample is at the singer-gig level by year; the main outcome variable is *GotGig*. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. *Indicator* is set to one in col (3) when the movie is a sequel and is set to one in col (6) for pop songs. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \ p < 0.05$, $* * \ p < 0.01$, $* * * \ p < 0.001$

Appendix I: Estimating Audience Endorsement Using Alternative Sample

Table I1: Audience Endorsements and Digital Cultural Production Excluding Same Region

	Rating			Reality Show Participant		
	Low	High	All	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)
Digital	0.118***	0.0384	0.0664***	0.186***	-0.160**	0.119***
	(0.0164)	(0.0273)	(0.0152)	(0.0207)	(0.0593)	(0.0194)
Woman	0.314***	0.00720	0.314***	0.544***	-0.277***	0.544***
	(0.0183)	(0.0194)	(0.0183)	(0.0238)	(0.0650)	(0.0239)
Digital x Woman	-0.291***	-0.00215	-0.291***	-0.511***	0.383***	-0.511***
	(0.0214)	(0.0274)	(0.0214)	(0.0283)	(0.0770)	(0.0283)
Indicator			-0.558***			-0.0791
			(0.0197)			(0.0551)
Digital x Indicator			0.355***			0.122*
			(0.0254)			(0.0617)
Woman x Indicator			-0.355***			-0.818***
			(0.0282)			(0.0762)
Digital x Woman x Indicator			0.337***			0.894***
			(0.0363)			(0.0890)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	2771110	370520	3141630	2035337	312522	2347859

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on audience ratings of their music and their participation in musical reality shows. The sample is at the singer-gig level by year with only songs for which singers are not from the same state as the music director; the main outcome variable is *GotGig*. The sample for columns 4–6 is smaller than the baseline sample because it includes only singers for whom we found reality-show participation. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. *High* is set to one in col (3) for singers with ratings of 4 stars or above for their music and is set to one in col (6) for singers who had participated in a reality show. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \ p < 0.05$, $* * \ p < 0.01$, $* * * \ p < 0.001$

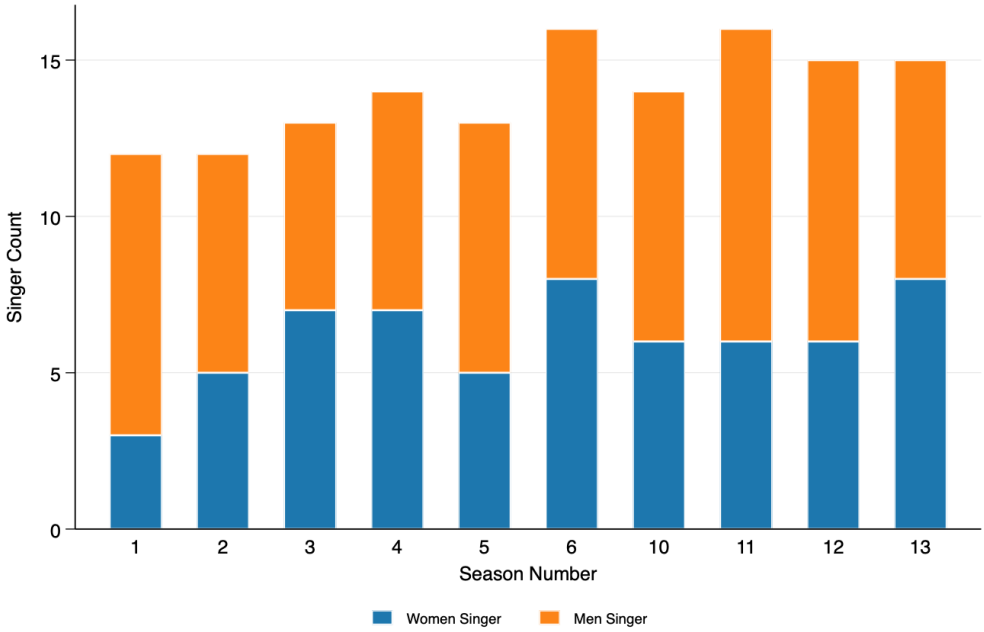
Table I2: Audience Endorsements and Digital Cultural Production with Excluding Mumbai-Born Singers

	Rating			Reality Show Participant		
	Low	High	All	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)
Digital	0.143***	0.0527	0.0738***	0.225***	-0.185**	0.116***
	(0.0186)	(0.0306)	(0.0173)	(0.0220)	(0.0682)	(0.0211)
Woman	0.390***	-0.00665	0.391***	0.733***	-0.333***	0.736***
	(0.0223)	(0.0199)	(0.0222)	(0.0292)	(0.0719)	(0.0291)
Digital x Woman	-0.400***	-0.0239	-0.400***	-0.725***	0.369***	-0.726***
	(0.0269)	(0.0314)	(0.0269)	(0.0351)	(0.0859)	(0.0350)
Indicator			-0.740***			-0.200**
			(0.0238)			(0.0632)
Digital x Indicator			0.464***			0.312***
			(0.0323)			(0.0733)
Woman x Indicator			-0.464***			-1.041***
			(0.0313)			(0.0872)
Digital x Woman x Indicator			0.426***			1.075***
			(0.0442)			(0.102)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	2198686	312004	2510690	1674514	284172	1958686

Note: This table provides OLS estimates of the differential effect of digital cultural production on men and women singers, depending on audience ratings of their music and their participation in musical reality shows. The sample is at the singer-gig level by year with only singers who are not from Mumbai; the main outcome variable is *GotGig*. The sample for columns 4–6 is smaller than the baseline sample because it includes only singers for whom we found reality-show participation. *Digital* and *Woman* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is a woman. *High* is set to one in col (3) for singers with ratings of 4 stars or above for their music and is set to one in col (6) for singers who had participated in a reality show. Actor/Genre Controls control for the count of men and women actors in the cast and the genre of the song (e.g., pop or classical). Standard errors are clustered at the film level. $* \ p < 0.05$, $* * \ p < 0.01$, $* * * \ p < 0.001$

Appendix J: Additional Figures

Figure J1: Number of Indian Idol Contestants by Gender



Note: This figure explores the gender composition of the participants of a popular reality show: Indian Idol. The information about participants is collected from Wikipedia: $https://en.wikipedia.org/wiki/Indian\_Idol\_(Hindi\_TV\_series)$. Seasons 7 to 9 are missing due to incomplete data.