Singing Your Own Praises:
Digital Cultural Production and Gender Inequality*

Abhishek Nagaraj
University of California, Berkeley
nagaraj@berkeley.edu

Aruna Ranganathan
University of California, Berkeley
arunar@berkeley.edu

February 7, 2022

ABSTRACT

New technologies are constantly transforming how culture is produced. Production-of-culture scholars have long posited that technological change influences the diversity of content in cultural fields. But how does such change affect demographic diversity among producers of culture? We study the advent of digital recording technologies in the production of music, and ask whether their adoption has shifted the allocation of artistic gigs between male and female artists. If so, how? Specifically, we argue that digital cultural production has the potential to *increase* gender inequality. Digitization reduces barriers to entry, but also necessitates greater self-promotion on the part of artists to stand out in a crowded labor market. Insofar as male artists can promote themselves more readily than can female artists, digital cultural production inadvertently increases the allocation of artistic gigs to male artists, though this self-promotion deficit can be mitigated when women benefit from audience endorsements. We develop and test this theory using in-depth interviews and a novel quantitative dataset relating to the labor market for studio singers in the Indian Hindi film industry ("Bollywood"). This paper contributes to the study of culture, technology, labor markets and gender, and explores the implications of technological change for women in the arts.

The production-of-culture thesis posits that technological change is a key driver of the diversity of content in cultural fields such as music, film, and television (Peterson and Berger 1972). Technology provides the tools with which people and institutions supplement their abilities to produce content, and changes in technology often create new opportunities in art and culture (Peterson and Anand 2004). For example, the advent of television led to the creation of diverse content intended for household consumption by mass audiences, such as sitcoms, and also created opportunities for film to adapt (Baumann 2001). Similarly, the vinyl 45-rpm record contributed to the advent of rock music (Peterson 1990), and affordable and portable cassette-tape players promoted diverse popular-music genres (Manuel 1993).

Though scholars have documented how technological change has diversified cultural content, its effect on the diversity of cultural producers themselves has been less studied. In particular, women are dramatically underrepresented in various cultural fields (Bielby and Bielby 1992); in the United States, only 9% of film directors, 25% of musicians and architects, 28% of advertising creatives, and 30% of television writers are women (U.S. Department of Labor, 2012; Hunt, 2013; Rickley, 2013; Grow and Deng, 2014; Smith et al., 2019). Scholars have begun to investigate predictors of the lack of gender diversity in cultural markets, such as gender differences within professional networks (Lutter 2015, Kuppuswamy and Younkin 2019, Askin et al. 2021). Given that new technologies are constantly transforming the production of culture, however, it is important to investigate whether technological changes help or hurt the representation of women in cultural markets.

The digital revolution is undeniably transforming the production of culture (Ryan and Peterson 1992, Klinenberg and Benzecry 2005, Waldfogel 2018). Cultural products are increasingly crafted through digital tools: artists can easily alter and repackage digitally produced

videos, rappers can digitally sample and remix tunes in new ways, and photographers can correct errors with the click of a mouse. Such *digital cultural production* is having a profound effect on the diversity of culture, enabling new forms of content; but how is it affecting the diversity of cultural producers themselves? In particular, how is the shift to digital cultural production affecting the allocation of gigs to male and female artists, and what mechanisms drive these effects? That is the question this paper tackles.

We argue that digital cultural production has the potential to increase gender inequality in cultural markets. In particular, we assert that digitization reduces barriers to entry into various cultural fields, flooding the labor market with new entrants. Thus cultural producers need to promote themselves more assiduously to stand out from their peers and secure gigs. Insofar as men are better able to self-promote than women, we argue that adoption of digital technologies will result in greater allocation of gigs to male artists than to their female counterparts. We further argue that audience endorsements—via, for example, reality shows and hits—help women artists in particular to overcome their self-promotion deficit and secure artistic gigs even in the context of digital production. This argument has important implications for theory and for practice. On the one hand, our theory is aligned with the popular narrative that digitization democratizes entry. But by making a distinction between entry and continued success, we suggest that the same phenomenon might inadvertently introduce gender inequality into cultural marketplaces by reinforcing pre-existing structural barriers faced by women.

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. Most of its films are musicals, and there is a thriving market for studio singers (male and female) to record songs for soundtracks. In the late 1990s, rapid adoption of

digital recording technology transformed music production by facilitating multiple takes and allowing for post-hoc error correction. We examine how adoption of digital recording affected the allocation of gigs to male and female studio singers in this cultural market.

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 two hypotheses, on the entry of new singers and on increasing gender inequality in the market following adoption of digital recording, as well as two additional hypotheses delineating the roles of self-promotion and of audience endorsements in securing artistic gigs.

To test these hypotheses, we built a unique dataset to track the singers of over 12,000 songs performed in approximately 1,600 films between 1985 and 2017. Using novel data on the technical talent employed in a given film's music and sound department crews (derived from films' credits), we tracked whether a particular song was recorded using analog or digital technology. We match this core dataset with a host of additional data from third-party sources, including singers' self-promotional activities on YouTube, participation in reality shows, and crowd-sourced music ratings, as well as the gender composition of a film's cast and the genre categories of recorded songs. 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 on a given film.

Our study makes three contributions to scholarship on the production of culture. First, we draw attention to the role of technological change in shaping diversity among cultural producers. Our argument complements the production-of-culture hypothesis with a "producer-of-culture"

hypothesis: that technological change affects not just *what* is produced but also *who* produces it. Second, despite narratives suggesting that digitization uniformly propels the careers of underrepresented artists, we show that adoption of digital technologies can exacerbate gender inequality in cultural markets. Third, we unpack how, counterintuitively, by democratizing entry into cultural fields, digital technologies might disadvantage female artists and engender demographic inequality. Our study also contributes to scholarship on gender diversity in creative industries. We first highlight a novel mechanism of gender differences in self-promotion that might explain why women continue to account for a much smaller share of the market in cultural industries than men. We also show that audience endorsements, via channels like reality shows and hits, can help women overcome barriers to success in cultural industries.

TECHNOLOGICAL CHANGE AND DIVERSITY IN CULTURAL MARKETS
Technological Change and Cultural Diversity

Scholars have long recognized that the production of culture results from interplay between actors and the technologies at their disposal (Dowd 2004). This perspective—that culture is shaped by the systems used in its production, including technological systems—has come to be known as the production-of-culture thesis (Peterson and Berger 1975, Peterson and Anand 2004). The literature offers several examples of new technologies' transformation of cultural output; the introduction of the electric guitar, for instance, expanded the musical vocabulary of rock music (Peterson 1990, Waksman 1999). Similarly, innovations in film technology made it possible for films to be long enough to tell complex stories (Baumann 2001). And advances in paint technology increased the array of available colors and broadened the range of locations where artists could paint (White and White 1965).

Scholars have shown that these technologies can give rise to new genres and new kinds of art, and thus can increase diversity in cultural offerings (Peterson and Berger 1972, 1975). For example, the spread of new percussive technology, such as drum machines, gave rise to the dance, disco, and new-wave genres (Mauch et al 2015: 5). Scholars have argued that it is not solely the technologies used to produce culture, but also innovations in the technologies used to reproduce and disseminate culture, that promote cultural diversity. For example, the advent of affordable and portable cassette-tape players in India in the 1980s created demand for music on cassettes, leading to increased diversity in popular music genres (Manuel 1993).

