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Structural Change and the Growth Contribution of Services: How Motion Pictures Industrialized US Spectator Entertainment

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Structural Change and the Growth Contribution of Services: How Motion Pictures Industrialized U.S. Spectator Entertainment*

Gerben Bakker[1]

Abstract

This paper examines the effect of a new technology on a labour-intensive service. Comparing primal and dual TFP-growth with final-year social savings, we find that, between 1900 and 1938, motion pictures increased entertainment output (measured in spectator-hours) by at least nine percent annually, mainly through intensive growth. Falling profit margins indicate that motion pictures increased competition, while real wages rising twice the national average suggests labour captured part of the efficiency gains. Surviving live entertainment experienced some intensive growth, reached a similar capital/labour ratio but paid lower wages. These findings suggest that some services can experience similar productivity gains as manufacturing and that traditional service-activities survive the onslaught of new technologies by transforming their production structure.

> So long as the number of persons who can be reached by a human voice is strictly limited, it is not very likely that any singer will make an advance on the £10,000 said to have been earned in a season by Mrs. Billington at the beginning of the last century, nearly as great as that which the business leaders of the present generation have made on the last.
>
> *Alfred Marshall*[2]

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When Charlie Chaplin was nineteen years old he appeared in three music halls a night. On one fine day he started in the late afternoon at the half empty Streatham Empire in London. Directly after the show he and his company were rushed by private bus to the Canterbury Music Hall and then on to the Tivoli (Charles Chaplin, 1964; Cyril Ehrlich, 1986). This constituted the maximum number of venues an entertainer could visit on an evening, and thus the inherent limit to a performer's productivity. Yet, barely five years had passed and every night Chaplin would appear in thousands of venues across the world at the same time. His productivity had increased almost unimaginably. He himself was able to capture only a small part of this efficiency increase, but yet this tiny percentage made him the world's highest-paid performer.[3]

Chaplin's experience epitomizes the massive increase in productivity modern service technologies have made possible. These efficiency gains often came as a thief in the night because inputs such as labour or capital have been used as output proxies, and because sharply falling prices kept expenditure shares modest even as quantities skyrocketed. What was widely noticed—in the entertainment industry at least—was the sharp increase in stars' income, even though these reflected only a limited part of the efficiency gains that the new technology brought about.

Services play an essential part in understanding economic growth and development. Stephen Broadberry (1997, 2006) and Broadberry and Sayantan Ghosal (2002), for example, note how demand patterns shift in favour to services as incomes rise, and how the superior productivity performance of the United States vis-à-vis Europe can be explained

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[2] 1947: 685-686; as quoted in Sherwin Rosen, 1981.

[3] Chaplin's weekly pay increased from $150 for the Keystone company in 1913, to $1,250 for Essanay in 1914, to $10,000 for Mutual in 1916, to about $13,000 for First National in 1918. The last figure is derived from a $1 million salary offer for 18 months of employment [Gorham Kindem, 1982: 82-83].

mainly by its productivity lead in services. Agriculture has reached astronomical levels of productivity and uses a small part of national resources, and manufacturing has gradually moved in the same direction: either it is highly competitive or heavily subsidized. Scholars have a relatively good knowledge and intuition about how productivity and automation work in manufacturing, and how it can be measured. For services, more research needs to be done.

Several studies have examined the contribution of new goods to economic welfare and productivity growth. William Nordhaus (1997), for example, by focusing on the services that light bulbs and other devices provide, concluded that the price decrease of light is severely understated in the consumer price index. Walter Oi (1997) examined the welfare effect of air conditioners and others the effects of products such as mobile phones, minivans and apple-cinnamon breakfast *Cheerios* (Jerry A. Hausman 1997a, b; Amil Petrin 1997). J. Bradford de Long (2000) evaluated the combined contribution of many new goods since the late 19th century.

More in-depth historical studies of specific service industries can increase our insight into the process of economic growth. The entertainment industry was one of the first services to become industrialized and therefore may be significant for understanding productivity growth in other service industries.[4] Performances were automated, standardized and made tradable, resulting in rapid market integration and massive output growth (Gerben Bakker, 2001). Moving images replaced actors, floor managers, musicians and stage hands. This industrialization may have been not unlike the way in which information and communication technology (ICT) would automate, standardize and make tradable certain services after 1945 (Chris Freeman and Luc Soete,

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[4] The term industrialization of services has been coined before, for example by Theodore Levitt (1976, 1983), although in a slightly different context.

1997: 403-408). The sharp growth in the quantity consumed per capita (eighteen times between 1900 and 1938) was partially hidden by a sharp fall in prices, keeping the expenditure share of entertainment relatively low and making the industrialization relatively unnoticed.

This paper analyses the impact of cinema technology on the productivity of the US spectator entertainment industry and on US economic growth. It uses growth accounting to estimate total factor productivity (TFP) growth between 1900 and 1938, and estimates social savings to quantify the accumulated effect cinema technology had had by 1938. It then compares accumulated TFP with social savings, quantifies the impact on the economy and compares this to that of other industries that adopted what some have called general purpose technologies (GPTs) (Nicholas Crafts and Terence C. Mills, 2005; Richard G. Lipsey et al., 1998).

Spectator entertainment is defined as theatrical entertainment such as opera, theatre, concerts, vaudeville, burlesque and cinema. Two benchmark years have been selected for the growth estimate: 1900, the first census year before cinema's take-off, and 1938, when the industrialization was complete. Since 1927 sound had driven out most live entertainment, and television had still to arrive.[5] Reliable and exact data sources could not be obtained easily. Especially for 1900, sometimes estimates had to be made based on indirect indicators. For this reason Appendices A and B explain each individual estimate in detail.[6] To make the estimates conservative, they have been stacked against productivity growth and social savings, leading to upper bound productivity estimates

[5] The other major new media—recorded music and radio—were partially different products and had not reached their peak yet. The phonograph had always remained a luxury, an elite product. Although in the 1920s radio expanded rapidly, it would only reach its peak during the 1940s and early 1950s. Choosing 1938 makes the estimates more conservative because motion picture and other live entertainment expenditure grew rapidly from 1940 onwards.
[6] These appendices are available at the journal's website, and are also available from the authors.

for 1900 and lower bound ones for 1938.[7] It is expected that further precision will not fundamentally affect the findings.

