Economic Inquiry

"WHAT'S WRONG WITH THE WAY I TALK?" THE EFFECT OF SOUND MOTION PICTURES ON ACTOR CAREERS

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The development of sound motion pictures in the late 1920s provides one of history's most evocative examples of the effect of technological innovation on employment. I begin by exploring the transition to sound, which lasted several years. I then analyze transition's effect on actor employment, and find it to be associated with a substantial increase in career terminations, not only among major stars (which film scholars emphasize), but also among more minor actors. Furthermore, I find that sound raised hazard rates generally. Finally, I calculate that the number of actors employed in movies increased substantially in the sound era.

"What's wrong with the way I talk? Am I dumb or sumpin'?"

– Lina Lamont, a talentless and annoyingly self-absorbed silent film star (played by Jean Hagen) facing the transition to sound in *Singin' in the Rain* (1952)

I. INTRODUCTION

Nearly a century after the fact, the transition from silent to talking pictures in the late 1920s remains the stuff of legend. Classic movies such as *Sunset Boulevard* and *Singin' in the Rain* portray, alternately, the pathos ("I *am* big", says former star Norma Desmond, "It's the *pictures* that got small") and the comedy (see the Lina Lamont quotation just above) of actors unable to meet the demands of the new medium. *The Artist*, a mostly silent film released in 2011, won the Academy Award for best picture (and best director and best actor) for its tale of a romance between an older silent star whose career is waning, and younger sound actor whose career is on the rise.

Film historians have researched the transition from silent to sound extensively, and generally agree that the coming of sound led to the premature termination of the careers of a number of major stars, although the reason has been debated. As interesting and informative as many of these studies are, they rarely proceed beyond qualitative analysis of a relatively small set of very famous actors. Given that most actor careers are of unpredictable (and generally short) duration even at the best of times, it would be surprising if at least some career terminations did not coincide with the transition to sound. Furthermore, no evidence has been presented as to whether the effect was restricted to major stars, or whether the careers of more "average" actors were influenced, as well.

In this paper, I conduct a systematic investigation of how the transition to sound affected the careers of silent film actors. Based on the results, I conclude that film scholars are correct—the coming of sound disrupted the roster of major stars profoundly. However, I find that the effect went well beyond major stars—the hazard rate (likelihood of an actor's career ending in a specified year given the actor had survived until that year) for *all* actors rose during the period of transition. Yet I also find that even after the transition period had ended, the hazard rate remained higher than it had been during the preceding silent era (although not as high as during the transition). Therefore, some of the dramatic effects

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ABBREVIATIONS

AFI: American Film Institute
IMDB: Internet Movie Database
MLB: Major League Baseball

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attributed to the transition from silent to sound films may simply reflect the fact that exit rates rose during the first decade of sound motion pictures.

I begin by reviewing the history of the development of sound films. The start of the transition to sound is typically marked by the release of *The Jazz Singer* in late 1927, although (1) sound films had been a technological possibility for some time previously, and (2) *The Jazz Singer* was basically a silent film in plot and structure that contained a few minutes of song and a few seconds of spontaneous dialogue. Nonetheless, *The Jazz Singer* was a huge hit, making it clear that "sound" films had large potential appeal. The transition period lasted several years, as movie producers struggled both with questions as to what a "sound" film should be, and with the technological challenges presented by the new medium. Nearly half of all feature films released in 1929 had little if any spoken dialogue and not until 1930 were the majority of the nation's cinemas wired for sound. I define the transition period as 1929–1932, but investigate alternate definitions, as well.

To determine whether the transition affected the careers of silent film actors, I investigate the years 1920 through 1940. I begin with 1920 because the feature film was by then well developed and the structure of the film industry—consisting of three vertically related activities (production, distribution, and exhibition)—well established (e.g., Hanssen 2000, 2010). I end with 1940 because many actor careers would be interrupted (or terminated) by the United States' entry into World War II the following year. Thus, I have 9 years over which silent films—and silent film actors—predominated (1920–1928), 8 years over which sound films—and sound film actors—predominated (1933–1940), and a 4-year transition period (1929–1932).

I begin by looking for evidence that the transition to sound disrupted the careers of major stars, as film scholars have posited. In order to define "major star" consistently over time, I employ the results of an annual exhibitor poll first conducted in 1915 (and continued through 2013), in which cinema managers were asked to name their "top ten money-making stars." Seventy-two different actors made this Top Ten list between 1920 and 1940, and most of these actors appeared on the list multiple times (not surprisingly—stardom is persistent). Nonetheless, the list is sharply bifurcated: a number of actors made the list multiple times in the 1920s, and a number of actors made the list multiple times in the 1930s, but none spanned both the silent and sound eras. Furthermore, the years up to and including the transition to sound were characterized by an unusually high rate of departure from the Top Ten listings. Stories about the effect of sound on the careers of major movie stars appear to have an empirical basis.

I then turn to systematic analysis of the larger population of movie actors. Drawing from the Internet Movie Database (IMDB), I assemble a data set of every actor who played one or more credited roles in feature films from 1920 through 1940, inclusive—nearly 10,000 actors in total. I define the beginning of an actor's career as the year in which she played her first credited role, going back to 1915 (shortly after the emergence of the U.S.-produced feature film). I define the end of her career as the year in which she played her last credited role through 1940; all careers that continued beyond 1940 are considered censored. Censoring not accounted for, the career of the average actor in my data set lasts about 5 years and the modal career lasts only a single year, the minimum possible given that roles are observed annually. Censoring accounted for, I find that about 20% of actors exit motion pictures in their first year, rising to 30% by the end of the second year. Actor exit rates were high, not surprisingly.

I employ duration analysis to measure whether the transition period is associated with a change in the rate of actor exits from the film industry. Estimating both continuous time and grouped duration data models, and controlling for actor age and gender (both of which affect exit rates), I find the transition period to be associated with a hazard rate (rate of exit) that is between 20% and 50% higher than that of the nontransition years. It does indeed appear that the transition to sound saw unusually high rates of departure from the movie-acting profession.

I then investigate whether actors who played bigger roles were affected differently than actors who played smaller roles (as noted, most studies have focused on famous stars). Film scholars have put forward two principal (and not necessarily mutually exclusive) explanations for the increase in career terminations brought about by the transition to sound: (1) some actors had voices that were simply at odds with their silent screen images (or images that did not translate well to sound films), and (2) a sound film required fundamentally different skills. I find very little difference in the transition period hazard rates

between actors who played major roles and actors who played more minor roles, which suggests that explanations turning on an actor's image are unlikely to explain the bulk of the increase in exit rates. It appears that the alternative explanation, that the required skills were different, may hold more generally.

Next, I compare silent-era and sound-era hazard rates. I find that the sound era is associated with substantially higher hazard rates than the silent era. Accordingly, whereas the transition period is associated with a near-doubling of exit rates as compared to the silent era, it is associated with only a 10% higher exit rate as compared to the sound era (at least through 1940). Therefore, some of the exits ascribed to the coming of sound may simply reflect the higher rate of actor "churn" that sound films appear to have brought with them.

Finally, the coming of sound was roughly coterminous with other events that may have influenced actor turnover—most significantly, the start of the Great Depression. Therefore, I construct a placebo test, examining an alternate entertainment business affected similarly by the Great Depression but *not* by film's transition to sound technology: Major League Baseball. If my movie estimates are picking up changes in actor hazard rates caused by talking films, and not by other factors, I should find weaker evidence of a corresponding change in hazard rates among baseball players. Indeed, I find no evidence at all—hazard rates among major leaguers were roughly constant over the period that talking pictures developed and movie actor hazard rates soared.

I finish by reviewing briefly how total actor employment differed between silent and sound eras. Examining the IMDB's genre categorizations, I find evidence that plots became more complex with sound; consistently, the average number of credited actors per film rose. The number of films released also rose, so that the net effect was a substantial sound-era increase in the annual employment of motion picture actors.

The fact that technological innovation may affect employment has long been recognized. The evidence presented here suggests that David Ricardo was correct when he wrote,

> *The opinion entertained by the laboring class that the employment of machinery is frequently detrimental to their interests is not founded upon prejudice and error, but is conformable to the correct principles of political economy. (On The Principles of Political Economy and Taxation 1821, chapter 31)*

But the evidence also supports John Stuart Mill's contention, "I do not believe that … improvements in production are often, if ever, injurious, even temporarily, to the labouring classes in the aggregate." (*Principles of Political Economy* 1848, chapter 6). The careers of many silent actors appear to have been ended prematurely by sound, but sound motion pictures boomed subsequently, and the number of Hollywood actors who played credited roles annually in the first decade of the sound era was nearly double that employed in the last decade of the silent era.

II. THE COMING OF SOUND

Linking pictures and sound had been possible for some time—Thomas Edison developed versions of both the movie projector and the phonograph in the late 19th century, and experimented with combining the two.[1] By the early 1920s, sound technology had advanced sufficiently to permit systematic synchronization with moving pictures. The lead in the adoption process was taken by Warner Brothers, then a relatively small film studio. Warner Brothers formed a joint venture with Western Electric in April 1926 to promote Western Electric's sound-on-a-disc system (known as Vitaphone). Rival studio Fox contracted for the competing Movietone sound-on-film system (sound-on-film would eventually become the industry standard). The other movie companies opted to wait, agreeing in 1927 that none of them would convert to sound until they

1. See, for example, Gomery (1985), Crafton (1997, 9), Eyman (1997, chapter 1). The slow movement to adapt sound to motion pictures (even after it was discovered in 1915 that connecting a power transformer and battery to existing electrical circuitry could increase the volume of recorded sound substantially, an innovation adopted by radio) is consistent with the observation that technology diffusion is usually "a … rather slow process" (Hall and Kahn 2003, 1). The key choice, as Hall and Kahn point out, is generally not between adopting and not adopting, but rather between adopting today and adopting tomorrow. It is noteworthy that the "first mover" was Warner Brothers, a minor studio with much lower levels of capital (physical and reputational) sunk in silent film production and in silent film stars than many of its rivals (and none in cinemas, which would have to be wired for sound). See Rosenberg (1972) for a seminal discussion of the diffusion of innovation.

all did.[2] By moving first, Warner Brothers leaped to the top rank of movie studios.[3]

The first public showing of a sound feature film occurred in 1926, when Warner Brothers "retro-fitted" their silent version of *Don Juan* with synchronized music and sound effects. The company then released several talking shorts over the following months, while rival studio Fox produced a talking newsreel. But the dawn of the sound era is generally considered to coincide with Warner Brothers' release of *The Jazz Singer* in late 1927. *The Jazz Singer* actually contains only three short sound sequences, each a song by its star, Al Jolson, accompanied by a bit of dialogue (291 words in all). Like *Don Juan*, it had been conceived as a silent film; a sound track was added later in the production process. *The Jazz Singer* was extremely popular, earning $2 million through 1931 (Crafton 1997, 111). The appeal of sound movies was clear.