Among the most significant technological transformations to affect the production of culture in recent times is the rise of digital technologies and digital cultural production (Peterson and Anand 2004). Computer-aided digital technology constitutes an integrated system that has permanently changed virtually every aspect of the production of culture in ways that are only now only becoming apparent (Ryan and Peterson 1993). The most fundamental effect of digitization is to restructure when, where and how the daily work processes of cultural production are performed (Klinenberg and Benzecry 2005). For example, the digitization of music allows for post-hoc pitch correction for singers unable to carry a tune (Peterson and Ryan 2004). Similarly, digital networks and their supportive infrastructure allow cultural producers to instantaneously transmit enormous amounts of information—audio, video, text, graphics, databases, and combinations of them all—across the globe, giving rise to practices like digital sampling in rap music (Kealy 1979, Bennett 1999, Lena 2003, Hesmondhalgh 2000).

This shift to digital cultural production, like prior technological innovations, is affecting the diversity of cultural content. In some cases, the result is new forms of culture. In the early 2000s, for example, blogging became a popular and increasingly influential form of online

cultural production— so much so that, in 2004, presidential candidates and other public figures began blogging to attract attention online (Klinenberg and Benzecry 2005). Digitization has also altered the loci of cultural production. The rise of "bedroom studios" outfitted with digital recording technology has enabled towns once dismissed as cultural backwaters to become thriving dance scenes, giving rise to an independent sector of the British dance-music industry (Randall 1992, Green 1996, Durant 1991, Hesmondhalgh 1998).

The literature has shown that digital cultural production can increase the diversity of cultural content. But what effect does it have on the labor-market prospects of different groups of cultural producers? If digital technologies are affecting the production of culture, they should affect the producers of that culture as well. Research from the production-of-culture perspective indicates that, when a new technology emerges, roles change and careers are made or lost (Ryan and Peterson 1993). Yet we have little insight into how adoption of digital technologies affects diversity among cultural producers themselves.

Some scholars argue that the digital age represents a revolutionary moment that promises to democratize cultural production (Toop 1995). These commentators are optimistic that the ubiquity of digital tools will disrupt patterns of inequality and help women and underrepresented minorities (Erigha 2015). For example, new platforms like YouTube could attract a wider range of content from a diverse array of cultural producers (Qu 2021). Similarly, because rap is inexpensive to produce with digital recording technologies, a whole generation of enterprising African-Americans could gain greater control over their own creative efforts and establish themselves as music producers (Ryan and Peterson 1993).

Other scholars argue that the uses of digital technology in the production of culture will maintain existing workplace norms and biases, and thus have no effect on diversity among

cultural producers (Grazian 2005). Some even expect technological change to actively harm minorities, such as women, by further empowering gatekeepers to block or facilitate the exposure of new artists (Toop 1984, Lopes 1992). These skeptics invoke past precedent when new media, such as radio and MTV, excluded black and female artists (Toop 1984, Denisoff 1986; Flanagan 1989). To weigh these contradictory perspectives, this paper focuses on gender diversity to ask how the shift to digital cultural production affects allocation of jobs to male and female artists.

Gender Diversity among Cultural Producers

Scholars have long shown that there is gender inequality in cultural markets. Compared to male television writers, women earn 11 to 25 percent less throughout their careers (Bielby and Bielby 1992). White men write about three-quarters of all scripts for Hollywood feature films and television series (Bielby and Bielby 1996). Female television writers are less likely than men to be executive producers of prime-time network series; in film, they are much less likely than men to be hired to produce and direct or to write (Bielby and Bielby 2002). This phenomenon is not restricted to film and television writers. A number of ethnographic studies capture the precariousness of the roles that women play as musicians, rappers and producers in various contemporary music scenes (for a review of the literature, see Grazian 2005). Other scholars have documented gender inequality among fashion designers (Stokes 2015), scientists (Tuchman 1989), and artists (Miller 2016).

Several mechanisms have been invoked to explain gender inequality in cultural markets. First, female cultural producers tend to wield less social capital than their similarly situated male counterparts. Male cultural producers are more apt to be insiders and to have broad and open professional networks (Lutter 2015). As a result, they tend to be better known, more likely to be

recruited, and perceived as better bets than equally successful female counterparts (Bielby and Bielby 2002, Grugulis and Stoyanova 2012). This pattern is surprising in light of new work showing that audiences prefer films with identifiably diverse casts (Kuppuswamy and Younkin 2020) and that, when men collaborate with women artists, their work is more novel (Askin et al 2021). Second, women are subject to typecasting and stereotyping that prevent them from getting their due as cultural producers (Zuckerman 1999, Goldin and Rouse 2000). For instance, women are seen as being better suited to the piano than the cello (DeNora 2002). Similarly, the bass is seen as a suitable instrument for women because it calls for an innate sense of rhythm, a quality widely attributed to women (Clawson 1999). Such typecasting limits women's professional opportunities in cultural markets. Finally, most artists are hired by specialized (often male) gatekeepers for short-term projects based on inherently ambiguous aesthetic criteria (Hirsch 1972, Bielby and Bielby 1992).[1] Given the high levels of ambiguity, risk, and uncertainty surrounding employment decisions, social similarity and gender stereotypes are likely to prevail in employment decisions, disadvantaging women.

Little attention has been paid in the literature to the role of technological change in mitigating or exacerbating gender inequality in cultural markets. Given that digital technology is revolutionary in its consequences, this is an important omission. One narrative asserts that digital technologies democratize cultural production and thus allow women to create and disseminate content to wide audiences; other scholars are skeptical (Snow 2001, Jenkins 2006, Bennett and Strange 2011). Both points of view are speculation; systematic studies of the question have yet to emerge. To address the void in the literature, we investigate systematically whether the adoption of digital technologies hurts or helps women singers and if so, how.

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[1] See Luo and Zhang (2021) for an example of female gatekeepers hiring more women, reducing gender inequality.

SETTING: BOLLYWOOD PLAYBACK SINGING

Our focus is India's Hindi-language film industry, based in Mumbai and often pejoratively called "Bollywood"; we will use the term *the Hindi film industry*. 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.[2] 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.[3]

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 film music's market share is small compared to that of independent music, in India popular music consists largely of film soundtracks, which have broad appeal across the nation. Each soundtrack consists of multiple songs sung by professional "playback" singers largely based in Mumbai. Both male and female singers are hired to serve as the screen actors' singing voices. However 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 lip-synched by 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. Being hired to sing in a

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

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

film is consequential for the singers, who are 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 can also generate other labor-market opportunities, notably live shows, and can confer status (DiCola 2013); popular film songs are prominent in the prevailing cultural conversation about music in India. In this context, film journalists have documented that today, female singers face a "lack of opportunities" and are treated as "second-class citizens" as compared to their male counterparts (Mukherjee 2017).

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; 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 "digital audio workstations" (DAWs), that 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.[4] Given the low cost and reduced space requirements of digital recording, new studios cropped up in Mumbai which were outfitted with DAWs. This paper asks how the shift to digital recording has affected the assignment of Hindi film songs to male and female 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 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 female singers, 5 male 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.[5] We tried to interview a diverse set of individuals with a focus on recruiting (a) a mix of male and female 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

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[4] Note that digital recording technologies did not, by design, favor men over women.
[5] www.bollywoodhelpline.com

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. The interviews followed a protocol and focused on respondents' experiences recording for analog and digital films, 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 male and female 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 Technology and the Labor Market for Studio Singers

As a first step, the interviews elucidated how recordings were conducted using analog technology. As one male singer (I04) 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, they 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]. And it was also, in the analog systems, that you have to go right from the beginning and start all over again. 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). Our interviewees described the extraordinary skill that analog recording technology required of singers: "the type of pressure under which these singers must have worked . . . is unimaginable today" (I25). One male singer (I08) explained:

> In playback singing, . . you have to be perfect. . . . Why? Because you are singing, there is another singer with you, maybe two singers with you, chorus singers, 70–100 musicians playing with you. . . . So you have to be very, very proficient and ready to sing . . . because if you make one mistake, everything will have to be done again, right from the beginning. . . . So we had to know everything by heart, not even words [lyrics] mistakes could be made.