This paper differs in three key aspects from William J. Baumol and William F. Bowen's (1966) work on stagnating productivity in the performing arts. First, it assumes that all spectator entertainment is part of the same market, irrespective of the delivery technology, whether live actors or projected images. Although they acknowledge the massive productivity increase enabled by audiovisual technologies, Baumol and Bowen assumed that the 'performing arts' formed an entirely different market. This was probably less accurate before 1940, when cinema and live entertainment were engaged in a competitive struggle, than in the 1960s, when the surviving live entertainment—either heavily subsidized (e.g. avant garde plays) or high-value added (e.g. Broadway musicals)—was far more differentiated, and that was precisely how it survived. Second, while Baumol and Bowen studied performing arts such as symphony orchestras and theatre, this paper includes popular entertainment such as vaudeville and burlesque, which were rather important before 1940. Third, the current paper uses a real output measure, the 'spectator-hour', rather than input proxies, such as the person-hours a string quintet uses to perform. The latter per definition underestimates productivity growth, because it disregards the spectator-hours the quintet could sell through audiovisual technologies.

This paper has five key findings. First of all, when measured properly, spectator entertainment experienced a phenomenal output growth in the early twentieth century, of about nine percent per annum on average. Most of this was hidden by a massive fall in prices because of sharp TFP-growth of over five percent per annum, higher than that of most other new activities during the period (Alexander J. Field, 2003).

[7] Following the approach Robert W. Fogel (1962, 1964) used to estimate the social savings of the US railroads.

Second, although live entertainment faced declining output, the surviving parts cannot be characterized as completely stagnant: TFP-growth was limited but existent, the capital/labour ratio increased sharply to equal that of cinema by 1938, and wages adjusted to the lower productivity relative to cinema. Third, although only hypothetically investigated here, a simple dimensional agglomeration benefit model suggests that urbanization-induced scale effects can only explain a small part of TFP-growth in the new sector (cinema), but potentially all of TFP-growth in live entertainment. Fourth, spectator entertainment had a not insignificant impact on national economic growth. Its social savings amounted to 2.2 percent of 1938 GDP, and it accounted for just under two percent of GDP-growth and more than three percent of national TFP growth between 1900 and 1938. This was somewhat lower than, but not unlike that of other new activities at the time. Fifth, the mark-up for spectator entertainment as a whole decreased significantly, indicating a substantial competitive effect of motion pictures on the spectator entertainment industry, and real cinema wages grew twice as fast as the national average, suggesting that labour inputs were able to capture some of the Schumpeterian profits from the new technology. Thus, a sharp rise in dynamic efficiency (TFP-growth through innovations) was accompanied by an increase in allocative efficiency (declining price-cost margins), avoiding—at least in the long run—a Schumpeterian trade-off.

The implications of these findings are, first, that certain service industries are not per definition stagnant, but, in the face of market forces, can adopt new technologies and potentially be subject to similar or even higher productivity growth than in agriculture and manufacturing. Second, inadequate output measurement may leave a substantial part of this growth unmeasured, and the current productivity estimates may therefore understate both national productivity growth as a whole as well as the part due to certain services. Third, even the surviving old-technology parts of these services are not necessarily stagnant, but can experience TFP-growth and had to undergo substantial changes in production technology and structure in order to survive, even though their relative share declined sharply.

The remainder of the paper is organized as follows: Section I sketches the historical background, shows that live entertainment was the next best alternative for cinema, and discusses measurement methods. Section II uses a Solow model to estimate TFP-growth both in quantities and in prices, tests to what extent actual wage/rental ratios differed from Cobb-Douglas-determined ones, estimates the changes in mark-ups, and, finally, investigates potential explanations for TFP-growth, separating out potential n-dimensional agglomeration benefits. Section III, following Robert W. Fogel (1962, 1964), estimates the 1938 social savings, and compares these to the accumulated Solow-residual. Section IV discusses the results and compares cinema's growth impact with that of other technologies, mainly GPTs, by estimating industry social savings relative to nationally aggregated social savings. Section V concludes.

I. Historical Background

During the nineteenth century the live entertainment industry grew rapidly. On the supply side, individual theatres made way for theatre circuits and local stock companies for travelling companies, helped by the railways. Central booking offices on Union Square in New York routed the creative inputs efficiently across the country. Innovations such as the steel frame and reinforced concrete enabled a sharp increase in theatre size as well as price differentiation, with cheaper tickets for the galleries. On the demand side, falling working hours, rising disposable income, increasing urbanization, rapidly expanding transport networks and strong population growth boosted consumption of entertainment.

At the turn of the century, when the existing industry had realized most of its production possibilities and faced decreasing returns to further process innovations, cinema was adopted. It industrialized live entertainment by automating it, standardizing it and making it tradable (Bakker, 2001). Actors and other creative inputs needed only to make one performance, which was reproduced infinitely. This standardized the public's viewing experience; they were guaranteed they would see the entertainment as advertised, without understudies, second-rank sets, reduced musical support or actors having a bad night. Before cinema, only creative inputs were mobile and relatively permanent in time, now the performances themselves became tradable. They were not produced anymore at the time and place of consumption, usually one of the characteristics of a service. The tradability increased competition among creative inputs for the audience's attention and integrated entertainment markets.

The industrialization process had a considerable effect on the number of actors and actresses (figure 1). Until the emergence of cinema, the number of actors and actresses per 100,000 inhabitants increased sharply. After cinema it stagnated, while the real revenue per creative input increased substantially. Although this is not direct evidence of causality, it is consistent with the industrialization hypothesis.