A. *"Kaput!"*[4]

Film scholars have long maintained that the coming of sound films altered fundamentally the roster of major stars.[5] Exactly why has been the subject of debate. Initially, the general feeling was that certain actors simply had weak voices. For example, the 1929 edition of *The Motion Picture Almanac* (published at the end of 1928) ran an article titled, "Have You a 'Screen' Voice," complete with a sample "experimental diagnosis sheet" and several speech worksheets. John Gilbert, MGM's most popular silent actor and the most famous purported victim of sound, was said to suffer from a malady known as "white voice" (e.g., Griffith and Mayer 1957, 248). Some of the other purported victims, such as Vilma Banky and Karl Dane, had strong foreign accents (Hungarian and Swedish, respectively). Hollywood producers rushed to sign Broadway actors, under the assumption that they, at least, knew how to talk. Yet stage and screen proved to be sufficiently different that many of the stage performers had only brief Hollywood careers.

Today, the "weak voice" explanation is largely discounted, and film scholars propose two (not mutually exclusive) alternatives. The first is that although a voice might be fine per se, it could clash with the image the actor had developed in silent films. For example, Basinger (1999, 396–97) writes of John Gilbert,

> *It was sound that killed Gilbert. Not because he had a bad voice or a high voice and not because his sound roles were silly, since some of them … are quite entertaining and modern. It was sound that killed him because sound diminished John Gilbert … His true forte was as the fulsome romantic idol. Sound added nothing to his ability to convey a man in love, to present a sensuous, impassioned romantic. On the contrary, sound subtracted heavily from it.*

In the same vein, whereas Greta Garbo's husky Swedish accent nicely fit her "woman of mystery" aura, Vilma Banky's heavy Hungarian accent undercut her delicate appearance, and thus her appeal. Similarly, Dolores Costello (another of sound's casualties) had a much remarked-upon "Madonna-like beauty" (Griffith and Mayer 1957, 224) that was strongly at odds with her flat speaking voice and pedestrian Midwestern accent.[6]

The second possible explanation is that the nature of the required skills changed (e.g., Walker 1979). It is important to recognize that silent and sound films are fundamentally different—a sound film (of the type we see today or even saw in the early 1930s) is not simply a silent film plus talking and music. Silent plots were by necessity simpler than sound plots; the lack

2. The "Big Five Agreement" was signed in February 1927 by five of the most important film companies: Loew's (MGM), Universal, First National (later purchased by Warner Brothers), Paramount, and Producers Distributing Corporation. The firms agreed that for 1 year none would adopt any sound technology unless (1) a standard had been identified as best for the industry, (2) that technology was made available to all producers on equal terms, and (3) it was to be adopted by all simultaneously. See for example, Gomery (1985) and Walker (1979) for more detail.

3. See Sedgwick and Pokornoy (1998) for an analysis of Warner Brothers' financial strategies from the early 1920s through 1940.

4. The subtitle is taken from Griffith and Mayer's (1957, 247–51) section on how sound affected the careers of silent stars.

5. John Gilbert was probably the biggest male star of the late-silent era; he made the last of a series of mostly unsuccessful sound films in 1934, and then proceeded to drink himself to death at the age of 38. Vilma Banky, Clara Bow, Colleen Moore, Marion Davies, Mary Pickford, Constance and Norma Talmadge, Dolores Costello, and William Haines were major stars who never made it big in sound (although some, like Mary Pickford, were approaching middle age). Karl Dane's story was particularly sad; he went from MGM's A-list in the late 1920s to peddling hotdogs outside the MGM gates in 1933, and shot himself in 1934 (Eyman 1997, 314).

6. Costello is "famous" for voicing the phrase "Merthy, merthy, have you no thister of your own" in the 1928 film *Tenderloin*, although there is some debate as to whether her lisp or the poor quality of sound recording (and broadcasting) technology is primarily to blame. That said, I watched her in the part-talking 1928 film *Noah's Ark* and can attest that any magic created by her ethereal appearance quickly dissipated when she spoke.

of dialogue meant that complicated ideas and story twists could not be communicated easily.[7] The cinematography was also somewhat different—wide-lens views of the scene and the action alternated with tight close-ups on the faces of the actors. Silence created a distance between actor and audience that encouraged exaggeration. The gestures and facial expressions that actors used were highly stylized—broad, sweeping movements and widening or narrowing of the eyes would indicate anger, anguish, happiness, and so forth in ways that were recognized by contemporary audiences, but are far removed from how people actually react (which is approximately what sound films show). Indeed, silent film acting bore some resemblance to mime (although the greatest silent actors were also able to communicate warmth and humanity). By contrast, sound films put a premium on *underacting*—the apparent "realism" of what one views on the screen magnifies the importance of every gesture or facial tic.[8] Eyman (1990, 226) describes the difference as follows:

> *Talkies were less romantic than silents, more real; less utopian, more democratic; less behavioral, more psychological. Because silent films were such an anomalous hybrid, and closer to ballet than to anything else in the arts, actors who had an aptitude for them often seemed comparatively ordinary, if not inadequate, in the more plebian talkies.*

Talkies also differed in more mundane ways; directors could no longer shout instructions during filming (as was the norm during the silent era), and actors could no longer improvise dialogue; they had to memorize lines. I will use my findings to distinguish—not definitively, but to the degree possible – between these two explanations.

7. Cinema-going was different during the silent era—patrons could show up in the middle of the film and simply stay through the subsequent showing until they were back to the point where they had arrived. Walker (1979, 97) writes, "Silent movies had enabled the casual customer to drop in, and within a minute or two be locked into the story and characters. Mime-acting made the characters' predicaments easily intelligible; sub-titles gave people emotional cues to follow rather than narrative points to recall. But dialogue altered this: it demanded attention." Sound films initially disconcerted audiences and theater management by requiring that all viewers arrive before the film began.

8. Basinger (1999, 393) writes, "The successful delivery of sound dialogue needs a certain nonchalance, an ease with words. Since the medium takes the viewers in close to the actor, there is no need for declaiming or hitting a point so the back row will not miss it. The medium calls for naturalism, behavior that people in the audience somehow take for the essence of the actor."

B. Defining the Transition Period

The trouble with the whole industry is that it talked before it thought (Joseph M. Schenk).[9]

In order to determine whether actor careers were affected by the coming of sound, I must define a transition period, to contrast with well-defined "silent" and "sound" periods. I will therefore briefly trace the development of the sound film and the dissemination of sound technology. It should be emphasized that the appeal of sound caught the industry by surprise, and a period of debate and experimentation followed, as acting (and writing, directing, filming, etc.) styles adjusted and technology (microphones, cameras, etc.) advanced.[10] It was also necessary to wire thousands of cinemas for sound, an expensive proposition.[11]

Despite the success of *The Jazz Singer* in late 1927, many industry pundits initially regarded sound as a fad, and even supporters expected talking and silent films to coexist indefinitely. The author of a Harvard case study of a cinema considering the conversion to sound in 1928 wrote, "It was difficult to judge the permanence of the appeal of sound pictures. Theatrical managers were convinced that the appeal at first was largely one of curiosity" (Clayton Theater 1930, 491). Jack Warner, the champion of the talking picture, said as late as 1928 that he expected most future films to be part sound and part silent (Crafton 1997, 174). Adolph Zukor, President of Paramount Pictures, was quoted in late 1928 as saying,

> *By no means is the silent picture gone or even diminished in importance. … there always have been subjects which could not be augmented in value or strength by the addition of sound and dialogue*. (*The Film Daily 1929 Yearbook*, 513)[12]

What followed was a period of debate and experimentation, aimed (however chaotically) at

9. Quoted in Walker (1979, title page).

10. The development and implementation process, requiring much tinkering and adjustment (e.g., Meisenzahl and Mokyr 2011), threw the industry into turmoil, with long-term effects on both competitive structure and organizational form. For more detail, see Hanssen (2002) and the citations therein. Bakker (2001) presents evidence that the transition to sound shortened director survival rates.

11. According to a 1928 article in *Variety* (June 6, 1928, p. 5) wiring for sound cost between $5,000 and $14,000 per cinema (approximately $75–200,000 in current dollars), depending upon cinema size and configuration.

12. *Scientific American* summed up the "scientific consensus": "[The silent film] has a wonderful appeal to its

determining what a sound film should be. Should it have talking scenes, and if so, how many? Should comedies remain nontalking (perhaps with a synchronized sound track) while dramas included speech? Initially, a number of producers responded by simply adding music and sound effects to what were essentially silent films, maybe including a few short scenes with spoken dialogue (which served more than anything to reveal how different silent and sound films really were). This led to confusion among fans and much unhappiness with the resulting product.[13]

The IMDB lists the "sound mix" used by film, which allows me to divide feature films into three categories: (1) silent, (2) sound sequences (synchronized music and sound effects; perhaps some spoken dialogue), and (3) fully talking.[14] The chart at the top of Figure 1 plots the proportion of films of each category released by year, from 1926 (when the first "sound" feature film was released) through 1932 (when essentially all feature films were fully talking). As noted, *Don Juan* appeared in 1926 and *The Jazz Singer* late in 1927, but the first fully talking films were released in 1928, and accounted for only 2% of all feature films released that year, while another 20% had sound sequences.[15] By 1929, more than half of all releases were fully talking, and less than 20% were completely silent. By 1930, nearly all feature films were fully talking.

Of course, to show talking films, one needed cinemas wired for sound. Warner Brothers initially promoted the establishment of Vitaphone sound systems in large cinemas in major urban areas. According to the *1929 Film Daily Yearbook*, by April 1928, the Vitaphone system was in use in 250 cinemas, and Western Electric, Warner Brothers' partner in sound, set the goal of 1,000 wired houses by the end of 1928.[16] However, more than 20,000 cinemas were then in operation, so this still represented a small minority (albeit with a focus on larger cinemas) and into 1930 at least, film producers tended to release both talking and silent versions of their feature films, the latter to be shown in unwired houses.[17]

To trace the wiring of cinemas for sound, I present data drawn from the *Film Daily Yearbook* (1929–1933 editions) and the *Motion Picture Almanac* (1929 edition) in the chart shown at the bottom of Figure 1. The pattern is roughly the same as that shown for the sound mix of films, directly above (not surprisingly). By the end of 1928, only 6% of the approximately 21,000 cinemas then in operation could show sound films. That had risen to more than 40% by the end of 1929, as the total number of wired cinemas hit 9,000, and to 60% (13,000 cinemas) by the end of 1930. However, the Great Depression was by then striking the film industry (which had enjoyed an initial respite), and over the next 2 years, nearly half of all cinemas closed. As one would expect, the majority of the closures were among cinemas that had never been wired for sound. By 1931, only about 10% of unwired houses remained in operation, and nearly all of them would close or convert by the end of 1932.