Another singer added that 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). A male singer (I04) concurred: "These guys in the old days had just one take. And they had to do it right. So everything—expression, pitch, timing—everything had to be perfect." Singers also described the pressure to perform and to deliver a good take. "When you came onto the floor, you were supposed to deliver, you were meant to deliver," one female singer (I11) said. "Yeah, and you just delivered. So if anybody made a mistake, then we had to go through it all over again. There was no question of different track recordings or punching or, you know, taking out one word or putting another thing or correcting it over here. No, you had to redo the whole thing." Another female singer (I10) 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 female singer (I02) 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." A composer (I07) 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." Another female singer (I11) 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."

Then, in the late 1990s, a slow technological shift from analog to digital technology began to transform how music was recorded, and thus 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). Another composer (I01) elaborated:

> Now, when it went digital, now we sat at home, 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, 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 composer (I07) 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, composer). The digital technology also offered copy-and-paste functionalities, which reduced pressures on signers for precision and consistency. A male singer (I08) 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 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). A composer (I07) 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; the doors were now open to new entrants. A composer (I20) 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) 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). A female singer quoted earlier (I22) 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) 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 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 Gender Diversity among Singers

Even if more singers are finding opportunities in the industry, as the previous subsection suggests, they are not necessarily working consistently or building careers in the industry. Many interviewees alluded to "one-hit wonders" (I05) who "just sing one song and disappear" (I01).

And given 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) declared. "You have people releasing stuff on YouTube. And reality shows are too many—and real good talent, also, you get to see." A singer (I08) 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) 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) 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 male singer (I22) 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 (I20) 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.

Female 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, though digital cultural production has enlarged the pool of singers now able to garner lucrative gigs, it has not benefited female singers at the same rate as it has male singers. Ironically, 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 gigs.

Mechanism: Gender Differences in Self-Promotion

We next sought to understand why the advent of digital technology might be diminishing women's chances of getting singing gigs. What we discovered is that, when barriers to entry are low, singers need to promote themselves in order to work consistently; in other words, they need to remind composers of their existence repeatedly. Our data suggest that male singers were better at doing so than women.

The increased importance of self-promotion was a consistent theme in our interviews. A music critic (I03) explained:

> So today it's become necessary to maintain your brand in a lot of ways. For example, you can do shows, you can do a lot of stuff, . . . like a mall may decide to have an event to promote a car, and therefore they'll call singers. And there are lots of these promotional activities and other things that happen around films. Earlier, it was just you either sang in a film or you sang on stage in a concert. Today it's become a lot more, as singers can start releasing YouTube videos if they feel that they have creativity that is not being explored by the industry.

A composer (I07) agreed:

> Today, singers need to focus on other things [apart from singing]. . . . It's about controlling the Spotify . . . and here's YouTube: make your video—here's your phone, shoot your

video, put it up on YouTube— . . . . Your PR skills are very important today. In the earlier days, you didn't need to do PR. Today your PR agent for social media and for press and whatever, public relations, could be a PR agency. . . . 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.

To convey the importance of self-promotion, a singer (I04) who hadn't been offered much work since the advent of digital production described a colleague:

I'll talk about Clinton. . . . So, you know, when I see the kind of songs that they're releasing on Insta and Facebook, the videos they come out with, and the photo shoots that they do . . . very, very, very trendy, very; it's just loaded with a lot of swag. And that is what is . . . getting the response from the Instagram crowd and Facebook—it's a lot of positive feedback, which is working for them. Not only is their music fabulous; their look is . . . they look really, really cool. And that's what everyone wants to see; the composers want to see that. And not only the way they are projected, the way they are marketed is just fabulous. So that's what is required today. Yes, it's an all-round package. It has to be an all-round package.

A composer (I09) added:

You have to try to do something which is, out of Bollywood to create your own identity, to create your own band, to create your own music. . . . There are so many avenues available now, so make use of all that. . . . All they have to do is put up their single on YouTube. . . . If somebody sees you who's got a requirement for a particular musical gig, he'll contact you.

There appeared to be a consensus that singers had "to be pushy" (I01) and "keep promoting themselves" (I20). Our data suggest, however, that women promoted themselves less than their male counterparts did. Women seemed to view self-promotion with distaste; they also faced familial opposition and backlash if they tried to promote themselves, and had less access to resources and capital to self-promote than their male peers did. Describing her lack of interest in self-promotion, one female singer (I10) said:

My family says, the reason why I'm not like this—I'm not like a mega-mega-superstar with 50,000 hits—. . . is because, you know, a lot of shit comes with the territory. You've got to be hobnobbing at parties. Nothing wrong with that. Let me, let me—you have your methodology; I have mine. I don't do that. I am not interested. I'm not here to win a popularity contest.

Another singer (I02), who no longer received offers of work after the advent of digital recording, and who eventually left the industry, expressed a similar sentiment: "I didn't want to remain in an industry in which every day and every song is a new test paper for you. In Bollywood today, you have to prove yourself every day . . . put yourself out there. Otherwise you won't get work."

Other female singers reported that their families were uneasy if they went on the road or promoted themselves. One composer (I07) described this phenomenon:

> The female singers are constrained, . . . chaperoned by their mothers . . . for safety or whatever. . . . They'll say "I have to look after my daughter. . . . It's the film industry, she's young." . . . Happens for boys too, but it's way worse for girls. . . . But today, it's like . . . "Please, don't bring your mom, come alone."

Another female singer (I05) had to decline a promotional opportunity because her parents wouldn't let her travel to London: "They had asked me to travel to London to do the show. But I didn't go because my parents were petrified of Bollywood. And they thought it was like some really . . . [unsafe] area and their innocent daughter is going to be eaten up. So they were like, 'No going to London' and all, and 'Go where we can be with you.' Stuff like that constrains you."

Women also described being expected to conform to a feminine ideal that entailed not promoting themselves. One of the rare female singers (I10) who has succeeded in the digital era described how she had eluded restrictive codes of behavior:

> This is as old as the stone ages, when women have been looked at as weak people . . . who shouldn't say much. There are feminine rules, . . but there should be no underselling of yourself as a human being. As human beings, god has made all of us equal. I am on par with anybody. I don't even think of myself as a woman. I'm very clear with that mission, very clear. I am not there to go "Hee hee, hoo hoo." None of that. I'll stand for my work.

Finally, women reported that self-promotion is expensive and that they lacked both the capital to make stylish YouTube videos and donors to support them. One female singer (I05) said:

It's very expensive. You can do it with small technology, small stuff and small budgets and all that. But if you want to make an impact, if you want to be a star out there, you have to have some classy work done. You can't just do ordinary stuff. You'll be remembered as ordinary.

Another female singer (I24) said, "To get a gig, you will have to show them your YouTube song, but . . . who's going to invest in your video? . . . This is very important; at this point it is very important. You believe in yourself, you see yourself out there, you connect with the universe, because it's difficult for us women to do solo albums and independent stuff, where you will need so much of promotion, my goodness. But that one independent song can give you a natural promotion."

This testimony suggests that, though self-promotion is critical to success in an expanded labor market, women are unable to self-promote as forcefully as men, thus constraining their labor-market opportunities. Based on this evidence, we propose:

H3: Digital cultural production hurts women because they are less likely than men to self-promote.

The Importance of Audience Endorsements for Female Singers

While women's self-promotion handicap was clear, our data suggested that audience endorsements might help alleviate this handicap. 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 industry decision-makers. Pointing out the role of audience endorsements, one singer (I15) 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 female singers' careers. Both types of endorsement gave women singers the boost they needed to stay in the mix; male singers also benefited but less.

Interviewees confirmed that the support of reality shows' audiences help bring singers to composers' attention. One male singer (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 male singer (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 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.