Central to the estimation of TFP-growth and social savings is the identification of the next-best alternative for motion pictures, following Fogel's (1962) approach. Between c. 1905 and 1917, prices for film increased while demand grew rapidly (Douglas Gomery, 1992), which usually suggests substitution. Films were often interspersed with live entertainment or vice versa. Particular good data for Boston in 1909 (Garth S. Jowett, 1974) show that local consumers could chose between at least eight forms of theatrical entertainment, ranging from opera at a $2 ticket price to moving pictures at ten cents (figure 2). Three years after their emergence, cinemas supplied half of Boston's capacity. Given the low prices, however, it took in only a sixth of expenditure. The rapid diffusion was reflected in the increasing price elasticity of demand at lower prices, as tentatively suggested by the evidence (table 1). The cheapest vaudeville reacted by interspersing live performances with films. These figures form a static, early snapshot of a dynamic process of creative destruction. The radical new technology not only swept away the traditional entertainment delivery technology, but also opened up new markets, supplying consumers that had never seen theatrical entertainment before. Gradually, cinema would automate away more and more lower-priced live entertainment, leaving standing only the most highly differentiated part of the most expensive entertainment.

In the late 1920s sound films constituted a major jump in substitutability by automating away most of the remaining live acts.[8] Before their introduction, Americans spent $1.33 per capita on theatre, versus $3.59 on movies, while in 1938 the figures were $0.45 vs. $5.11 (figure 3). These stylized facts suggest that cinema was used increasingly as a substitute for other entertainment. Theatre historians note the increasing competition of motion pictures (Thomas G. Moore, 1968). Jack Poggi (1968: 79, 43), for example, writes:

> First the movies created a new audience, many of whom had never been to the theatre; but the desertion of the galleries in theatres in all the large cities indicates that they also began to lure away that part of the theatre audience with the lowest income. Then, as the movies improved in quality and respectability, people from the business and professional classes might be expected to change

[8] For a detailed study of the disastrous effect of talkies on musicians' employment see James P. Kraft (1994a, 1994b). On the impact of sound film on British musicians, see Ehrlich (1986: 197-210). Ehrlich discusses the cinema organ as an important labour-saving innovation before the coming of sound.

> their entertainment habits. (...) Possibly the habitual New York theatregoers went to both theatre and films for a time and then gradually limited their attendance at live theatre to special occasions. This theory would explain why the less popular plays began closing more quickly, causing a drop in the number of theatre weeks. (...)
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> The motion pictures could not have crushed the legitimate theatre if there had been a real preference for live drama. Theatre managers would never have turned their buildings over to the movies if they could have made more money by booking plays; a few might have been satisfied if there had been equal profit, or even a little less, in live theatre. Again we come back to the same point: people were simply not willing to pay the price necessary to maintain live theatre, except in the largest cities. If they could get what they wanted from the movies, why should they look elsewhere?

Quantitative production data (figure 3) suggest a process of creative destruction, in which cinema technology industrialized spectator entertainment in two stages: from the mid-1900s onwards, it automated away small-town live entertainment (proxied by ‘road productions’) and from 1927 talking pictures creatively destroyed the high-value-added metropolitan live entertainment (proxied by ‘Broadway’).

During this process of creative destruction industry and market definition changed. Sometimes final-year industry/market definition is used and it is then argued that the new high-productivity service served an entirely different market. While initially film and live entertainment were close substitutes and had high cross-price elasticities, over time, the live entertainment that survived became more and more differentiated from film. It became either heavily subsidized or a commercial metropolitan premium product. Given the available evidence, this paper will treat live entertainment as the next-best alternative to film.

A key remaining issue is then a common definition and measurement of output. Often employment or capital is used to proxy output growth in services (Robert Millward, 1990). As these are inputs, this inevitably leads to observing limited TFP-growth.[9] This paper therefore uses the ‘spectator-hour’, borrowed from the airline industry. The seats in a venue times the performance duration constitute the number of spectator-hours produced, the proportion filled the hours actually sold, the proportion empty the amount perished. This does not take into account changes in the quality of a spectator-hour, which is difficult to measure for the case of entertainment. Given the massive increase in production expenditures and the many new product characteristics—such as cinema itself, the feature film, talking pictures, air-conditioned venues—quality change was probably positive.[10] Gary Becker (1965) has shown that an increase in wages will decrease the consumption of time-intensive activities. In theory, quality could be proportionate to a spectator-hour’s marginal opportunity cost and inversely proportionate to the marginal availability of leisure time. Between 1900 and 1938, opportunity costs (real hourly wages) increased by 2.17 percent per annum and the ‘exchange rate’ (the spectator-hour as percentage of available leisure time) decreased by 1.22 percent per year.[11] This would suggest a net average minimum quality increase of a spectator-hour of 0.95 percent per year was needed to keep drawing consumers into venues. Given the difficulty to measure quality, and the assumptions that have to be made, quality change is ignored here, and this makes the TFP-estimate more conservative.

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[9] The TFP figures below give support to Millward’s idea that for services capital growth is a better proxy than labour growth, but also suggest that it is far from perfect, and that real output measures are needed.

[10] The lack of interaction with the audience and recorded sound could be considered inferior characteristics. Until talking pictures arrived, however, both aspects were provided by live entertainers synchronous with, and in between, pictures.

[11] In 1900 the opportunity cost of one spectator-hour was 19 cents (the average hourly wage) and 3.9 percent of weekly leisure time ((144 hours)/2-average working hours). In 1938 this cost was 43 cents and 2.5 percent of leisure time.

II. The Growth in Total Factor Productivity

A. TFP-Growth in Quantities

TFP is estimated with the classic Cobb-Douglas production function from Robert M. Solow (1957):

(1) $$Y = AK^{\alpha}L^{1-\alpha}$$

(2) $$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + s_k \frac{\Delta K}{K} + s_l \frac{\Delta L}{L}$$

With Y = output (in spectator-hours), K = capital, L = labour, A = the Solow residual, and s_k and s_l are the factor income shares.