Even after cinemas had been wired and talking films were the norm, experimentation continued, as the technology improved and acting, presentation, and storylines were refined. Directional microphones, three-way speaker systems, and techniques for "looping" (the rerecording of vocals postproduction) were all developed in the 1930s (e.g., Crafton 1997, chapters 13 and 14).[18] To allow sufficient time for silent actors to exhibit the requisite ability (or not), I will define the

audience—an appeal entirely distinct from that of the spoken play. It is in no wise an imitation of the spoken play; it is a thing by itself. Why, therefore, replace it with a more or less realistic imitation? Our belief is that the talking picture has great possibilities in many directions, but as a factor in the motion picture field it must not be taken seriously." Quoted in Eyman (1997, 53).

13. For fans, determining whether a film had spoken dialogue (as most desired) or merely synchronized music and sound effects became a source of tension. As the editor of the *1929 Film Daily Yearbook* (page 501) wrote, "Overzealousness of exhibitors in efforts to cash in on the [sound] craze was developing a danger for sound films in the form of misleading advertising. The "See and Hear" keynote lines were being used for synchronized as well as dialogue films. The difficulty of ascertaining the difference led to a reaction, which soon made itself felt at the box office. Since, the exhibitors have been wary of misleading copy."

14. For a more detailed description of the IMDB data, see Section IV.

15. Warner Brothers again took the lead, releasing the 50% talking feature *The Lion and the Mouse* in May of 1928 (*The Jazz Singer* had been less than 10% talking), and the first fully talking picture, *The Lights of New York* (based on a Broadway play), the following July. See, for example, Crafton (1997).

16. Flush with cash from the unexpected success of *The Jazz Signer*, Warner Brothers began to acquire cinemas in 1928 (e.g., Sedgwick and Pokornoy 1998, 198–99). All the biggest studios were then vertically integrated; see, for example, Hanssen (2010).

17. Among the "Twenty Compelling Film Facts" listed in the *1930 Film Daily Yearbook* (page G) is that "Nearly 350 silent versions of dialogue [talking] pictures are on '29–30 [film] lists."

18. For example, Crafton notes that the soundtrack of the 1930 Josef von Sternberg classic *Morocco*, starring Gary Cooper and Marlene Dietrich, was "rather noisy. The splices are clearly audible because they were not altogether successfully blooped" (360). With regard to *The Big Trail*, a 1930

FIGURE 1
Proportion of Silent Versus Sound Feature Films (1926–1932)

Source: Top: IMDB. Bottom: *1929 Film Daily Yearbook*, p. 577; *1929 Motion Picture Almanac*, p. 111; *1930 Film Daily Yearbook*, p. 3; pp. 706–; *1931 Film Daily Yearbook*, p. 706; *1932 Film Daily Yearbook*, p. 706; *1933 Film Daily Yearbook*, p. 706.

"transition period" as beginning in 1929 and ending in 1932. As a robustness test, I will also estimate the results for several alternative periods: 1928–1931, 1929–1931, and 1930–1932.

III. MAJOR MOVIE STARS AND THE COMING OF SOUND

Because film scholars have long proposed that sound shortened the careers of a number of famous silent-era actors, I begin my analysis with major movie stars.[19] Of course, that requires me to define "major movie star" in a manner that is consistent over time. I will make use of a unique measure: results from an annual poll of movie exhibitors, who were asked to list their ten

Western directed by Raoul Walsh and starring a young John Wayne, "[s]ometimes the balance between the planes of sound effects is not good. On the steamboat landing, for instance, the actors can scarcely be heard through the layers of din. … [and] occasionally the voices did not come from the mouths of the players" (364–65). A pre-Sherlock Holmes Basil Rathbone successfully plays a detective in a 1930 film despite the fact that "microphone placement problems sometimes make his speech fade in and out" (365). And so forth.

19. During both the silent era of the 1920s and the sound era of the 1930s, most actors worked on a per day, week, or film basis. Major movie stars, however, generally worked under long-term contracts (see, e.g., Hanssen and Raskovich 2019). These long-term contracts typically contained a semi-annual renewal option, allowing studios to rid themselves easily of actors whose popularity dipped (e.g., because of the coming of sound). Where an actor's contact did not contain a renewal option (usually because the actor was so big a star the studio was willing to forgo it), the contract had to be bought-out instead. Silent star John Gilbert was one of the few "casualties of sound" to refuse a buy-out; MGM had to keep churning out his pictures (films that that fans refused to see) until not even Gilbert could take any more (see, e.g., Basinger 1999).

TABLE 1
Actors with at Least Three Appearances in "Moneymaking Top Ten" From 1920 Through 1940

Name	# Appear.	First Year	Last Year	Name	# Appear.	First Year	Last Year
Douglas Fairbanks	7	1920	1926	Janet Gaynor	5	1930	1934
Mary Pickford	7	1920	1926	Joan Crawford	7	1930	1936
Norma Talmadge	6	1920	1926	Marie Dressler	4	1931	1934
Marion Davies	4	1921	1925	Norma Shearer	4	1931	1934
Gloria Swanson	4	1921	1925	Wallace Beery	8	1931	1940
Rudolph Valentino	4	1922	1925	Will Rogers	4	1932	1935
Thomas Meighan	5	1922	1926	Joe E. Brown	3	1932	1936
Harold Lloyd	7	1922	1928	Clark Gable	9	1932	1940
Lon Chaney	6	1922	1929	Shirley Temple	6	1934	1939
Colleen Moore	8	1923	1931	Bing Crosby	3	1934	1940
Fred Thomson	3	1925	1927	Fred Astaire	3	1935	1937
Hoot Gibson	3	1926	1929	Ginger Rogers	3	1935	1937
Clara Bow	5	1927	1931	James Cagney	3	1935	1940
Richard Barthelmess	3	1928	1930	Robert Taylor	3	1936	1938
William Haines	3	1928	1930	Sonja Henie	3	1937	1939
				Mickey Rooney	3	1938	1940
				Tyrone Power	3	1938	1940
				Spencer Tracy	3	1938	1940

Source: Motion Picture Daily annual poll of exhibitors. Does not include pre-1920 or post-1940 appearances.

top "money making stars." From 1915 through 2013, the *Motion Picture Herald*, a trade weekly, and its successor the *International Motion Picture Almanac*, surveyed thousands of exhibitors annually.[20] A version of the following request was made: "Please list the ten players whose pictures drew the greatest number of patrons to your theater over the last twelve months" (*Motion Picture Herald*, December 28, 1935, 13). Votes were tallied and actors ranked according to number of votes received (order of ranking by individual exhibitors was disregarded). If one is willing to assume that exhibitor respondents answered honestly (and they had no reason not to), one can expect the actors most popular with audiences to have received the most votes.[21]

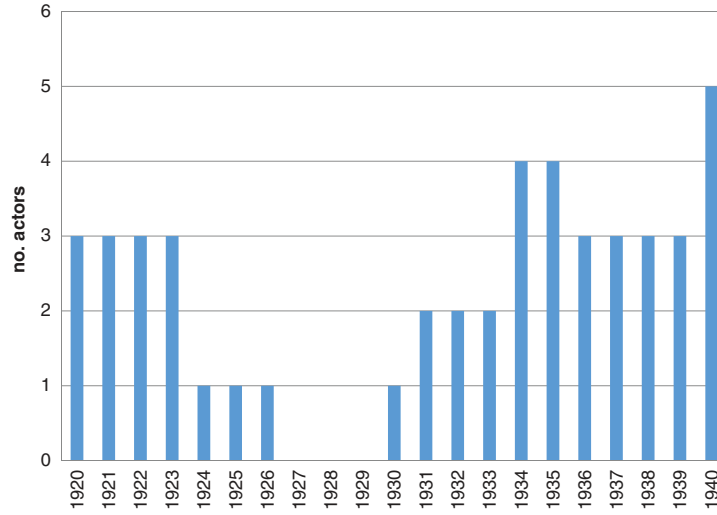
I will begin my analysis in 1920, by which time the feature film and the structure of production-distribution-exhibition that would characterize the industry for the rest of the silent era were well established. I will end in 1940, just before the United States entered World War II, bringing the careers of many actors to a precipitous (and sometimes permanent) halt. Seventy-two different actors made the Top Ten between 1920 and 1940 inclusive (excluding 1930s ninth most popular actor, the canine star Rin Tin Tin). Table 1 lists the years of appearance between 1920 and 1940 for the 33 actors who were voted to the Top Ten at least three times over that period. To the left I put all actors who made their debuts on the list in the 1920s, and to the right all actors who debuted on the list in the 1930s, by initial year of appearance. It is notable that each actor made the list as either a silent star or a talking star—none span the two eras. This is not to say that all the careers played out entirely within one or the other era; for example, Greta Garbo and Joan Crawford were popular actors in silent films before becoming Top Ten stars in sound films, and a number of the silent Top Ten stars acted in sound films, but not to the same level of acclaim.[22] Figure 2 plots the number of each year's Top Ten stars who were still on the list 5 years later. The years surrounding the

20. The weekly publication was known as the *Exhibitor's Herald* from 1915 to 1928. After absorbing a rival publication, *Motion Picture World*, it was renamed the *Exhibitor's Herald World* (1928–1930) and then the *Motion Picture Herald*. The *Motion Picture Herald* was eventually closed, and the poll continued in an annual sister publication, the *International Motion Picture Almanac*.

21. Even casual perusal of the Top Ten data indicates that the chosen actors are major stars. For example, the 2011 Top Ten were (in order): Brad Pitt, George Clooney, Johnny Depp, Leonardo DiCaprio, Matt Damon, Sandra Bullock, Bradley Cooper, Robert Downey, Jr., Meryl Streep, and Ben Stiller.

22. For example, the three silent era late-comers to the Top Ten list are Clara Bow, whose last film was released in 1933 when she was only 28 years old; William Haines, whose last film was released in 1934 when he was only 34 years old; and Richard Barthelemess, who lasted until the early 1940s and played a number of sound roles, but is best known today for his work in silent films. Silent star Colleen Moore made the list in 1931, but her most recent movie at that point was a non-talking film released in 1929. After an enormously successful silent career, Moore retired in 1934 at the age of 35, having made only four talking films.