A third male singer (I06) added: "I appreciate every platform which gives newcomers an opportunity to perform and get introduced with the larger-than-life kind of audiences. Earlier, people didn't have that many platforms."[6] A composer (I09) added: "Everybody's watching you; what else you need? But then that is where their work starts, after you achieve that recognition. How hard you work, what is it that you work on, what are the projects that you accept, what do you do? So reality shows, they really, really help you. Main thing is to get work, OK? So definitely, reality shows help talent in a very, very, very big way."

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[6] 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.

Agreement appeared to be widespread that women singers in particular benefited from reality shows as a platform to showcase their work. One composer (I09) 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) also mentioned Shreya Ghoshal, who gained prominence from a reality show:

> I'm pretty sure that there are 100 female 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.

A female singer (I05) described having found work only after getting audience endorsement via a reality show: "I wasn't getting any work. Then what happened was, I was in college, and I got the opportunity to travel to Germany to attend and participate in the 16th Pop Song Festival in Germany. . . . And after winning the Grand Prix, I was also adjudicated as the audience darling there. Got that award as well. . . . And . . . that's when I . . . came back home, and there was this composer, one of the well-known ones, and he approached me to sing a song since I'd won the Grand Prix."

Like reality shows, hit songs benefited female singers by demonstrating audience

approval. One female singer (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 female singer (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.

A third singer (I15) described how a hit song had made her a contender in the industry:

> So Anil [a music arranger] must have heard my first hit song, and he was working with Bappi, Bappi Da [a composer]. So he must have said that "Listen, yeah, there's this Christian girl and . . . she's got something unique and fresh about her." And I mean, that's how it happened. I'm sure he didn't say "She's fantastic" or anything, because I wasn't. But I was fresh, I was new; my pitch was on point. And I was raw but I was enthusiastic. And they say when destiny and opportunity meet—I mean, that moment had to have happened. . . . And that was the start of my life's journey, really.

Hit songs benefited male singers too, but seemed to matter less. One male singer (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.

Another male singer (I18) concurred:

> More than a break, I'd say . . . I was able to get work after work, with high speed, because I never got a brake; I got an accelerator [*laughter at his own pun*]. Incidentally, . . . I never aimed to do playback singing; I always aimed to do albums. But at that time, I think it was

a transition of music industry, and the industry opened up to new voices. And I didn't really need to establish myself or have a hit; I just started getting work.

Our evidence points to a unique role for audience endorsements, via reality shows and hit songs, in promoting the work of female singers and helping them to overcome their self-promotion deficit. Thus we hypothesize:

H4: Digital cultural production's negative impact on women is less severe among reality-show participants and highly rated singers.

QUANTITATIVE DATA AND MEASURES

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

Building Our Dataset

No single database offered all the information we needed; thus we 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 characterizing each film, including the size of its cast, the gender of each cast member, and the name of the composer; (d) singers' self-promotional activities on YouTube; 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 commercially important films. 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 male or female based on their first names and familiarity with them. 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, an interviewee (I15) who studies the history of Indian cinema informed us, while discussing "*Hum Dil De Chuke Sanam*" (one of the first Hindi film soundtracks to be digitally recorded):

> 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 A 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 singers' self-promotion, we turned to YouTube. Though a singer can self-promote in multiple ways, including networking and stage shows, lack of data on these offline activities makes YouTube an excellent alternative. As our qualitative data suggested,

YouTube is the primary online platform for Indian film music, with over 400 million monthly active users.[7] Both experienced and new singers use the platform to upload original music, covers, and other types of videos to promote their talents to the public and to composers, who are known to scour the platform for new talent. Not all singers have official YouTube "channels" (specialized accounts to distribute music), but we identified a subset who do. Using the YouTube API, we were able to measure their activity on the platform, including how many songs they had uploaded.

To understand singers' participation in reality shows, we had a research assistant manually search the internet (including Wikipedia) for biographies of singers who had sung more than four of the songs 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.

Jointly, HGM, the *Hindustan Times*, IMDb film credits, MySwar, and singer-level data on YouTube engagement and reality-show participation provide a rich overview of the Hindi film music industry's labor market and technological choices 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 music 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

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[7] https://techcrunch.com/2021/01/11/youtube-and-whatsapp-inch-closer-to-half-a-billion-users-in-india/

may have many singers.[8] We strive to avoid selecting on the dependent variable, which we would be doing if we considered only 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 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 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 B 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 8,546,939 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

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[8] 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.

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.[9] We define *Female* as a dummy variable set to one for female 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 *Female* variable to examine H2.

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 male and female cast members in a given film and control for the natural potential for female or male singers to be 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 male or female singers.

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

Mechanism Variables. To measure the extent to which singers self-promote, we manually searched YouTube channels for any singer with more than four songs in our dataset.[10] Of these, 388 had at least one official channel on YouTube. We define *High Video Uploads* as a dummy variable that equals one if a given singer has uploaded more than the median number of videos on a YouTube channel (38). We can use this variable to test H3. Note that we use this variable as a proxy for singers' tendency to self-promote via both offline and online channels.[11] 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.

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 female; about 59% of gigs are digital. The average film in the sample features 19.6 male and 7.7 female actors. Though we will control for different genres, note that on average 27% of gigs belong to the pop genre.

Panel B describes the labor markets for male and female singers respectively. A total of 956 male singers sang at least one song in a film; only 547 female singers did so, a pattern that suggests some labor-market bias in this market. Men also appear to have uploaded more YouTube videos than women (73 vs. 67, a difference of about 10%). Participants in reality shows represented 16% of men and 21% of women; their songs' average crowdsourced ratings

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[10] Searching for all singers was not feasible given their large number.
[11] Digital self-promotion via YouTube is not to be confused with our key independent variable, the adoption of digital recording technologies.

on HGM are similar at about 3.5 stars out of 5, suggesting no difference in audience preferences between male and female singers.

INSERT TABLE 1 HERE

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 male singers over female singers and we also control for song genre. In Appendix C, we plot the share of male cast members in the films in our sample by calendar year. This plot shows that the share of male cast members in major Hindi language films is constant or somewhat declining from a level of about 70-75% before the year 2000 to 65-70% post 2000. Despite this pattern, we explicitly control for the gender composition off the film's cast for additional robustness. Such a specification can be used to examine entry (H1), gender allocation of jobs (H2), and the roles of self-promotion (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 male and female cast members and genre of

the gig. Standard errors are clustered at the level of the individual film, since the treatment

(digital cultural production) varies at this level; that is, because all gigs in a given film have the

same treatment status, it is important to adjust for serial correlation within each film (Abadie et

al 2017).

The estimates from this specification appear in Table 2. Column (1) includes composer

FEs, column (2) adds actor/genre controls, and column (3) presents the full model with all fixed

effects and controls. 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 .192 represents a nearly 80% 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.

<center>INSERT TABLE 2 HERE</center>

Digital Cultural Production and Opportunities for Female Singers

We next examine whether the trend toward digital cultural production has affected male

and female singers differently. Figure 3 is a stacked bar chart illustrating the number of gigs

allocated to male singers (light-blue bars) and female singers (dark-blue bars) in analog (Panel

A) and digital soundtracks (Panel B). Short black horizontal lines indicate hypothetical 50%

parity levels based on the total number of gigs in a given year. In the analog era, female singers were assigned 47% of all gigs. The gap between the dark-blue bars and the black lines grows considerably in the digital era; women win only 34% of all singing jobs in digitally recorded films. In other words, though the market for singers was quite limited in the analog era, the shares of female singers and male singers were quite similar. As digital recording began to expand the labor market, gigs were increasingly allocated to male singers at the expense of female singers.