For all spectator entertainment, output growth was remarkably high: over nine percent annually for almost forty years.[12] Two-fifths of this is explained by an increase in inputs, the rest is due to intensive growth, which was over five percent annually, significantly higher than in most other industries (table 2). Labour productivity grew at a rate of six percent per annum, and less than a tenth of this could be explained by capital deepening.

The changes in the production structure were significant. Capital was growing two percentage-points faster than labour, doubling the capital-labour ratio. The technical rate of substitution increased doubled from $749 per person-year-of-education[13] (hereafter pyedu) to $1,587. In 1938, about $16,000 in capital could replace one worker (table 3). Between 1900 and 1938 the production structure moved upwards along the Cobb-Douglas isoquant, substituting labour for capital (figure 4). The marginal product of labour increased twelve times to 1,889 spectator-

[12] For the estimation of factor elasticities, value of human capital and the effect of international trade, see Appendix A.

[13] Labour is measured in person-years of education (pyedu). One pyedu is one worker (working 1938-average working hours) times the national average number of years of education.

hours per pyedu while real wages only doubled.[14] The marginal product of capital rose fivefold to one spectator-hour per dollar of capital.

Although the underlying Cobb-Douglas function probably is not a perfect model of actual production, empirical research has shown that it usually is a good approximation.[15] It is clear from figure 4 that the observed technical rates of substitution (TRS), as exemplified by the wage/rental ratio (the dotted lines) were higher than the TRS calculated from the Cobb-Douglas function (the full tangent lines). The respective TRS have been calculated as follows:

(3) $$|TRS| = \frac{w}{r}$$

(4) $$|TRS| = \frac{1-\alpha}{\alpha}\frac{K}{L}$$

Two important conclusions can be drawn: first, for all situations (figures 4 – 6), the observed technical rate of substitution (3) is higher than the Cobb-Douglas (CD)-determined rate of substitution (4), suggesting that we may have over-estimated wage rates and underestimated rental rates. Second, the geometric difference between (3) and (4) increased between 1900 and 1938, from 1.02 to 1.15 (table 3). The rise can be caused by labour increasing its share in income above the competitive level through regulation or monopoly power (trade unions), or by the Cobb-Douglas model not perfectly capturing features of the underlying production structure such as increasing returns and imperfect competition.

We can use (3) and (4), which should be equal on the observed point on the isoquant, to calculate what r should be given w and vice versa, using:

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[14] For comparison, hourly real unskilled wages/pyedu increased with 0.87 percent annually, assuming that the education of unskilled workers increased at the same rate as the national average (wages deflated by CPI, calculated from Samuel H. Williamson (2006), using education data from Angus Maddison (2005). All hourly wages/pyedu increased 0.98 percent (US Department of Commerce, 1975).

[15] Studies of various industries found the sum of capital and labour elasticity (α and ‘1-α’) varying from c. 0.85 to 1.1.

(5) $$r = \frac{w}{|TRS|} = \frac{\alpha}{1-\alpha}\frac{L}{K}w$$

(6) $$w = r \cdot |TRS| = \frac{1-\alpha}{\alpha}\frac{K}{L}r$$

Using this technique, 1900 rental rates would be 12.7 instead of 12.3 percent, and 1938 rental rates 12.2 instead of 10.6 percent, or alternatively, 1900 wages could be \$92 instead of \$95 and 1938 wages \$168 instead of \$193 (table 3). The 1900 differences were probably not significant, given the degree of precision of our estimates (see Appendix A and B).

Another reason for the difference between (3) and (4) may be the degree of inaccuracy in the estimation of alpha (the capital factor income share), and (3) and (4) can be reconciled by calculating alpha given r, w, K and L:

(7) $$\alpha = \frac{rK}{rK + wL}$$

This suggests that the income share of capital in 1900 was similar to our assumed income share but in 1938 about ten percent lower (table 3). The capital share in income decreased, possibly because labour was able to capture a substantial part of the Schumpeterian profits of the technological innovation and the concurrent deepening of the capital/labour ratio.[16]

The question remains how overall productivity growth can be disaggregated in contributions from live and cinema technology. Assuming that in 1900 nearly all output was provided by live technology, we can calculate the growth rates for live entertainment.[17] On average,

[16] Because of limitations of the data, all interest, rents and profits are included into the cost of capital, so the cost implicitly included returns to entrepreneurship as a production factor. See section 4 for an estimate in the increase in mark-up, and indicator of entrepreneurial profits.
[17] This is warranted given the film industry's very small size in 1900 (fixed cinemas would only emerge five years later).

live output fell by 1.24 percent a year. Labour declined even faster, but was accompanied by a slower capital decline and a modest TFP-growth of 0.69 percent annually, or about thirty percent over the whole period. Labour productivity increased by 1.18 percent annually—from 370 to 579 spectator-hours per pyedu—and 0.48 percentage point was due to capital deepening. The modest growth in efficiency of a declining technology surprises, and probably was partially caused by agglomeration effects and the competitive pressure of cinema.[18] The latter is reflected in the doubling of the capital/labour ratio. By 1938 it was roughly the same as that for cinema, concurring with Solow's (1957) prediction that capital/labour ratios converge in the long-run. The technical rate of substitution was also similar. Capital productivity decreased somewhat, from 1,484 to 1,131 spectator-hours per $1,000 of capital (table 3). Although the marginal productivity of live labour more than doubled between 1900 and 1938, it was only a small fraction, about a sixth, of that of film labour. The marginal product of live entertainment capital remained nearly unchanged between 1900 and 1938, reflecting limited opportunities for further mechanical innovation. It was far lower than that of film capital.