FIGURE 2
Number of Actors on Top Ten List Five Years Later



Source: *Motion Picture Daily* annual poll of exhibitors.

transition to sound appear very low relative to the years that preceded and followed them.

Thus, evidence from exhibitor polls suggests that the careers of top stars were indeed disrupted by the coming of sound, as film scholars have proposed. I now turn to a systematic analysis of the larger population of movie actors.

IV. ALL CREDITED ACTORS

I develop a data set of all actors who played credited roles in feature films from 1920 through 1940. My source is the IMDB, a website that seeks to provide information on all films ever released and distributed in the United States (it lists films dating back to the 19th century).[23] I exclude documentaries and animated films from my analysis, because neither has actors in the traditional sense. The IMDB also includes data on actor age and gender. Because it is important to control for age when estimating an actor's "mortality," and the effect of age may differ by gender (see Fleck and Hanssen 2016), I will exclude actors with no birth year listed.[24]

My data set, thus defined, consists of 8,930 actors, each of whom played at least one credited role in a feature film between 1920 and 1940, inclusive.[25] I set up the data as an unbalanced panel. An actor enters the panel the first year in which he or she plays a credited role and leaves it the last year he or she plays a credited role. I will consider an actor's career to be ongoing in year t if he or she played any credited roles in any subsequent year $t + k$, where $k \geq 1$. I will consider an actor's career to terminate in year t if the actor played no credited roles in any subsequent year.

23. According to its own statistics (http://www.imdb.com/stats), the IMDB has compiled information on several million actors who acted in nearly half-a-million feature films, millions of TV episodes, and hundreds of thousands of film shorts. (It is updated continually.) To test the accuracy of IMDB data, I compared them to film listings from the American Film Institute (AFI) (https://catalog.afi.com/Catalog/Showcase) for selected years (the process is time consuming). I found a match rate of about 95%, with most differences accounted for by the fact that my dataset includes serials (which the AFI does not) and excludes documentary, animated films, and shorts (which the AFI includes occasionally). In addition, my data are restricted to U.S.-produced films and coproductions, while some of the films listed by the AFI are foreign productions.

24. Fleck and Hanssen (2016) find that female actors play lead roles at younger ages, exit motion pictures at younger ages, and have shorter careers on average than male actors. Actors for whom no birthdate is listed are likely to be less well-known and thus may have more poorly documented careers. Actors without birthdates account for about 10% of total credited roles listed by the IMDB for the 1920–1940 period (but only 3% of lead roles).

25. I define a "feature films as a film of 50 minutes or longer." Film "shorts," mostly musical or comedy, were a regular part of movie viewing through at least the 1930s.

TABLE 2
Summary Statistics

Variable	Mean	Standard Deviation	Min	Max	# Obs.
Entire sample					
Career years	5.91	4.83	1	26	42,447
Age	38.3	13.9	0	86	42,447
Male	0.68	0.46	0	1	42,447
Ever-lead = 1					
Career years	7.33	5.23	1	26	19,548
Age	36.2	13.2	0	85	19,548
Male	0.62	0.49	0	1	19,548
Ever-lead = 0					
Career years	4.70	4.01	1	26	22,899
Age	40.0	14.3	0	886	22,899
Male	0.74	0.44	0	1	22,899

Source: IMDB. 8,930 actors who played a credited role in at least one feature films between 1920 and 1940, inclusive.

I will consider an actor's career to be censored if he or she played a credited role after 1940, when my sample period ends. I take actor careers back to 1915, 5 years before the start of my sample period, so that (e.g.) an actor who played at least one credited role in a feature film in every year from 1915 through 1919 will enter the data set in his sixth career year. Actors whose careers began before 1915 may be subject to some censoring, but given that relatively few feature films were produced in the United States before 1915, this latter censoring is probably not consequential.[26] There is thus a possible (censored) maximum of 26 career years per actor in my data set.

The top of Table 2 provides summary statistics. The average career lasts slightly more than 5 years and the average actor is 38 years old.[27] Roughly two-thirds of the observations are accounted for by males. Figure 3 presents a histogram of the length of actor careers. More than half the actors in the data set have careers of 2 years or less in length, not adjusting for censoring. Consistent with the stereotype, for most actors, time in the spotlight is brief.

A. The Effect of the Transition to Sound on Actor Careers

How were actors affected by the transition to sound? In Figure 4, I plot the percentage of actors in year t who also played a role in any year $>t$, through 1940. Consistent with the short career lengths shown in Figure 3, anywhere from 15% to 20% of actors who played a credited role in a given year disappeared from the data set subsequently. As compared to the silent years, the transition years of the late 1920s/early 1930s show a fall in the proportion of actors who played credited roles in subsequent years, a hint that the transition years may have increased actor mortality. But note that the increase appears to extend beyond the transition period—whereas all but one of the pre-1927 years show repeat rates of 85% or more, only one of the post-1927 years does so.

The right-censoring present in the raw career-length data will lead to an underestimation of the duration of actor careers if not taken into account—some "employment spells" were ongoing when the sample period ends in 1940. Career length is censored for approximately one-third of the actors in the data set—and censoring affects more sound-era than silent-era actors, for the simple reason the former enter the data set later than the latter. I will therefore turn to duration analysis.

I begin by plotting Kaplan–Meier empirical survival curves—the Kaplan and Meier (1958) estimator takes censoring into account. The top of Figure 5 plots a survival curve for the entire 1920–1940 time-period, while Table 3 presents the underlying data.[28] Survival rates are lowest at the beginning of an actor's career—nearly 20% of actors cast in credited roles did not make it beyond their first year, and nearly 30% did not make it beyond their second. After 3 years of experience, the rate of survival increases, and then remains relatively constant, with about 10% of actors exiting with every additional career-year that passes. The median career lasts about 5 years.

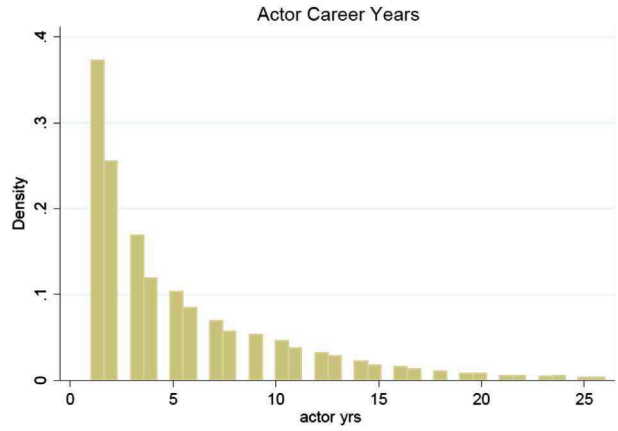
The bottom of Figure 5 plots Kaplan–Meier survival curves separately for the transition and nontransition years. The dashed transition period survival curve is everywhere below the solid nontransition-period survival curve—for all levels of experience, exit rates were higher during

26. The first feature films released in the United States were imported from Europe circa 1911/1912. The revolutionary (and controversial even then) *The Birth of a Nation* opened in New York in March 1915, ran for 802 straight performance, broke box office records wherever it was shown, and demonstrated that the potential audience for feature films was huge. See, for example, Balio (1985, 111–13)

27. The "0s" in the age data do not reflect missing observations, but rather the fact that babies were sometimes cast in films.

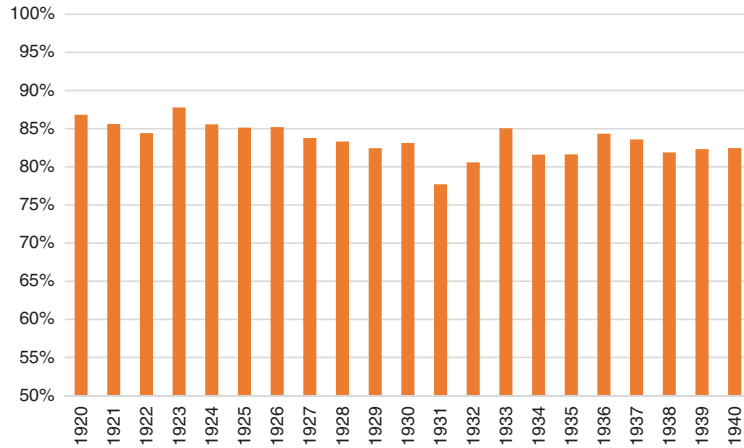
28. The Kaplan–Meier empirical survival function is $S(ti) = \prod_{j \le t}(1 - \frac{di}{ni})$, where t signifies the time period; n_i is the number of subjects at risk at the beginning of time period t_i; and d_i is the number of subjects who exit during time period t_i. Censored observations are excluded, so that $c_i = n_{i-1} - d_{i-1} - n_i$.

FIGURE 3
Histogram of Actors by Career Length (Years)



Source: IMDB—8,930 actors who played credited roles between 1920 and 1940, inclusive.

FIGURE 4
Proportion of Actors Repeating in a Future Year (1920–1940)

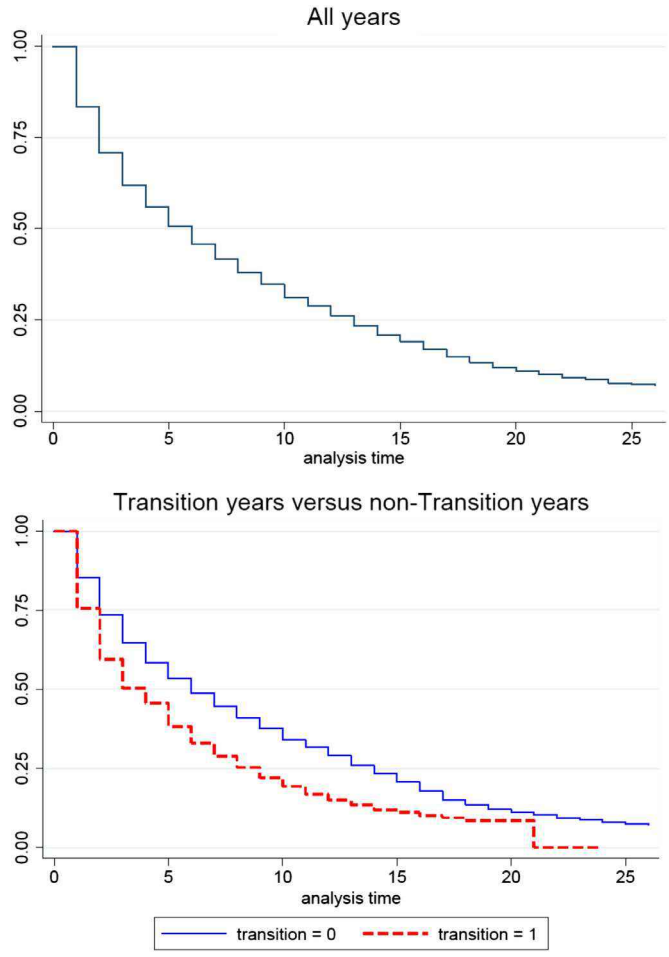


Source: IMDB—8,930 actors who played credited roles between 1920 and 1940, inclusive.

the transition to sound. In other words, the probability of making it to period $t+1$ (one's sixth year, say) given one had survived until period t (one's fifth year) dropped for all values of t.