INSERT FIGURE 3 HERE

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

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

The key dependent variable is the interaction $Digital_g \times Female_s$ which compares the impact of digital cultural production on female and male singers' likelihood of getting gigs. 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 female 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 Female 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 female 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 $Digital_g \times Female_s$ with $AfterFire_{gt} \times Female_s$ 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 $Digital_g \times Female_s$ estimate in column 3, suggesting that the local effect of digital cultural production on the treated composers is quite large.

INSERT TABLE 3 HERE

The Role of Self-Promotion

Having found support for our first two hypotheses, we turn to evaluating H3: that digital cultural production harms women because they are less likely than men to promote themselves. To test this idea, we rely on singers' self-promotional activity on YouTube. As described earlier, we examine data on a subset of singers with official YouTube channels to determine whether self-promotion on YouTube explains the differential impact of digital cultural production on male and female singers' likelihood of being hired. Specifically, we estimate regressions in which we introduce $High\ Video\ Uploads_s$ which classifies singers' self-promotional activities

on YouTube as above the median, and examine the effect of digital cultural production on female singers via (a) a split-sample analysis that distinguishes those with $High\ Video\ Uploads_s = 1$ from those with $High\ Video\ Uploads_s = 0$, and (b) a triple interaction framework in which $High\ Video\ Uploads_s$ is interacted with the $Digital_g \times Female_s$ term.

Table 4 presents estimates from this analysis. The first column presents estimates for singers with low levels of self-promotional activity; the second column examines those with high activity, and the third column combines the two categories. As is clear in columns 1 and 2, the negative effect of digital cultural production pertains only to female singers who rarely self-promote. When considering the triple interaction, female singers with a high number of video uploads successfully counteract almost the entire negative effect of digital cultural production (-0.426); this difference is statistically significant. In other words, the negative effect of digital cultural production is turned off for those female singers who engage in vigorous self-promotional activity.

Combined with our qualitative data, this analysis suggests that limited self-promotion largely accounts for female singers' lost opportunities when music is digitally recorded and when composers can hire from a large pool of singers.

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 female 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. The first set of results reveal that high ratings erased women's disadvantage relative to men in digital films; these results demonstrate that appearances on reality shows help women outperform men in digital films. The estimate in column 4 is positive and significant. The negative effects of digital cultural production are significant for those without reality-show experience (column 5); the difference between those with and without experience is positive and significant (column 6).

These results strongly confirm H4, which asserts that the negative effects on female 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 female 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 female singers. We attributed this effect to (3) women's inability to self-promote as effectively as men, 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 female singer by about 9%. This negative effect can be attributed, at least in part, to women's lack of self-promotion activities; women who self-promote profusely on YouTube are not hurt by digital cultural production in terms of career opportunities. Further, the negative effect of digital cultural production is mitigated for those who win audience endorsements through hit songs or reality-TV shows. Our results suggest that digital technology does not merely shape the content of cultural production but can also shift the balance of power between male and female artists in cultural industries.

Labor-Market Implications of Technological Change in Cultural Markets

The sociological literature in the production-of-culture tradition has long explored the effects of new technology on the diversity of cultural offerings. Scholars have studied the contributions of such technologies as photography, movies, television, and the 45-rpm phonograph record to the content of cultural production (Becker 1982, Ryan 1985, Peterson 1990, Crane 1992). We complement research in this tradition by proposing a "producer-of-culture" hypothesis: that technological change affects not just *what* is produced but also *who* produces it. Cultural markets shape society not merely via the content that is disseminated to the masses but also by creating leaders and icons who profit from their talent by producing new culture while influencing the next wave of cultural producers and content. By offering a labor-market perspective on cultural markets, where content does not emerge in a vacuum but is instead produced by individuals with particular constraints and preferences, we provide a more complete accounting of the role of technology in shaping culture.

By focusing on cultural labor markets, our study speaks to ongoing debate, in academic scholarship and in the public sphere, about the role of technology in shaping demographic inequality among cultural producers. Commentators have pointed out that technological change has facilitated artists' ability to create, distribute, and promote their own work, thus opening up the market to new artists and outsiders who had typically been excluded from cultural production (Waldfogel 2018). This argument implies that technological change will promote greater diversity among cultural producers, including greater gender diversity in the music industry. Other scholars have posited that, because new technologies are situated in human and organizational processes that are themselves biased, they will perpetuate and perhaps even exacerbate demographic inequalities (Grazian 2005). Descriptive statistics documenting the scarcity of minority cultural producers, such as female music artists and black film actors, support the latter assertion that entrenched inequities among cultural producers persist. Our novel descriptive data and quantitative estimates shed light on this debate and support the latter view that digital cultural production can be detrimental for minority cultural producers, such as women, even in settings like ours where female singers had previously enjoyed success relatively to that of their male counterparts.

We also leverage unique qualitative data to develop a theory of *how* digital cultural production harms the prospects of female cultural producers. Our qualitative data and results confirm that digitization lowers barriers to entry and has attracted a flood of new talent into the industry; our theory asserts that, ironically, this very process serves to promote gender inequality. Our theory distinguishes between entry and ongoing success in cultural industries, and shows how digital recording can encourage the first outcome but subvert the second, especially for women. In the course of introducing a novel theoretical logic that links technological change to

gender inequality in cultural markets, we specify the process by which digital technologies can be detrimental to female cultural producers.

Self-Promotion and Gender Diversity in Creative Industries

We also contribute to scholarship on gender diversity in cultural industries. Scholars have thoroughly documented gender inequality in creative industries (for e.g., Askin et al 2021). Here, we pinpoint a novel mechanism that helps to explain this inequality: differences in the extent to which men and women promote themselves and their work. That men tend to self-promote more than women has been demonstrated among scientists (King et al 2017, Zhu et al 2019), innovators (Subramani et al 2021), and M-turkers (Exley and Kessler 2019). We argue that gender differences in self-promotion are particularly relevant in cultural industries where adoption of digital technologies has expanded the size of the labor market and thus made promoting oneself and one's work imperative for getting gigs.

Artists have always had to promote themselves to secure opportunities for exhibition, publication, and performance. Writers must pitch their work to editors and publishers; musicians seek out promoters and concerts; fashion designers continually look for new projects (Stokes 2013). This practice has become ever more crucial as digital technologies have reduced barriers to entry in cultural markets. Thus creative workers today must continually promote themselves and their work to sponsors and funders, to ancillary creative workers who function as gatekeepers (e.g., gallery owners, concert bookers, editors, and composers), and to audiences. We find that women tend to view promoting themselves negatively and to encounter familial opposition and backlash when they do so; their access to resources and capital for self-promotion also tends to be more limited than their male peers'.

Our findings align with some insights from prior work. Scholars have suggested that self-promotion requires self-confidence, which is systematically eroded in female artists and musicians (Miller 2016). Women in artistic careers report significant self-doubt about their abilities (Sargent 2009). Other women artists report that support personnel such as bookers, promoters, and critics also doubt their abilities (Groce and Cooper 1990; Harris and Giuffre 2015; Leonard 2007). On average, women are less confident about their artistic and musical abilities than are men (Wehr-Flowers 2006). Because female artists' self-confidence is systematically eroded in multiple artistic fields by disparaging micro-interactions, they might develop a distaste for promoting their work, which can hurt their careers in the digital world.

Women's family commitments might also conflict with self-promotional activities; they might encounter familial opposition to putting themselves "out there." The prevailing expectation that artists will make themselves continually available for self-promotion implicitly assumes a stereotypically masculinized artist unencumbered by family or domestic responsibilities (Banks and Milestone 2011; Stokes 2013).