The film industry was extremely small in 1900. The first cinemas, the Nickelodeons, emerged only in 1905. Any disaggregated 1900 estimate has a high degree of impreciseness and will affect TFP-growth substantially. Therefore, it has been assumed that non-cinema technology accounted for all output in 1900, given the film industry's infinitesimal size. Using the 1938 live entertainment technology share in total output of spectator-hours, and assuming a constant rate of decline in its share, we can then for each year calculate the hypothetical share of

[18] On agglomeration effects see section II.D, below. It is not unusual for a declining technology to increase in efficiency. James M. Utterback (1996), for example, shows that gas lighting's efficiency improved remarkably, and prices fell concurrently, when faced with the competition of electric light.

live entertainment, and then take the average of this time series as the average share of live entertainment, which amounts to 26.3 percent.[19] This will then enable us to make a rough estimate of the growth contribution of cinema technology:

(8) $$g_{live+film} = s_{live} g_{live} + s_{film} g_{film}$$

(9) $$g_{film} = \frac{g_{live+film} - s_{live} g_{live}}{s_{film}}$$

Where g denotes the annual average growth rate and s the share of the respective technology in output.

Cinema output growth was about thirteen percent per annum, while its contribution to industry TFP-growth, over seven percent-point annually, was also substantial and over ten times higher than live TFP-growth. Productivity in 1938 was 3,855 spectator-hours per pyedu and 7,251 spectator hours per $1,000 of capital. In both cases productivity was about six times that of live entertainment technology. Factor costs differed substantially from live technology (figure 6). In 1938, wages were over fifty percent higher and capital costs nearly forty percent (table 3).[20] This is suggestive of cinema's productivity lead over live entertainment. The actually estimated wages and rentals vary more from their CD-determined equivalents than live wages and rentals. Wages were fifteen percent higher than CD-wages, and rental rates were nine percent (1.6 percent-point) lower than the CD-rate (table 3). Estimated capital elasticity was ten percent higher than the CD value. These differences could partially

[19] An alternative method is to take benchmark estimates of live entertainment's share for 1909, 1914, 1919, 1921, 1923 and so on, using data from US Department of Commerce (1975), combined with growth indicators of the early film industry (Bakker, 2005: 344-347) and then interpolating geometrically. This yields a lower estimate of 22.4 percent. To keep our estimate of TFP-growth caused by cinema technology conservative, the higher live entertainment share is used.

[20] Live entertainment, however, was classified within a wider category, 'Amusements and recreation' (see Appendix B). Only aggregate average wage is available and this is taken here as the live entertainment wage. Capital costs include entrepreneurial profits, which may explain the large difference.

reflect data inaccuracies and partially the circumstance that cinema technology possibly conformed less to the Cobb-Douglas model than live technology, for example because of more sharply increasing returns to scale and imperfect competition.

B. TFP-Growth in Prices

A dual method to estimate of TFP growth was used by Zvi Griliches and Dale Jorgenson (1967) and has been applied to economic history, by, for example, Pol Antras and Hans-Joachim Voth (2003) and Nicholas Crafts (2003).[21] The decline in price of a good, all factor prices remaining the same, must be the result of an increase in efficiency. The dual of expression (1) thus becomes:

$$(10) \quad \frac{\Delta P}{P} = \left(s_k \frac{\Delta r}{r} + s_l \frac{\Delta w}{w} \right) - \frac{\Delta A}{A}$$

or:

$$(11) \quad \frac{\Delta A}{A} = \left(s_k \frac{\Delta r}{r} + s_l \frac{\Delta w}{w} \right) - \frac{\Delta P}{P}$$

The dual estimates show that spectator entertainment experienced a phenomenal and rarely precedented fall in real prices, of over four percent per annum for nearly forty years, before television had even arrived (table 4). This is all the more exceptional since it took place in the face of wages that rose nearly twice as fast as the national average and an only mildly falling rental rate. Because live entertainment prices fell by only 1.3 percent annually, film technology must have been the largest downward force on prices. Our estimation technique suggests it may have had an effect equivalent to a six percent price fall over almost forty years.

[21] For a fuller discussion of the works that applied this method in economic history see Antras and Voth (2003): 56.

Because the rental rate for 1900 was an estimate, a Cobb-Douglas factor price determination is used to test the estimates' sensitivity. Assuming that wages did not differ much from the national average, the rental rate is calculated using (5) and then the 'CD-Dual' TFP-growth. This turns out to be similar, but between one and six percent higher than the original dual estimate (table 4). This suggests that the estimates' sensitivity to potential estimation errors is sizable but limited.

A potential explanation for the difference between primal and dual estimates is that the industry was not perfectly competitive, as assumed by the Cobb-Douglas model, and that part of TFP-growth was actually caused by a fall in the price over marginal cost, the 'mark-up'. A lower TFP-growth based on quantities than on prices—i.e. prices decrease faster than they should—then points to a decrease in mark-up and thus a more competitive industry (Crafts and Mills, 2005). The mark-up can be computed as follows:

(12) $$\frac{\frac{P_t}{MC_t}}{\frac{P_0}{MC_0}} = \left(1 + (g_{primal} - g_{dual})\right)^t$$

Where P and MC denote price and marginal cost, and g denotes primal or dual TFP-growth as a fraction.

Because the mark-up is far more sensitive to the estimates' precision than anything else, the findings based on it should be considered rather tentative. For all spectator entertainment the mark-up was somewhat lower in 1938 than in 1900—possibly about seven percent. This total hid a 29 percent decline in the live mark-up. The constructed mark-up for motion pictures (using (9) above) suggests a two percent increase. Given our estimates' precision, however, all we can probably say is that it hardly changed.

The decrease in over-all mark-up suggests that cinema had a competitive effect on the spectator entertainment industry, by not only increasing productivity dynamically through innovations, but also by increasing allocative efficiency. The stable mark-up for cinema suggests that firms managed to capture substantial Schumpeterian profits to their innovations and appear not inconsistent with Joseph Schumpeter's views on market power, innovation and dynamic efficiency. Despite a stable mark-up compared to live entertainment, the new technology's productivity contribution to society was many times larger, as reflected in the phenomenal price decrease. Although data lack to estimate it precisely, it is not unlikely that the deadweight loss in total welfare due to non-decreasing mark-ups in cinema was several times less than the increase in total welfare due to lower prices. In the long run, therefore, there thus does not appear to have been a Schumpeterian trade-off between static and dynamic efficiency. It also suggests a substantial increase in total welfare that is not taken into account into our calculation of TFP-growth and social savings.