The Kaplan–Meier calculations are made under the assumption that the sample is homogenous, but, in fact, the actors in the data set differ in two important and observable ways: by age and by gender. Age has been shown to affect career mortality, and the effect to differ by gender (Fleck and Hanssen 2016). Any sorting along such characteristics may mask true changes in the hazard function. For example, if silent actors "aged out" in large numbers coincident with the coming of sound (which occurred roughly a dozen years after the feature film became the norm), one could find the pattern displayed at the bottom of Figure 5.

FIGURE 5
Kaplan–Meier Empirical Survival Curves—Actors (1920–1940)



Source: IMDB—8,930 actors who played at least one credited role in a feature film between 1920 and 1940, inclusive.

To control for time-varying age and gender, I will estimate proportional hazards models.[29] The proportional hazards model not only allows the inclusion of time-varying covariates, but also avoids the necessity of making assumptions regarding the underlying distribution of the baseline hazard. The instantaneous hazard function for individual i at time $t > 0$ takes the form

$$h_i(t|x) = \lambda_0(t) * \exp(\boldsymbol{x}'_{it}\beta), \tag{1}$$

where λ_0 is the (nonnegative) baseline hazard function, which is permitted to vary with time; $\boldsymbol{x}$ is a vector of covariates associated with individual i at time t; and β is a vector of parameters to be estimated. The hazard rate measures the instantaneous probability of leaving state s (in this paper, employment in credited roles) at time t, conditional on having survived in state s until time t.

I begin with the widely used Cox proportional hazards model. The initial regressor of interest will be an indicator variable signifying the transition period years.[30] I will present hazard ratios in my tables rather than raw coefficients, because hazard ratios are easier to interpret. A hazard ratio

29. On duration models, see, for example, Kiefer (1988) and Wooldridge (2002, chapter 20).

30. Thus $\exp(\beta)$ can be interpreted as the proportional change in the hazard rate associated with moving from a regressor value of zero to a regressor value of one.

TABLE 3
Empirical Survival Function

Actor Career Year	Beginning Total	Exits	Censored	Survival Function	Standard Error
1	8,930	1,478	659	0.83	0.00
2	6,793	1,029	435	0.71	0.00
3	5,329	670	300	0.62	0.01
4	4,359	417	268	0.56	0.01
5	3,674	354	236	0.51	0.01
6	3,084	290	197	0.46	0.01
7	2,597	239	162	0.42	0.01
8	2,196	189	139	0.38	0.01
9	1868	161	146	0.35	0.01
10	1,561	157	110	0.31	0.01
11	1,294	98	117	0.29	0.01
12	1,079	100	83	0.26	0.01
13	896	96	66	0.23	0.01
14	734	79	50	0.21	0.01
15	605	52	51	0.19	0.01
16	502	57	35	0.17	0.01
17	410	48	30	0.15	0.01
18	332	34	29	0.13	0.01
19	269	30	17	0.12	0.01
20	222	17	28	0.11	0.01
21	177	15	19	0.10	0.01
22	143	13	21	0.09	0.01
23	109	6	23	0.09	0.01
24	80	9	25	0.08	0.01
25	46	2	21	0.07	0.01
26	23	1	22	0.07	0.01

Source: IMDB. 8,930 actors who played credited roles between 1920 and 1940, inclusive.

is calculated by dividing the "treatment" hazard (in this case, the hazard rate during the transition period) by the "control" hazard (in this case, the hazard rate during the nontransition years). A hazard ratio of 1.10, for example, would indicate that the treatment is associated with a 10% increase in the hazard, while a hazard ratio of 0.90 would indicate that the treatment is associated with a 10% decrease in the hazard. I will present *z*-statistics from a test of the null that the hazard ratio is equal to one (i.e., the variable has no effect on the hazard rate). I will also include age and age-squared, and age and age-squared interacted with a male dummy variable, to allow age to affect males and females differently.

Estimated hazard ratios and corresponding *z*-statistics from the Cox model are shown in Table 4, columns 1 and 2. The first column shows the result without age and gender controls; the second column including age and gender controls. The predicted effect of the transition to sound is essentially invariant to the inclusion of the controls (although the controls themselves have statistically significant effects on the hazard rate). Transition to sound is associated with a 43% higher hazard rate—greater likelihood of exit—than the nontransition years.

The Cox model requires the assumption that the exact duration of spell lengths is known. However, in my data set, I do not observe the precise moment that an actor exits from motion pictures, but rather the last year in which an actor played a credited role in a feature film. In other words, I observe the underlying continuous durations only in disjoint intervals, with all actors who exited in a given year grouped together. Some will no doubt have exited earlier than others (in January rather than November, say), which introduces spurious "ties" (i.e., equal observed durations for different actual durations) that may affect the estimated hazard rate. I will therefore also estimate a grouped duration data model, based on the framework developed by Prentice and Gloeckler (1978). Prentice and Gloeckler add to the Cox model the assumption that the baseline rate is piecewise constant—that is, constant within each measured interval, but may vary from one interval to another. Each career-year will thus be allowed a different but constant baseline hazard, up through the 20th year. Relatively few actors in the data set experience careers that extend beyond 20 years (see Table 3), so career years 21 through 26 are grouped together and assumed to have the same, constant baseline hazard.

TABLE 4
The Transition Period (Hazard Ratios)

	Cox Model		Grouped Data Model	
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Transition	1.432	1.438	1.229	1.224
	(11.2)	(11.3)	(6.4)	(6.3)
Age		1.021		1.031
		(2.9)		(4.1)
Age^2		1.000		1.000
		(−1.5)		(−2.4)
Male		1.781		1.843
		(3.4)		(3.6)
Male × age		0.945		0.939
		(−6.4)		(−7.1)
Male × age^2		1.001		1.001
		(7.1)		(−7.9)
# obs	42,447	42,477	42,477	42,477
# subjects	8,930	8,930	8,930	8,930
# failures	5,641	5,641	5,641	5,641
Ln likelihood	−46,874	−46,668	−16,244	−15,946

Notes: Time to exit (i.e., career end), in years (z-statistics in parentheses). The table shows hazard ratios, with z-statistics in parentheses. The data set covers the 1920–1940 period, but counts years playing credited roles back to 1915. An actor's career is censored if he/she played a credited role after 1940.>

Columns 3 and 4 of Table 4 show hazard ratios from the grouped duration data model.[31] The transition to sound is associated with a 23% increase in the hazard rate relative to the non-transition years, a somewhat smaller effect than implied by the Cox model, but still large in magnitude and highly statistically significant. The age and gender controls are statistically significant, and of roughly the same implied magnitude as in the Cox estimations; as also in the Cox estimation, they appear to be largely orthogonal to the transition period indicator.

To check the robustness of these findings, I do three things. First, I rerun the analysis using three alternate transition periods: 1928–1931, 1929–1931, and 1930–1932. The estimates (not shown but available upon request) are qualitatively equivalent to those presented in Table 4: The transition period hazard rate rises by 30%–45% in the Cox model, and by 15%–30% in the grouped duration data model. Second, following Meyer (1990), I estimate a version of the grouped data model that incorporates a Gamma-distributed random variable to account for unobserved individual heterogeneity—"frailty"—across individuals (estimates again not shown). The variance of the gamma mixture is very small as compared to its standard error, and the estimated hazard ratios are essentially the same (to several digits) as those presented in Table 4, suggesting that unobserved individual heterogeneity is not important in explaining the effect of the transition to sound on career duration. Third, while most of the actors in my sample who exited during the transition period likely debuted in silent films—even during the 4-year transition period, the modal career lasted 3 years—some may have debuted in talkies, which were the norm by the early 1930s. What would happen were I to restrict my analysis solely to actors who began in silent films? To do this in a simple fashion, I estimate the equations shown in Table 4 on the set of actors who debuted in movies before 1928 (results again not shown, but available upon request). I find the transition period to be associated with an increase in hazard rates of between 25% and 45%—roughly the same as for the full set of actors.

B. "Major Actors" Versus "Minor Actors"

Thus, the period of transition to sound technology is associated with a substantial rise in the hazard rate for *all* actors who played credited roles in feature films, not merely the major stars. That said, the definition of major stars I employed in Section III was very exclusive—many popular actors had long and successful careers without being voted to the Top Ten.[32] Were actors who were generally better known—although not necessarily Top Ten stars—more or less likely to make the transition to sound than lesser known actors?

As discussed in Section II, the reason why the coming of sound shortened actor careers is debated: Was it because the actor's silent image was simply wrong for sound (or for that actor playing in a sound film), or was it instead because sound roles required different skills—skills that many silent actors lacked? The explanations are not mutually exclusive, but to the degree better-known actors were more seriously affected by

31. I use the maximum likelihood-based estimation procedure developed by Jenkins (1997), who provides a concise and lucid summary of the grouped duration data model. I also employ Jenkins' procedure to estimate the effect of incorporating a gamma mixture distribution to summarize unobserved heterogeneity (see what follows).

32. Top Ten actors account for less than 1% of all actors in my data set, and less than 2% of the actor-year observations. Estimating hazard rates for the set of Top Ten actors separately, I find slightly smaller hazard ratios than for the entire population of actors (e.g., 1.15 vs. 1.23 using the grouped data model), but they are imprecisely estimated (which is not surprising given the tiny size of the Top Ten sample).

the coming of sound, an image-based explanation becomes more plausible, whereas if both better- and lesser-known actors were similarly affected, the skills-based explanation becomes more plausible.

To distinguish between better-known and lesser-known actors, I will make use of the fact that the IMDB lists for each film the order in which actors appeared in the credits. I will classify an actor listed as first or second in the credits as playing a "lead role."[33] This is an imperfect designation—there are sometimes more than two leads in a film (as in a Marx Brothers production, say), or it may be difficult to determine whether there are any leads (as in "all-star" projects). However, to the degree the order of listing in the credits is correlated with the significance of the role, first or second listing can serve as a proxy for having played an important role.