More generally, women are apt to encounter backlash when they try to promote their work. Self-promotion tends to be viewed as more socially acceptable for men than for women (Martin 1998; Ridgeway 2011). Gender norms tend to prescribe role expectations (i.e., cultural beliefs) regarding what men and women should and should not do (Eagly and Karau 2002); research consistently shows that men are expected to behave in an agentic manner (assertive and self-reliant) while women are expected to behave in a communal manner (caring and other-oriented) (see Auster and Ohm 2000). Self-promotion on the part of women is thus considered counter-stereotypical, which can lead to backlash. For example, in an experimental study of hiring, Rudman (1998) shows that women who emphasize their accomplishments are penalized

in terms of likability and hire-ability. Women who request raises—a behavior that resembles an artist's self-promotion—are perceived more negatively than men who do likewise, and are sometimes sanctioned for doing so (Bowles et al. 2007).

Even when women overcome backlash instigated by self-promotion, they may lack sufficient access to capital, resources, and networks to promote themselves successfully. Artistic fields can resemble "old boys' clubs," where information, resources, and opportunities circulate via men's friendship networks that remain inaccessible to women (Banks and Milestone 2011; Cohen 2013; Finney 1993). In the absence of clear, structured standards and hiring processes, gatekeepers can all too easily decide which painters to show, which musicians to book, and which screenwriters to hire on the basis of who comes most readily to mind.

This paper also addresses the role of audiences in helping women overcome disadvantage. Even if female artists face barriers to self-promotion, fans and followers can act on their behalf to promote their abilities to industry decision makers. Our interview data documents how female 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 acknowledge the benefits of exposure 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); 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. Also the global leader in viewership and number of tickets sold, the industry produces almost three-quarters of all recorded music sold in India.[12] Our results examine the impact of new technology in music production on the industry's labor market.

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. For several reasons, we believe our results to be pertinent to those markets. First, 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—lowering skill requirements and increasing the size of the labor market—to be a widespread phenomenon.

Further, though reliance on studio singing is unusually high in the Indian context, studio singers are employed in films around the world. Some win recognition comparable to that of India's most popular singers. Marni Nixon, for example, became famous for voicing Audrey Hepburn's Eliza in *My Fair Lady* and characters in *West Side Story* and *The King and I*. Also, the dynamics of album-based music can resemble those of studio singing: prominent songwriters and music producers routinely recruit artists to realize their vision on a recorded album. If digital technology prompts a flood of new talent to approach such decision makers, we might expect increased gender inequality in other musical labor markets as well.

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

More broadly, gatekeepers characterize such other cultural markets as art (e.g., gallery owners), film (film producers and directors), and fashion (editors and buyers). If digital technology attracts much larger pools of talent in those arenas, we might expect growing gender inequality in their labor markets as well.

Readers might also assume that India is unique in the starkness of its gender norms. It is useful to keep in mind, however, that female 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 thus expect technological change to harm female cultural producers always and everywhere? More research is needed, but there are compelling reasons to expect this finding to generalize as long as female artists are subject to more severe constraints on promoting their own work. Much of the research documenting differences in self-promotion comes from western contexts, in fields as diverse as scientific research and online platforms; this pattern suggests that whenever technological change lowers barriers to entry, we can expect female producers to suffer.

Finally, our work has implications that transcend gender inequality. For example, Black producers on the online social network TikTok have recently "gone on strike" to protest serious forms of racial inequality on the platform. Our research suggests that, given an overwhelming supply of creative content on digital platforms, even highly talented black artists are apt to suffer because of constraints on promoting their work and finding followers. No matter the context, as long as minority groups face constraints on differentiating themselves and advertising their creative talent through self-promotion, a more digital creative market will operate to their detriment.

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Figures and Tables

Figure 1: Share of Songs Recorded Using Digital Technologies, 1985-2017
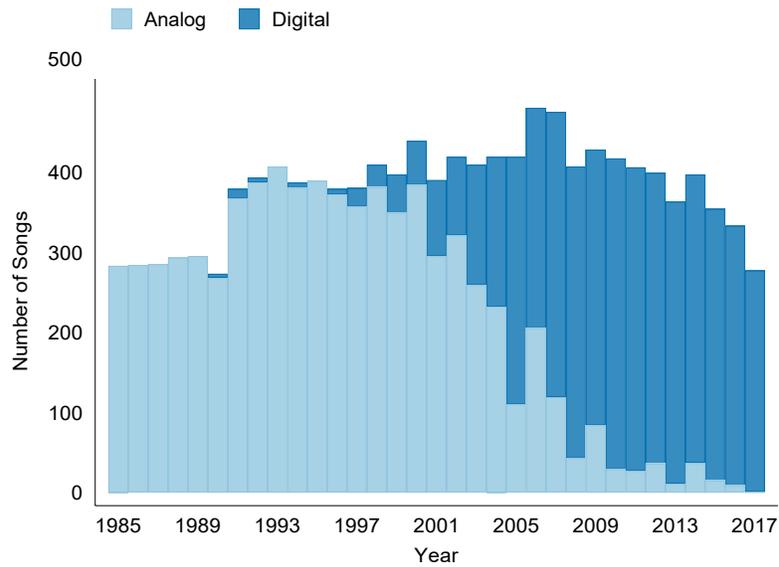
*Note:* This figure explores the diffusion of digital recording technology over time. For each year, we calculate the number of songs recorded using analog technology and digital technology. Light-blue bars represent analog songs; dark-blue bars represent digital songs. Because the data are stacked, 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
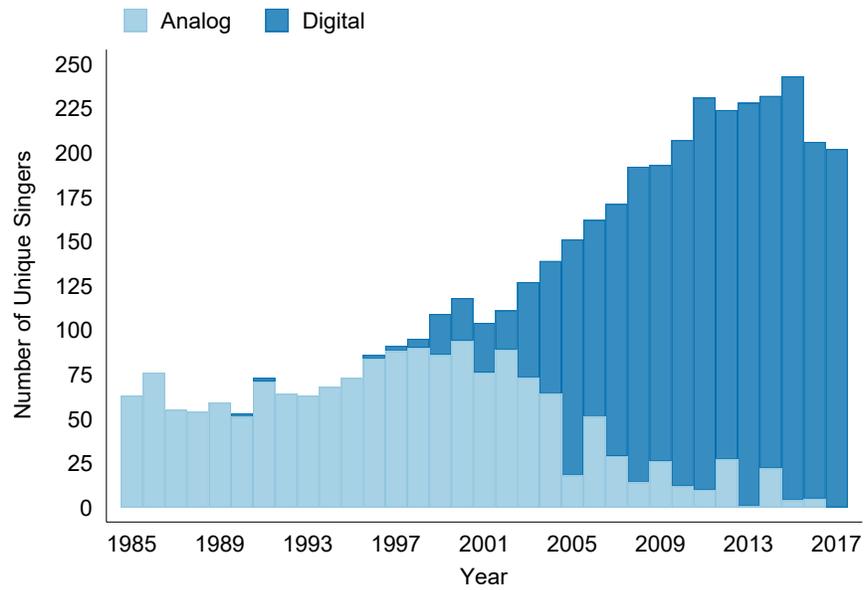
Panel B. Debuts
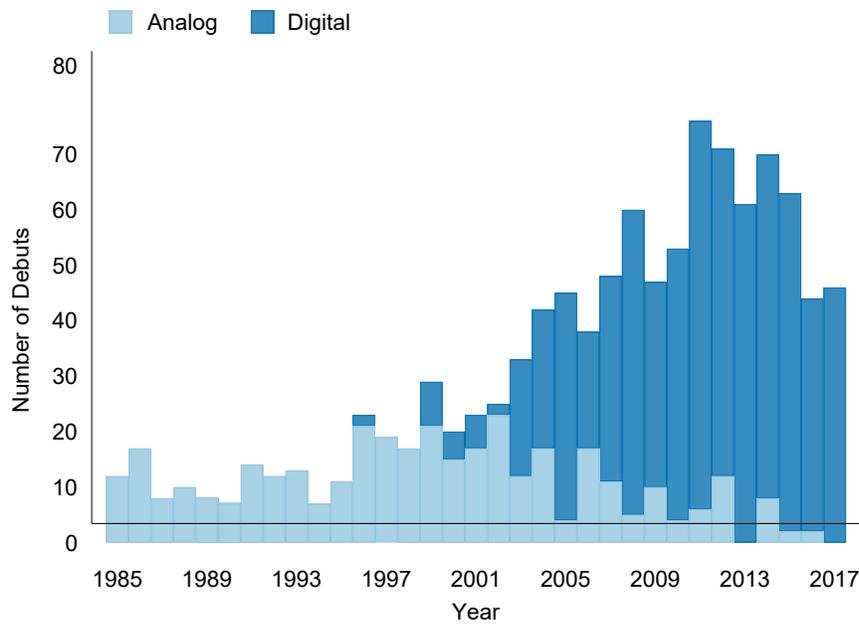