Trusts controlling the supply of creative talent dominated both the theatre and vaudeville business. Without the trust, theatres could not book top-quality talent and talent could not play the best theatres. The motion picture industry itself eventually became highly concentrated and was found guilty of violating antitrust laws. Yet, paradoxically, in a Schumpeterian sense it may have had a beneficial competitive effect on the entire spectator entertainment industry.

Assuming the industry made no losses and given that for spectator entertainment as a whole the 1938 mark-up was 0.93 of the 1900 mark-up, the latter must have been equal or greater than 1.08, and the profit margin must have been equal or greater than seven percent. The live mark-up must have been far higher—at least 1.41—and the margin 29 percent. Given theatre and vaudeville trusts and the high concentration of other forms such as the burlesque circuits, this high margin is not all that surprising. Profit margin, price elasticity of market demand and industrial concentration are closely related (Robert E. Dansby and Robert D. Willig, 1979; Massimo Motta, 2004):

(13) $$\frac{P}{MC} = \frac{1}{1+\frac{HH}{\varepsilon}} = \frac{1}{1-\frac{HH}{|\varepsilon|}}$$

Where ε (<0) is the price elasticity of market demand and HH the Herfindahl-Hirschmann Index (1=monopoly, 0=perfect competition).
If we estimate price elasticity conservatively at roughly ≤ -1.3 (table 1) and we make the bold and probably not entirely realistic assumption that price elasticity hardly changed between 1900 and 1938, then the minimum mark-up suggests that in 1900 for all spectator entertainment HH ≥ 0.0963, using:

(14) $$HH \geq \left(1-\frac{MC}{P}\right)\cdot|\varepsilon|$$

This indicates a fairly concentrated industry and is not inconsistent with the existence of the trusts. A four-firm concentration ratio of 50 percent roughly equates with a HH of 0.0963 (Lawrence J. White, 1987). An industry structure with the five largest firms serving 25, 15, 10, 5 and 5 percent of the market, for example, results in a HH of about 0.1000.[22] For comparison, in 1900, the infinitesimal motion picture industry had a HH of about 0.3500, declining to about 0.1000 by 1907 (Bakker, 2005), implying mark-ups of at least 1.37 and 1.083, if we assume │ε│ ≥ 1.3.[23] Between 1920 and 1940 HH fluctuated between about 0.750 and 0.1000, but this was a less accurate indicator, because the Hollywood studios were found

[22] For comparison, the U.S. Department of Justice in the Reagan era would generally *not* investigate merges that led to HHs < 0.1000, to HHs between 0.1000 and 0.1800 if the change in HH < 0.0100, or to HH > 0.1800 when change in HH < 0.0050.
[23] In 1908, however, the Motion Picture Patents Company was formed, a cartel that aimed to monopolize production and distribution. From 1912, it was prosecuted by the Department of Justice. Ultimately, it was found in violation of the Sherman Act by the U.S. Supreme Court.

guilty of collusion.[24] The HH for live entertainment would be ≥ 0.3770 in 1900, equivalent to three firms sharing the entire market, which may not be that unrealistic, given the trusts.

C. The Impact on National Economic Growth and Productivity

This section will estimate the share of entertainment in national GDP and TFP-growth, based on the profit and expenditure share in total GDP (following Crafts, 2004a). The entertainment industry was responsible for just under 1/50th of US GDP growth between 1900 and 1938 (table 5). Most of this was due to intensive growth, which accounted for between 1.6 and 1.7 percent of GDP-growth, about 2.5 times as much as could be expected based on its average output share in GDP (0.65 percent). This growth contribution is large compared to the industry's modest size. It was, for example, over two-thirds of the intensive growth contribution of steam in Britain between 1870 and 1910 (Crafts, 2004a).

Cinema's share of national TFP-growth was even larger. Its intensive growth was about five times as large as national TFP-growth (table 6).[25] About 1/30th of national TFP-growth can be explained by that in entertainment, four times higher than entertainment's share in GDP. This supernormal contribution suggests that entertainment was part of the broad-based U.S. shift to accelerated TFP-growth in this period, and that it also was part of the surge of TFP-growth outside manufacturing during

[24] If we multiply the estimated 1900 mark-up of 1.37 by 1.02 (table 3), we arrive at a 1938 mark-up of 1.39, which concurs with a HH of 0.3670, a sign of a highly concentrated industry. This is not inconsistent with the collusion between the five large and three smaller Hollywood studios, eventually leading to the Supreme Court's Paramount Decree in 1948.

[25] Angus Maddison (1995: 255). Several TFP-growth estimates exist for the U.S. private non-farm economy. Growth rates for various intervals were converted into one estimate for 1900-1938, using weighted geometric averages. Alexander Field (2003) finds a growth rate of 1.70, Moses Abramovitz and Paul David (1999) 1.40 and Robert Gordon (2000) 1.43 percent per annum (as quoted in Field). Maddison's estimate is used because it encompasses the whole economy. Other estimates leave entertainment TFP still several times general TFP-growth.

the 1930s identified by Alexander Field (2003, 2006). Compared to TFP growth in other US service industries, the growth still remains exceptional. TFP-growth, for example, was 'only' 1.8 percent per annum between 1919 and 1938 in the telephone industry, 3.9 percent in electric utilities and 2.2 percent for the railroads (John Kendrick, 1961, as quoted in Field, 2003).[26]

D. Potential Explanations

The question remains how the substantial TFP-growth, even in the declining live entertainment business, can be explained.[27] First, it could be partially due to imprecise measurement. It is, for example, possible that the improvements in the quality of labour—such as increased experience, training, improved health—have been underestimated and that the industry's ageing resulted in substantially higher levels of human capital. Further, changes in the quantity of labour, such as hours worked and intensity of effort, may not have been adequately measured. Nevertheless, the estimates have been made with the best evidence available (see Appendix A and B). This is what we have now, whether we like it or not.