I will explore whether the transition to sound affected actors who played at least one lead role, thus defined, ("ever-leads") differently from actors who never played a lead role ("never-leads"). Of the 8,930 actors in the data set, 2,589 played at least one lead role. The second part of Table 2 shows summary statistics for "ever-leads" and "never-leads" separately. Actors who played at least one lead role had longer careers—more than 3 years longer on average—were slightly younger on average, and much more likely to be female (which probably accounts for the age difference; female actors tend to start and end their careers at younger ages). These differences suggest my measure is indeed picking up more and less "important" actors. Consistently, although actors who played one or more lead roles account for about 30% of the actors in the data set, they make up nearly half of the actor-year observations in the panel.

I will begin by including an (ever-lead × transition period) interaction term along with an ever-lead dummy variable in the Cox model estimation. The interaction term will pick up whether the transition period affected actors who played lead roles differently than actors who did not. The estimated hazard ratios and corresponding z-statistics are shown in the first two columns of Table 5. Playing a lead role is associated with substantially lower career mortality, not surprisingly, but the point estimates on the interaction term are very close to 1.0, the z-statistics are very small, and the hazard ratios for the transition period indicator are more-or-less the same as those shown in Table 4. It appears that the transition period affected major and minor actors in roughly the same way.

Turning to the grouped duration data model, given that each career year is allowed a different but constant baseline hazard, I cannot include a transition period interaction term. Instead, I simply estimate hazard ratios separately for ever-leads and never-leads. The results are shown in columns 3–6 of Table 5. Similar to the Cox model results, the point estimates of the hazard ratios for the transition period are nearly equal across the two groups.

In short, the coming of sound appears to have affected major and minor actors (defined by whether the actor ever played a lead role) similarly. Indeed, if anything, the point estimates indicate that less well-known (never-lead) actors had slightly *higher* hazard rates. This suggests it is unlikely the increased hazard rate—rate of exit—associated with the transition years was due primarily to the actor's silent film image. Rather, it suggests the alternative: that the skills needed to succeed in sound films were simply different than the skills needed to succeed in silent films.

C. Silent Era Versus Sound Era Exit Rates

By using a single transition period indicator, I am picking up how the transition-period hazard rate compares to the average hazard rate over the silent and sound periods combined. However, it is possible that hazard rates changed with the coming of sound. To see if this were so, I replace the transition period indicator variable with separate silent era (1920–1928) and sound era (1933–1940) indicator variables. Doing so will not affect the influence of the transition period on average, of course, but will allow the influence to differ across the two eras.

Table 6 presents the results. Whereas the silent-era hazard is 30%–50% below the transition period hazard, the sound-era hazard is

33. The nature of credits has changed somewhat over time. During the silent era, most films provided only opening credits; with the coming of sound, closing credits became more common, often in conjunction with abbreviated opening credits. For example, 1922s classic *Robin Hood*, starring Douglas Fairbanks, has only opening credits, while 1938s classic *The Adventures of Robin Hood*, starring Errol Flynn, has both opening and closing credits, with the opening credits listing 10 actors and the closing credits listing 20 (beginning with the 10 from the opening credits—in the same order). As a general rule, whether opening or closing credits (or both) were provided, credits generally began with leads and followed with supporting roles. The same is true today; see, for example, https://www.studiobinder.com/blog/where-credit-is-due-film-credits-order-hierarchy-with-free-film-credits-template/.

TABLE 5
Ever-Leads Versus Never-Leads and the Transition Period (Hazard Ratios)

	Cox Model		Grouped Data Model			
			Ever-Lead = 1		Ever-Lead = 0	
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Transition	1.466	1.467	1.253	1.250	1.307	1.307
	(10.4)	(10.4)	(3.5)	(3.5)	(7.2)	(7.2)
Ever-lead	0.405	0.393				
	(−24.9)	(−25.0)				
Transition × ever-lead	0.982	0.984				
	(−0.3)	(−0.2)				
Age		1.019		1.141		0.995
		(2.6)		(6.8)		(−0.8)
Age^2		1.000		0.998		1.000
		(−2.6)		(−6.0)		(−0.8)
Male		1.396		4.079		0.910
		(2.1)		(3.0)		(−9.6)
Male × age		0.946		0.867		0.969
		(−6.5)		(−5.9)		(−3.4)
Male × age^2		1.001		1.002		1.000
		(7.8)		(6.7)		(4.9)
constant			0.082	0.008	0.121	0.095
			(−9.0)	(−10.8)	(−7.0)	(−4.6)
# obs.	42,447	42,477	19,548	19,548	22,899	22,899
# subjects	8,930	8,930	2,589	2,589	6,341	6,341
# failures	5,641	5,641	1,403	1,403	4,238	4,238
Ln likelihood	−46,416	−46,219	−5,019	−4,867	−10,711	−10,563

Notes: Time to exit (i.e., career end), in years (z-statistics in parentheses). The table shows hazard ratios, with z-statistics in parentheses. The data set covers the 1920–1940 period, but counts years playing credited roles back to 1915. An actor's career is censored if he/she played a credited role after 1940.

less than 10% below. The two duration models now produce hazard ratios that are much closer in value. In short, it appears that although the rate of actor exit fell somewhat after the very early 1930s, it did not return to what it had been through most of the 1920s. This suggests the possibility that some of the effect generally attributed to the transition period may instead reflect the fact that actor rates of exit were simply higher (at least through the 1930s) once sound films became the norm.

It should be emphasized that because I measure hazard rates only through 1940, I cannot say whether the higher career mortality (relative to the silent era) I document for the 1930s continued, was magnified, or fell back in subsequent years. Moul (2001) argues the quality of sound films improved in the 1930s with cumulative experience, as the result of "learning by doing." It is certainly true that 1939 has been labeled a "golden year" for motion pictures—it saw the release of *Gone with the Wind*, *The Wizard of Oz*, *Mr. Smith Goes to Washington*, *Stagecoach*, and a number of other now-classic films.[34] But "learning" presumably occurred during the silent era, too. Motion pictures were then a relatively new phenomenon, with feature films dating back only to the early-to-mid-teens.[35] Many critics consider the art of the silent film to have reached its apex in the late 1920s (just as sound films emerged), with the release of such motion picture classics as *Sunrise*, *The Passion of Joan of Arc*, and *The Crowd*. Motion pictures have continued to change through the present day. Determining whether actor hazard rates have risen, fallen, or remained unchanged over time is a topic for future research.

V. THE INFLUENCE OF THE GREAT DEPRESSION: A PLACEBO TEST

The transition to sound, however I define it, necessarily overlaps other potentially important events; most notably, the onset of the Great

34. See, for example, Sennet (1989) and Hischak (2017). See Sedgwick (2002) for a discussion of product differentiation in movies from the mid-1940s through the mid-1960s.

35. For a brief history of the emergence of the feature film and how it affected the structure of the film industry, see Hanssen (2000, 401–08) and the citations therein.

TABLE 6
Silent Period Versus Sound Period (Hazard Ratios)

	Cox Model		Grouped Data Model	
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Silent	0.512	0.508	0.689	0.691
	(−18.1)	(−18.3)	(−10.0)	(−9.9)
Sound	0.925	0.927	0.926	0.931
	(−2.3)	(−2.2)	(−2.2)	(−2.1)
Age		1.023		1.030
		(3.0)		(4.1)
Age^2		1.000		1.000
		(−1.6)		(−2.3)
Male		1.709		1.824
		(3.3)		(3.6)
Male × age		0.945		0.940
		(−6.4)		(−7.0)
Male × age^2		1.001		1.001
		(7.1)		(7.9)
Constant			0.086	0.039
			(−10.0)	(−11.6)
# obs.	42,447	42,477	42,477	42,477
# subjects	8,930	8,930	8,930	8,930
# failures	5,627	5,627	5,627	5,627
Ln likelihood	−46,694	−46,482	−16,199	−15,927

Notes: Time to exit (i.e., career end), in years (z-statistics in parentheses). The table shows hazard ratios, with z-statistics in parentheses. The data set covers the 1920–1940 period, but counts years playing credited roles back to 1915. An actor's career is censored if he/she played a credited role after 1940.

Depression.[36] Is this likely to contaminate my results? On the one hand, it is certainly possible that rising unemployment rates nationwide increased the stock of would-be actors, which could in turn have influenced actor hazard rates. On the other hand, an "excess supply" of actors—working at menial jobs in hopes of a chance at movie stardom—is a longstanding phenomenon.[37] Furthermore, as shown in Table 6, the transition period displays a higher actor hazard rate than the rest of the 1930s, despite the fact that Depression unemployment rates continued to rise until 1933, and did not return to the level of 1930 until 1941.[38]

Nonetheless, I will conduct a placebo test, examining an entertainment business affected similarly by the Great Depression but *not* by the coming of sound films: Major League Baseball (MLB). If my transition period measure is truly picking up the effect of sound technology, and not of something else, it should not be associated with higher hazard rates among baseball players.[39]

A number of factors make baseball players a potentially good comparison group. First, there is no obvious mechanism by which sound motion pictures can have affected ballplayer hazard rates directly.[40] Second, the Great Depression, at least in theory, *could* have affected ballplayer hazard rates in the same manner that it might

36. That is, unless I restrict the definition of the transition period to 1928–1929, which I did as a robustness test. The 1928–1929 period is really too short and too early in the transition process to expect it to yield much (as Figure 1 shows, there were very few sound films released in 1928, and less than half of all cinemas were wired for sound by the end of 1929). Nonetheless, using the 1928–1929 definition, I find that both the Cox and the grouped data model estimates continue to indicate an increase in transition period hazard rates, although of much smaller magnitude. The hazard ratio in the Cox model estimate is about half that for the 1929–1932 transition period definition, although still statistically significant at less than 1%. The grouped data model estimates are positive, but small and statistically insignificant.

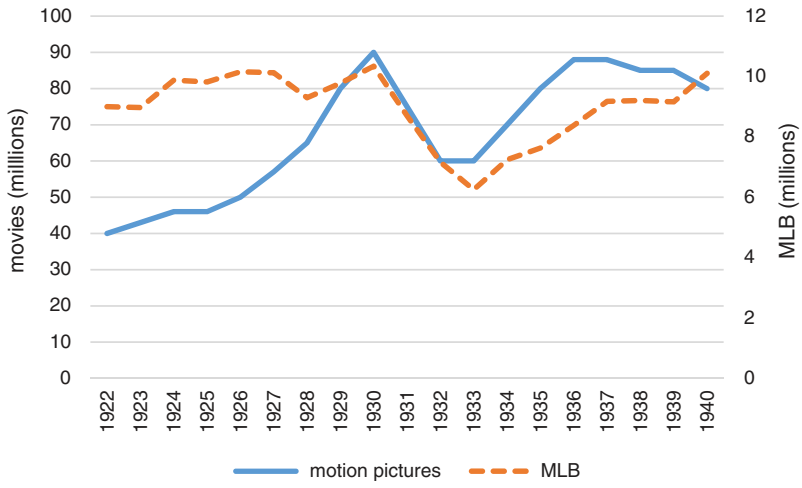
37. A famous industry ad from the early 1920s (run in newspapers around the country) reads in large print, "Do not Try to Break into the Movies," and in smaller print beneath, "Out of 100,000 Persons Who Started at the Bottom of the Screen's Ladder of Fame, ONLY FIVE REACHED THE TOP." In 1927, the publication *Photoplay* ran a four part series titled, "The Truth About Breaking into the Movies" that ended with the ominous warning, "Do not go to Hollywood!" See, for example, Burr (2012, 43). A copy of the industry ad can be found at https://martinturnbull.com/2012/11/10/dont-try-to-break-into-the-movies-advertisment/. For a discussion of, and some citations from the literature on, the labor supply and careers choices of creative artists (including actors), see Throsby (1994).