Note: This figure shows patterns of entry into the labor market for studio singers in the Hindi film industry over time. Panel A plots the number of unique singers who performed in analog and digital films in a given year; singers are assigned to one category or the other if more than 50% of their gigs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

Figure 3: Distribution of Male and Female Singing Gigs

Panel A. Analog ($\mu = 0.47$)
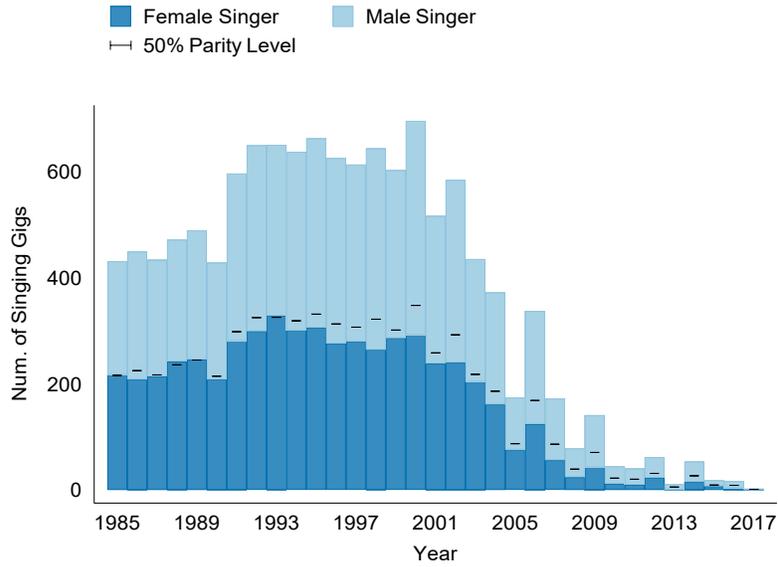
Panel B. Digital ($\mu = 0.34$)
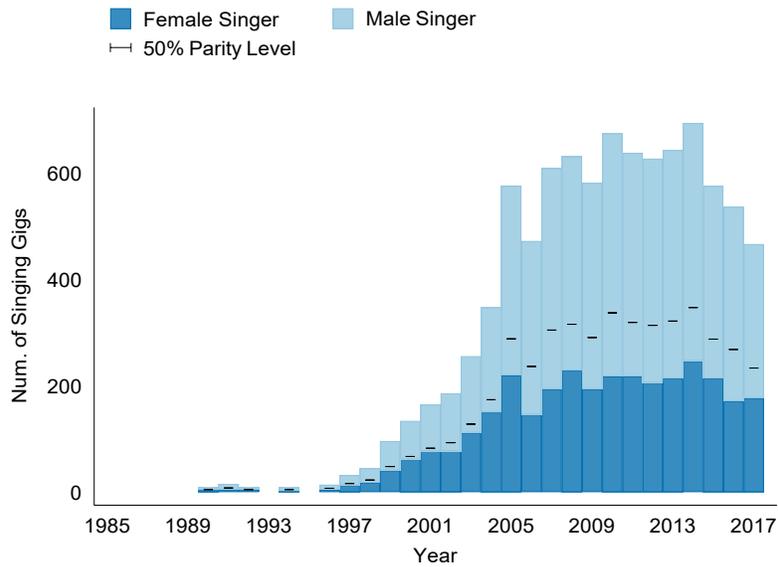
Note: This figure explores the share of gigs assigned to men and to women for analog songs and digitally recorded songs. For every calendar year, we calculate the number of analog gigs assigned to women and to men; Panel A presents this data as a stacked bar chart. Light-blue bars indicate gigs assigned 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
Female	0.36	0.48	0.00	0	1
Pop	0.27	0.45	0.00	0	1
Number of Male Actors	19.60	14.74	16.00	1	206
Number of Female Actors	7.74	6.64	6.00	0	76

Panel B: Singer-Level Statistics

Male 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
YouTube Videos	73.52	120.07	41.00	0	1527

Female 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
YouTube Videos	67.16	193.67	35.00	0	2278

Note: The table in Panel A provides overall summary statistics of the main dataset. *GotGig*, *Digital*, *Female*, *Pop* are dummy variables that range from 0 to 1. *Pop*=1 signifies that a song belongs to the pop genre. The mean of the *GotGig* variable indicates the probability that a random active singer is hired for a random song in a calendar year. 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. *YouTube videos* provides the number of such videos uploaded to the official accounts of singers in our sample. *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.

Table 2: Digital Cultural Production and Labor Market Entry

	Likelihood of Getting Job		
	(1)	(2)	(3)
Digital	-0.00298	-0.00310	-0.0000188
	(0.00520)	(0.00512)	(0.00543)
Debut	-0.0199	-0.0199	-0.0199
	(0.0237)	(0.0237)	(0.0237)
Digital x Debut	0.192***	0.192***	0.192***
	(0.0295)	(0.0295)	(0.0295)
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 male and female 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 Female Singers

	Likelihood of Getting Gig			IV
	(1)	(2)	(3)	(4)
Digital	0.0411***	0.0410***	0.0440***	-2.285
	(0.00568)	(0.00560)	(0.00592)	(6.007)
Female	0.0944***	0.0944***	0.0944***	0.140***
	(0.00586)	(0.00586)	(0.00586)	(0.0167)
Digital x Female	-0.0905***	-0.0905***	-0.0905***	-0.169***
	(0.00734)	(0.00734)	(0.00734)	(0.0278)
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 female singer will be hired for a singing job after digital cultural production. The sample is at the singer-gig level, by calendar year; the main outcome variable is *GotGig*. *Digital* and *Female* are dummy variables that equal one if either the gig is for a digital soundtrack or the singer is female. Actor/Genre Controls control for the count of male and female 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 *Female* is instrumented with *AfterFire* x *Female*. *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 Effect of Digital Cultural Production for Women by Extent of Self-Promotion

	(1) High	(2) Low	(3) Both
Digital	0.195*** (0.0227)	0.00136 (0.00889)	0.122*** (0.0156)
Female	0.492*** (0.0310)	-0.0254** (0.00875)	0.501*** (0.0315)
Digital x Female	-0.417*** (0.0346)	0.00781 (0.0106)	-0.426*** (0.0350)
High Video Uploads			-0.00151 (0.0128)
Digital x High Video Uploads			-0.0974*** (0.0164)
Female x High Video Uploads			-0.527*** (0.0335)
Digital x Female x High Video Uploads			0.435*** (0.0379)
Year FE	Yes	Yes	Yes
Composer FE	Yes	Yes	Yes
Actor/Genre Controls	Yes	Yes	Yes
N	1330327	4454146	5784473