A second type of explanation can involve 'errors' of specification, factors that are not captured very well in the Cobb-Douglas production function, such as changes in capacity utilization, changes in the industry structure, agglomeration effects or the elasticity of substitution. In this section, we will deal with the latter two.[28]

First of all, the Cobb-Douglas function used assumes constant returns to scale. If returns were increasing, they should be captured in

[26] Growth rates derived from the intervals 1919-1929 and 1929-1941. Only the sub-sectors 'Trucking and warehousing' and 'Transportation by air' had higher TFP-growths than film (13.6 and 13.7 percent annually) for 1929-1941 (Field, 2006: 219).
[27] This section partially follows the approach from Charles H. Feinstein (1981).
[28] Potential changes in the industry structure, as far as reflected in a changing mark-up have been discussed in section II.D.

TFP-growth, part of which, then, would not be caused primarily by technical progress, but by scale effects (Edward F. Denison, 1967: 225-254). The latter are not always separable from the former, because scale economies were made possible partially by new technology. Increasing returns could be a result of greater capacity utilization and thus lower average costs, given that many costs are fixed. The causes divide into those due to inherent technological effects—for example that larger steel-frame venues or one celluloid master performance that can be reproduced infinitely decreases average costs—and those due to increasing population density. Both effects will influence each other, but are not entirely the same. Potentially there are technology-induced scale effects at constant urbanization, urbanization-induced scale effects at constant technology and the joint effects.

Inherent technological change probably improved the utilization rate of capital on a massive scale: before film, entertainment venues were dependent on visiting human creative inputs, which made operation unprofitable on marginal times of a day, week, year and on marginal places. Replacement of these inputs by celluloid made more of these marginal slots profitable. The utilization rate of creative inputs (human capital) increased massively, because they could be in many places at the same time (Bakker, 2001). Utilization of physical production capital also increased substantially. Whereas theatre scenery needed to be reproduced for duplicate companies to travel the provinces/countryside and inputs such as scenery, stage equipment, lighting were only used part of the day (mainly evenings), film scenery and equipment was used far more intensively, often around-the-clock. The large Hollywood studios, for example, maximized capacity utilization by shooting B-movies during night-time. Although B-movies yielded far less revenue, their costs were literally marginal.

To gain insight into the potential contribution of agglomeration economies on TFP-growth, the population in cities with over 25,000 inhabitants has been used as an urbanization indicator.[29] We then use the common understanding of technical economies of scale from industrial organization, the 'cube-square' rule, which assumes that they are either two-dimensional or three dimensional.[30] It is assumed that when the population of a city increases, inputs only need to increase with the square root or the cubic root of its population increase, broadly analogue with horizontal and/or vertical city expansion (equations 15-17).[31] This seems particularly relevant for services such as entertainment facilities, where a population increase allowed a larger scale, because more people could be served by the same facility.[32]

(15) $$Inputssaved = \frac{urb_t}{urb_0} - \left(\frac{urb_t}{urb_0}\right)^{\frac{1}{\sigma}}$$

(16) $$Inputssavedperannum = \left(\frac{urb_t}{urb_0}\right)^{\frac{1}{t}} - \left(\frac{urb_t}{urb_0}\right)^{\frac{1}{t\sigma}}$$

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[29] Given power law effects/distribution of city sizes, urbanization growth is roughly the same if we used another indicator, for example inhabitants in cities of 100,000 or more. See, for example, Jan Eeckhout (2004). The calculations for table 6, using equation (16), have been replicated using the number of inhabitants in cities of over 100,000 population. This yielded a growth rate that only differed in the second decimal (2.59708 versus 2.58914, an infinitesimal difference of 0.00794 percentage-point).

[30] See, for example, F. M. Scherer and David Ross, 1990; Hal R. Varian, 1992: 14-17, David Besanko et al., 2004: 85; L. Cockenboo (1987). The understanding is based on the circumstance that the surface area of a cube is proportional to the square of its side, while the volume is proportional to the cube of its side. Inversely, the radius (or perimeter) of a circle increases with the square root of its surface, and the surface area of a ball increases with the cubic root of its content.

[31] Urban population as a proxy for city growth rather than GDP may underestimate agglomeration benefits, because GDP per capita increased sharply. On the other hand, agglomeration diseconomies have been ignored; to the extent that these affected service delivery systems, this may result in an upward bias.

[32] On increasing returns, economic geography and international trade see Masahisa Fujita, Paul Krugman and Anthony Venables, 1999.

(17) $$Nationalinputssavedperannum = \left(\frac{pop_t}{pop_0}\right)^{\frac{1}{t}} - \left[\frac{(pop_t - urb_t) + \left(\frac{urb_t}{urb_0}\right)^{\frac{1}{\sigma}} urb_0}{pop_0}\right]^{\frac{1}{t}}$$

Where urb = the number of persons living in cities with more than 25,000 inhabitants, pop = national population, sigma (>1) = the assumed dimension of agglomeration economies (2 or 3), t = the number of years over which the effect is estimated. TFP-growth explained increases obviously in σ and in urb_t.

Following the cube-square rule, the geometric average of two- and three-dimensional effects is used as a rough and ready hypothetical estimate. Because cinemas were nearly all located in cities of some kind, and our urbanization proxy is assumed to proxy size increases for all sizes of agglomerations, expression (16) seems most appropriate. As much as a quarter of TFP-growth can be hypothetically attributed to agglomeration effects (table 7).[33] All live TFP-growth can potentially be attributed to agglomeration effects. Without rising urbanization, live TFP may have been stagnant or even declining.[34] Similar agglomeration economies may hold for other industries with service delivery systems,

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[33] The geometric average of two and three dimensional TFP-growth explained for the nation as a whole, including non-urbanized areas, using equation (17) is 0.44 percent, or less than a third of the effect in the urbanized areas alone. This could potentially explained about two-fifths of US national TFP-growth during the period (1.14 percent per annum (Maddison 1995)).