38. Bureau of Labor Statistics, *Historical Statistics of the United States Colonial Times to the 1970, Part I* (U.S. Government Printing Office, 1975), Series D 85-86 Unemployment: 1890–1970, 135.

39. I thank an anonymous referee for suggesting this test.

40. This is not true of an ostensibly more similar comparison group: Broadway actors. Sound motion pictures rendered stage and movie acting more alike, and thereby inspired a migration of actors from Broadway to Hollywood (indeed, the IMDB maintains a webpage titled "Broadway to Hollywood Exodus in the late 1920s-mid 1930s" that lists over 100 actors; https://www.imdb.com/list/ls052786758/). As Crafton (1997, 352–54) writes in a sub-section titled, 'Flirting with Broadway,' "There was no obvious formula for mastering the new medium [sound technology]. Some studios evidently expected a hybridization between Broadway and Hollywood to occur, hence the rush to purchase musical and dramatic properties, their authors and their personnel, lock, stock and barrel." Pioneering silent (and subsequently sound) film director Alan Dwan is quoted in an interview as follows: "[In the silent era] the theater actors were terrible [as movie actors]. They could not work our way. They'd come in and say 'What do I do? Let me read the script.' But if there *was* a script, they did not know what they were reading, because it's nothing like a play; and we'd just say, 'You come in and say so-and-so' and they'd come in and they could not remember what it was – *or* you could not stop them [talking]. … it was a different technique altogether. But with talking pictures, they [theater actors] have an advantage because they can deliver lines: a good actor can make a dull scene sound pretty good with his ability to speak, and if he has some pretty good lines it's interesting." (Bogdanovich 1997, 67).

FIGURE 6
Attendance—Motion Pictures and Major League Baseball (1922–1940)



Source: *Historical Statistics of the United States, Colonial Times to 1970, Part 1*, Series H 862–877, pp. 399–400.

have affected Hollywood hazard rates—as alternate employment opportunities dwindled, the migration of would-be athletes to baseball, as of would-be actors to movies, may well have increased.[41] Finally, as Figure 6 shows, the Great Depression hit motion pictures and MLB similarly—an initial respite until 1931, followed by a substantial downturn through 1933, and then a gradual recovery.

I will set up my baseball panel similarly to my actor panel, and just as I included all actors who played at least one credited role in a feature film in any year from 1920 through 1940, I will include all players who appeared in at least one Major League ballgame in any season from 1920 through 1940.[42] As with the actors, a player enters the panel the first season in which he appears in a game and exits the panel in the last season in which he appears in a game. The player's career is ongoing in season t if he plays any games in any subsequent season $t+k$, where $k \geq 1$, and terminates in year t if he appears in no games in any subsequent season. Careers are censored if a player appeared in any games after the 1940 season, when the sample period ends. Thus defined, my data set contains 2,823 different ballplayers who played in the major leagues from 1920 through 1940. The average ballplayer was on an MLB roster for five seasons, censoring not accounted for, similar to the career length of the average movie actor in my data set.

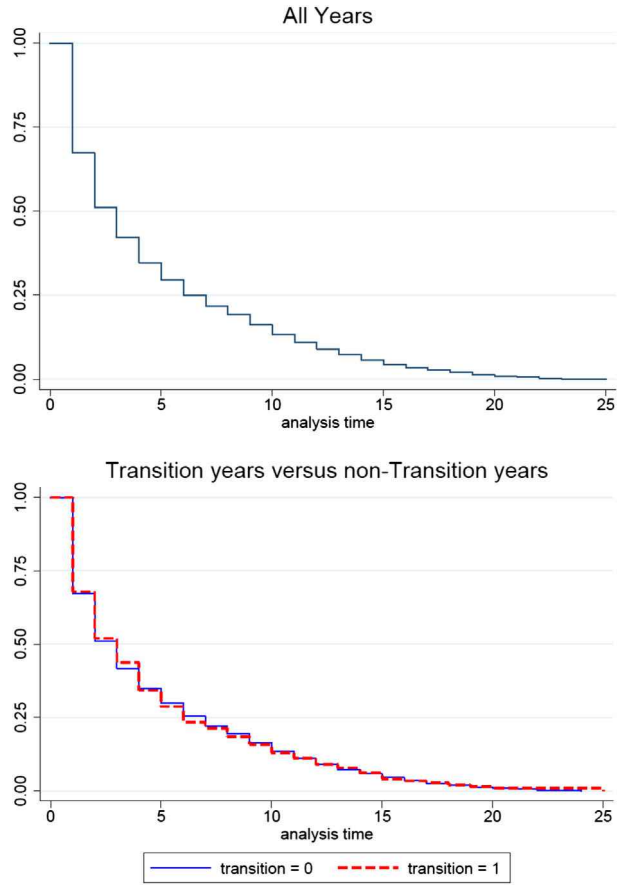
At the top of Figure 7, I plot a Kaplan–Meier empirical survival curve for this set of ballplayers. MLB of the '30s and '40s appears to have had a higher rate of turnover even than contemporaneous Hollywood—more than one-quarter of the players in the data set lasted only a single season, censoring taken into account. Most germane to this analysis, as the chart at the bottom of the figure shows, survival rates over the 1929–1932 transition period appear no different than survival rates for other years. This stands in in stark contrast to what the bottom of Figure 5 shows for actors.

Estimated hazard ratios and corresponding z-statistics for MLB players are presented in Table 7. In no case is there any indication of higher turnover of ballplayers during the transition years. Indeed, the point estimates suggest slightly *lower* hazard rates over the 1929–1932 interval, although none are

41. While both movies and baseball suffered financial problems in the early 1930s (several studios entered receivership and the American and National Leagues lost money collectively), compared to alternative industries, they did relatively well and recovered relatively quickly (see, e.g., Figure 6). See, for example, Balio (1993) on the motion picture industry during the Great Depression, and Surdam (2011) on Depression-era MLB.

42. There are numerous on-line sources of baseball data. My data are downloaded from Sean Lahman's well-known website: http://www.seanlahman.com/baseball-archive/statistics/. I use his "Batting.cvs" file.

FIGURE 7
Kaplan–Meier Empirical Survival Curves—MLB Players (1920–1940)



Source: Sean Lahman data set ("Batting.cvs")—2,823 MLP players who appeared in at least one game between 1920 and 1940, inclusive.

statistically significantly different than one. In short, the results of the placebo test are consistent with the proposition that the transition period measure, when applied to actors, is picking up the effect of sound technology, and not of the Great Depression.[43]

VI. A QUICK LOOK AT MOVIE ACTOR EMPLOYMENT

With the coming of sound technology, films changed in ways that affected the total number of actors employed. To begin with, sound allowed for more complex plots. The change, noted by film scholars (as discussed in Section II), can be observed in corresponding changes in IMDB genre classifications. The typical IMDB classification consists of a combination of one

43. The Great Depression was not the only possible confounding event; there was also the rise of radio, an alternate source of entertainment. National radio networks CBS and NBC were established in the late 1920s, and the first hugely popular radio program, *Amos 'n' Andy*, was launched in 1929 (Hillard and Keith 2005, chapter 2). Although studio bosses and team owners were leery, radio would eventually become a means of generating substantial revenue and publicity for both movies and baseball. Initially, studios forbade radio appearances by actors under contracts and many teams banned live broadcasts of their games, but a happy symbiosis eventually resulted, in which movie stars would portray on radio scenes from upcoming films, and baseball would prove to be the perfect radio sport. For more on each relationship, see, for example, Jewell (1984) and Walker (2015).

TABLE 7
Placebo Test—Major League Baseball Players (Hazard Ratios)

	Cox Model		Grouped Data Model	
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Transition	0.997	0.973	0.996	0.968
	(−0.1)	(−0.1)	(−0.1)	(−0.1)
Age		1.11		1.082
		(3.4)		(1.9)
Age^2		1.000		1.000
		(−0.5)		(1.0)
# obs.	10,516	10,516	10,516	10,516
# subjects	2,823	2,823	2,823	2,823
# failures	2,251	2,251	2,251	2,251
Ln likelihood	−15,553	−15,408	−5,307	−5,141

Notes: Time to exit (i.e., career end), in years (z-statistics in parentheses). The table shows hazard ratios, with z-statistics in parentheses. The data set covers the 1920–1940 period, but counts seasons played back to the start of the player's career. A player's career is censored if he played in any season after 1940.

or more of 20 "primal" IMDB categories.[44] For example, the genre listed by the IMDB for 1925s (silent) *The Gold Rush* is "Adventure, Comedy, Drama," for 1925s (silent) *The Big Parade* is "Drama, Romance, War", for 1939s (talking) *Gone with the Wind* is "Drama, History, Romance," and for 1939s (talking) *The Wizard of Oz* is "Adventure, Family, Fantasy." Films released from 1920 through 1928 (silent films) represent 137 genre classifications (i.e., combinations of the primal categories), while films released from 1933 through 1940 (sound films) represent 502 genre classifications, more than tripling in number. While these genre classifications are necessarily subjective, for both the silent and the sound films only 3.5% of movies were excluded because of lack of information, suggesting the difference is not merely that sound films are better documented or easier to view. Furthermore, the direction of change in the primal categories is similarly suggestive. The biggest relative increases moving from silent to sound are in the categories "musical" (no surprise there), "mystery" (probably tough to spin a mystery without spoken dialogue), and "crime" (characterized by ambiguous bad guys). The biggest relative decreases are in "comedy", "romance", and "western"—genres with simple stories that the silent screen told well.

In addition, the number of actors credited per film rose with sound, as one might expect given more complex plots. For a storyline to be simple, the number of characters the viewer must keep track of has to be small. The average silent feature film listed 8.5 credited actors, while the average sound feature film listed nearly 13. In other words, sound appears to have increased the employment of credited actors by more than one-third on a per film basis.