Note: This table provides OLS estimates for the effect of YouTube self-promotion on digital recording's negative impact on female singers' employment. The sample is at the active singer-gig level by year; the main outcome variable is *GotGig*. The sample is smaller than the baseline sample because it includes only singers for whom we found an official YouTubeaccount. We measure YouTube activity in 2021 for singers who have been active in the industry since 1990 as a proxyfor their offline and online self-promotional tendencies. *Digital* and *Female* are dummy variables that equal one if thegig is for a digital soundtrack or if the singer is female. *High Video Uploads* is set to one if a singer's YouTube account has more than the median number of uploaded videos (38) and zero otherwise. Actor/Genre Controls control for the count of male and female actors in the cast and for 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		
	(1) High	(2) Low	(3) Both	(4) Participants	(5) Non-Participants	(6) Both
Digital	0.00923 (0.00750)	0.0482*** (0.00739)	0.00344 (0.00664)	-0.110** (0.0387)	0.103*** (0.0124)	0.0696*** (0.0120)
Female	0.00590 (0.00676)	0.101*** (0.00712)	0.104*** (0.00709)	-0.247*** (0.0484)	0.228*** (0.0127)	0.228*** (0.0126)
Digital x Female	-0.00368 (0.00899)	-0.0985*** (0.00907)	-0.101*** (0.00905)	0.275*** (0.0547)	-0.240*** (0.0163)	-0.240*** (0.0163)
High-Rated			-0.335*** (0.00795)			
Digital x High-Rated			0.179*** (0.00997)			
Female x High-Rated			-0.103*** (0.0101)			
Digital x Female x High-Rated			0.102*** (0.0134)			
Reality Show						-0.00960 (0.0394)
Digital x Reality Show						0.0208 (0.0441)
Female x Reality Show						-0.463*** (0.0549)
Digital x Female x Reality Show						0.511*** (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	1824579	6733377	8557956	561416	3516410	4077826

Note: This table provides OLS estimates of the differential effect of digital cultural production on male and female 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 *Female* are dummy variables that equal one if the gig is for a digital soundtrack or the singer is female. *High-Rated* is set to one for singers with ratings of 4 stars or above for their music; *Reality Show* is set to one for singers who had participated in a reality show. Actor/Genre Controls control for the count of male and female 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: 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 B: Example of Sample Construction

Panel A: Construction of Singer-Song Links
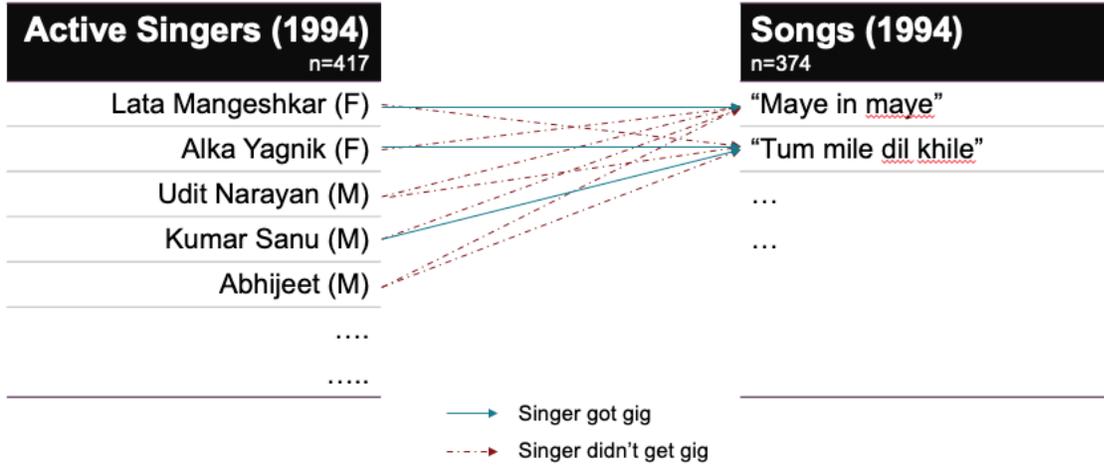
Panel B: Sample Extract

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 C: Share of Male Actors in Film Casts by Year, 1985-2017
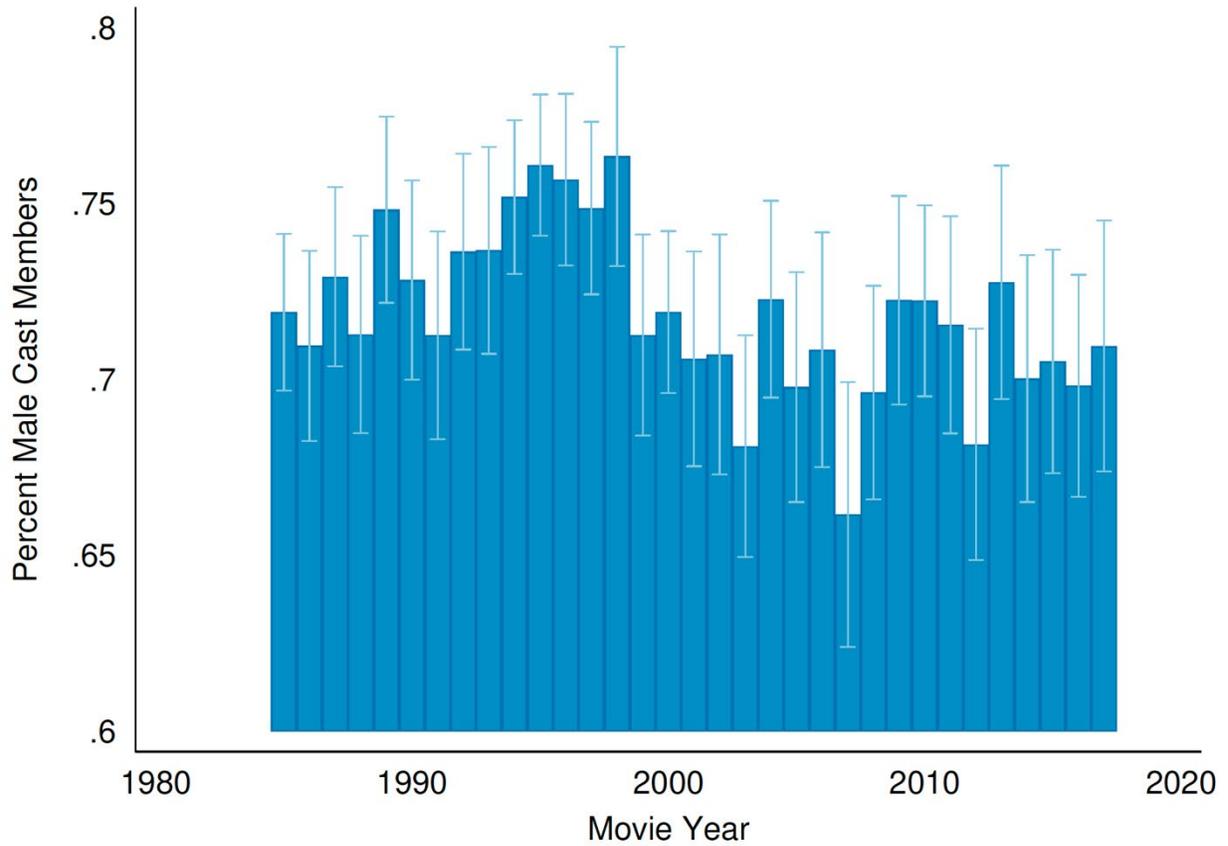
Note: This figure explores the gender composition of film casts based on manually coded actor gender from IMDb cast data for the sample of films we analyze. For each film, we calculate the proportion of male actors as a share of the total cast and then average this variable across all films in a given calendar year. This figure plots this average (along with 95 percent standard error bars) for every year between 1985-2017.