Finally, the sound era (through the 1930s) saw the production and release of substantially more films. The average number of U.S.-produced feature films rose from 140 per year over the 1920–1928 period—the silent era—(195 per year from 1925 through 1928), to about 450 per year over the 1933–1940 period—the sound era. Movie attendance rose from an average of about 50 million tickets sold per year over the 1922–1928 period to an average of nearly 80 million over the 1933–1940 period (see Figure 6), even as nominal ticket prices increased from the mid-1930s onwards (and the early 1930s was a period of deflation). How much of this rise in attendance was due to sound rather than to other factors is impossible to say. But the combination of more actors per feature film and more feature films per year resulted in a near-doubling of the number of different actors playing credited roles in feature films annually, from an average of 450 per year in the 1920s to nearly 800 per year in the 1930s. Thus, in terms of simple actor employment numbers, the early sound era had the silent era beat.[45]

VII. CONCLUSION

The replacement of silent by sound motion pictures may not be history's most important technological development from a social welfare

44. The primal categories are: action, adventure, biography, comedy, crime, drama, family, fantasy, film-noir, history, horror, music, musical, mystery, romance, sci-fi, sport, thriller, war, and western. The IMDB writes of its genre classifications, "It should be remembered that these definitions are guidelines—no single definition can cover every possible eventuality. Some of these genres are objective; for the others, a little leeway is given." See, https://help.imdb.com/article/contribution/titles/genres/GZDRMS6R742JRGAG?ref_=helpms_helpart_inline#).

45. Determining whether actor salaries changed with the coming of sound is very difficult—information is scattered and incomplete. The silent era hosted a number of major stars who produced their own movies—Mary Pickford (perhaps the greatest star of the silent era), Douglas Fairbanks, Charlie Chaplin, Gloria Swanson; generally, these stars made a fortune (except for Swanson, who lost a fortune on a single movie that was never released). The actor-producer largely disappeared with the coming of sound, returning in the post-World War II era following the decline of the studio system (see, e.g., Hanssen and Raskovich 2019; Weinstein 1998). That said, during both the 1920s and 1930s, most movie stars were under long-term contracts that paid them flat weekly salaries.

perspective, but it provides one of history's most colorful examples of how product innovation can affect employment. Almost since its inception, the disruptive effect of sound technology on the careers of some of the silent era's most important actors has fascinated observers. In this paper, I conduct what I believe to be the first systematic analysis of the effect of the introduction of sound technology on actor careers. I analyze a data set of nearly 10,000 actors who played in motion pictures from 1920 through 1940, inclusive. I find the transition period to be associated with a large rise in hazard rates—in the rate at which actors exited from the movie acting business—not only among major stars but also among those who played more minor roles. I also find that sound films raised hazard rates generally, so that whereas the transition period is associated with 30%–50% higher hazard rates as compared to the silent era, it is associated with only about 10% higher hazard rates as compared the sound era (at least through the 1930s). The sound era also saw an increase in both the number of actors cast per movie (sound plots could be more complex) and the number of movies produced, leading to a sharp rise in the total number of actors playing credited movie roles.

In a widely cited article, Van Reenen (1997, 256) notes the "dearth" of studies on the direct effect of innovation on employment, a dearth he attributes to the fact that

> It is difficult to obtain firm-specific measures of technology on a consistent basis over time. Furthermore, when this information is available, one must control for the fact that technology, as well as employment, are chosen by the firm.

This paper examines a technological innovation that not only upended an industry but was adopted by all firms at roughly the same time (by force of necessity—silent films were rendered obsolete). Of course, the motion picture industry is idiosyncratic in many ways. Yet there have been other, similarly dramatic developments and diffusions in the entertainment business: the effect of radio on vaudeville, the effect of television on movies, the effect of streaming on both—to mention only a few. If the information technology industry continues to churn out Schumpeterian innovations (digital actors anyone?), the coming of sound motion pictures may offer an increasingly relevant example for the years to come.

According to the IMDB, which lists salaries for select stars for particular films, silent stars Norma Talmadge and John Gilbert were making $7,500 and $10,000 per week, respectively, in the 1920s, as compared to $4,000 per week in the 1930s for two of their sound counterparts, Bette Davis and Clark Gable. (How accurate are these IMDB listings? I have a copy of Humphrey Bogart's 1942 contract with Warner Brothers obtained from the USC archives; he was paid $2,750 per week, which is the same number as listed by the IMDB.) A 1927 article on the salaries of big silent-era stars states, "Lon Chaney earns $3,500 a week, say the well-informed along Hollywood Boulevard; Wallace Beery, $2,500; Adolph Menjou, $3,000; Gloria Swanson, before leaving Paramount, $7,500; Pola Negri, $5,000, and Laura La Plante, $1,700." (*Literary Digest*, July 9, 1927). In sum, there is little evidence that actor salaries rose with the coming of sound, and may even have fallen, but definitive conclusions are impossible to draw.

REFERENCES

Bakker, G. "Stars and Stories: How Films Became Branded Products." *Enterprise & Society*, 2, 2001, 461–502.

Balio, T. "Struggles for Control, 1908–1930," in *The American Film Industry*, edited by T. Balio. Madison, WI: University of Wisconsin Press, 1985.

——— *Grand Design: Hollywood as a Modern Business Enterprise, 1930–1939*. New York: Scribner, 1993.

Basinger, J. *Silent Stars*. Hanover: Wesleyan University Press, 1999.

Bogdanovich, P. *Who the Devil Made It*. New York: Ballantine Publishing, 1997.

Burr, T. *Gods Like Us: On Movie Stardom and Modern Fame*. New York: Pantheon Books, 2012.

Clayton Theater. "Selection of Sound Equipment to be Installed, 1928," in *Harvard Business Reports, Vol. 8, Cases on the Motion Picture Industry*. New York: McGraw Hill, 1930, 490–9.

Crafton, D. *The Talkies: American Cinema's Transition to Sound, 1926–1931*. New York: Scribner and Sons, 1997.

Eyman, S. *Mary Pickford: America's Sweetheart*. New York: Donald I. Fine, 1990.

——— *The Speed of Sound: Hollywood and the Talkie Revolution*. New York: Simon and Schuster, 1997.

Fleck, R. K., and F. A. Hanssen. "Persistence and Change in Age-Specific Gender Gaps: Hollywood Actors from the Silent Era Onward." *International Review of Law and Economics*, 48, 2016, 36–49.

Gomery, D. "The Coming of the Talkies: Invention, Innovation, and Diffusion," in *The American Film Industry*, edited by T. S. Balio. Madison, WI: University of Wisconsin Press, 1985.

Griffith, R., and A. Mayer. *The Movies*. New York: Simon and Schuster, 1957.

Hall, B. H., and B. Kahn. "Adoption of New Technology." NBER Working Paper No. 9730, 2003.

Hanssen, F. A. "The Blockbooking of Films Reexamined." *Journal of Law and Economics*, 43, 2000, 395–426.

——— "Revenue-Sharing in Movie Exhibition and the Arrival of Sound." *Economic Inquiry*, 40, 2002, 380–402.

——— "Vertical Integration during the Hollywood Studio Era." *Journal of Law and Economics*, 53, 2010, 519–43.

Hanssen, F. A., and A. Raskovich. "Casting Actors to Discover Stars during the Hollywood Studio Era." Working Paper, 2019.

Hillard, R. L., and M. C. Keith. *The Broadcasting Century and Beyond*. Burlington, MA: Focal Press, 2005.

Hischak, T. S. *1939: Hollywood's Greatest Year*. Lanham, MD: Rowman and Littlefield, 2017.

Jenkins, S. P. "Discrete time proportional hazards regression (pgmhaz)." Stata Technical Bulletin STB-39, September: 22–32. Reprinted in *Stata Technical Bulletin Reprints*, vol. 7, H.J. Newton (ed.), 109–121, 1998. College Station, TX: Stata Corporation, 1997.

Jewell, R. B. "Hollywood and Radio: Competition and Partnership in the 1930s." *Historical Journal of Film, Radio, and Television*, 4, 1984, 125–41.

Kaplan, E. L., and P. Meier. "Nonparametric Estimation from Incomplete Observations." *Journal of the American Statistical Association*, 53, 1958, 457–81.

Kiefer, N. M. "Duration Data and Hazard Functions." *Journal of Economic Literature*, 26, 1988, 646–79.

Meisenzahl, R., and J. Mokyr. "The Rate and Direction of Invention in the British Industrial Revolution: Incentives and Institutions." NBER Working Paper No. 16993, 2011.

Meyer, B. D. "Unemployment Insurance and Unemployment Spells." *Econometrica*, 58, 1990, 757–82.

Moul, C. "Evidence of Qualitative Learning-by-Doing from the Advent of the 'Talkie'." *Journal of Industrial Economics*, 49, 2001, 97–109.

Prentice, R. L., and L. A. Gloeckler. "Regression Analysis of Grouped Survival Data with Application to Breast Cancer." *Biometrics*, 34, 1978, 57–67.

Rosenberg, N. "Factor Affecting the Diffusion of Technology." *Explorations in Economic History*, 10, 1972, 3–33.

Sedgwick, J. "Product Differentiation at the Movies: Hollywood, 1946 to 1965." *Journal of Economic History*, 62, 2002, 676–705.

Sedgwick, J., and M. Pokornoy. "The Risk Environment of Film Making: Warner Bros in the Inter-War Years." *Explorations in Economic History*, 35, 1998, 196–220.

Sennet, T. *Hollywood's Golden Year, A Fiftieth Anniversary Celebration*. New York: St. Martin' Press, 1989.

Surdam, D. G. *Wins, Losses, and Empty Seats: How Baseball Outlasted the Great Depression*. Lincoln, NE: University of Nebraska Press, 2011.

Throsby, D. "The Production and Consumption of the Arts: A View of Cultural Economics." *Journal of Economic Literature*, 32, 1994, 1–29.

Van Reenen, J. "Employment and Technological Innovation: Evidence from U.K. Manufacturing Firms." *Journal of Labor Economics*, 15, 1997, 255–84.

Walker, A. *The Shattered Silents: How the Talkies Came to Stay*. New York, William Morrow and Co.: 1979.

Walker, J. R. *Crack of the Bat: A History of Baseball on the Radio*. Lincoln, NE: University of Nebraska Press, 2015.

Weinstein, M. "Profit-Sharing Contracts in Hollywood: Evolution and Analysis." *The Journal of Legal Studies*, 27, 1998, 67–112.

Wooldridge, J. M. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press, 2002.