[34] If we reverse the argument and assume that TFP-growth in live entertainment could only have taken place because of agglomeration effects, then the dimension of those effects would have been 1.36 for the primal case, and 2.55 for the dual case (and 1.77 for the average). Even less of motion picture TFP-growth could then be explained by urbanization. Results derived from (16) above, of course:

(18) $$\sigma = \frac{\ln\left(\frac{urb_t}{urb_0}\right)}{t \ln\left\{\left(\frac{urb_t}{urb_0}\right)^{\frac{1}{t}} - \left[\left(\frac{A_{live_t}}{A_{live_0}}\right)^{\frac{1}{t}} - 1\right]\right\}}$$

such as retail, hospitals and banks. Scale effects caused by other factors, for example those caused by making one celluloid master performance that can be reproduced infinitely, are not captured directly in the agglomeration effects.

A second effect that can explain TFP-growth is the elasticity of substitution between labour and capital, i.e. the change in the capital/labour ratio over that in the technical rate of substitution (the change in the ray through the origin over that in the tangent in figures 4-6).[35] The Cobb-Douglas function assumed a constant elasticity of one. It is possible that the actual elasticity was far lower, which would result in capital deepening disproportionately increasing the technical rate of substitution and thus the marginal product of labour, making the technological progress in the entertainment industry strongly labour saving.[36] This would mean that more of the growth in labour productivity could be explained by adding more capital, reducing the Solow residual. Given the significant capital deepening in entertainment, TFP-growth may have been inflated substantially by a lower elasticity.

TFP-growth can also be explained by structural change, by the transfer of labour and capital from the traditional sector (live entertainment) to the modern sector (cinema). Technical progress only partially found its expression in physical capital and for a large part in other ways, such as a change in the organization of production, with most content produced centrally in studio-complexes rather then routing inputs through theatre circuits.

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[35] $\varsigma = \frac{d \ln \frac{K}{L}}{d \ln TRS}$. In the model used this was zero, of course, as $\frac{TRS}{\frac{K}{L}} = \frac{1-\alpha}{\alpha}$ remains constant by assumption.

[36] A point made for steam by Crafts (2004a). For the whole US economy in the nineteenth century, it has been argued that the elasticity was less than one and technical progress was labour saving. Moses Abramovitz (1993) and D. Rodrik (1997).

III. The Social Savings

A. Estimate of the 1938 Social Savings

Another way to assess the economic impact of a new technology is by estimating its social savings. The classic Fogellian price counterfactual assumes that demand is entirely inelastic, so that consumers keep consuming the same quantity at any price (Fogel, 1962; 1979).[37] It calculates how much more society needs to pay if a service could only be provided by the next-best alternative. It measures the full technological impact of a new technology and should equal compounded TFP-growth (Crafts, 2004b).

The social savings exercise is rather innocent of rearrangement of productive activities as entertainment costs change, and of imperfect competition in the entertainment sector. The calculations therefore, must be seen as no more than a rough and ready approximation:

(19) $SS = (q_a \cdot p_c) - (q_a \cdot p_a)$

With SS as the social savings, q_a and p_a actual prices and quantities and p_c the counterfactual price.

Two assumptions are made to make the estimate more conservative. First, the counterfactual unit cost and price is set equal to the actual live entertainment cost and price.[38] Second, quantity produced is set equal to the output actually sold, not the amount produced, i.e. the venues' "production capacity" (seats x showing times x duration), because the latter requires several other assumptions.

The social savings of cinema technology amounted to 2.3 percent of US GDP (table 8). Consumers would have to spend about three and a half times as much on entertainment and about six times as much labour and capital would be needed. This is not out of line with social savings for

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[37] On the relationship between the price elasticity of demand and social savings see Fogel (1979) and Bakker (2004).

[38] It was rather difficult to obtain cost data on live entertainment, a problem not uncommon in social savings calculations. See for example G. R. Hawke (1970).

railways or steam, but may have attracted less attention, because the phenomenal productivity growth made prices fall sharply and kept the GDP-share small.

A critic could argue that in the absence of cinema, live entertainment would have developed differently and also could have increased productivity by alternative technological improvements, such as larger venues or the fast rotation of creative inputs by plane. Around 1900, however, live entertainment was already close to this productivity possibility frontier. Venues were larger then ever before, the fastest trains were used to move the creative inputs around—sometimes even entire theatres were moved, on showboats—and booking systems were highly efficient (Bakker, 2001). Cinema emerged when live entertainment technology was reaching its final production possibility frontier, when further process innovation yielded sharply diminishing returns. Only a radical product innovation, in a process of creative destruction, would set the industry on a path of newly increasing productivity growth.

B. Social Savings and the Intensive Growth Contribution[39]

There is a reason why it is relevant, if not very realistic, to assume completely inelastic demand: these social savings should equal the compounded intensive growth contribution of cinema, while disregarding the extensive growth contribution. Proponents of the social savings methodology would argue that the additional capital inputs for the entertainment industry merely displaced other investments that could also have earned the going rate of return. The "unique" contribution of cinema was to be found only in the cost reduction benefits of intensive growth. The counter argument from those favouring growth accounting is that cinema technology must be embodied in a new and special form of

[39] This section follows the methodology set out in Dudley Baines, Nicholas Crafts and Timothy Leunig (2000); Crafts (2004a, 2004b); Foreman-Peck (1991).

capital equipment. As such it is more intuitive to include extensive growth in the effects of cinema on the economy (Dudley Baines et. al., 2000).

Subtracting the social savings from 1938 GDP, re-computing the 1900-1938 real GDP growth rate, and subtracting this from the actual rate yields the growth reduction due to cinema's absence. This can then be compared to the intensive growth contribution (table 9):[40]

$$(20) \quad SS_t = 1 - \left\{ 1 - \frac{s_y \dfrac{\Delta A}{A}}{\left(1 + \dfrac{\Delta GDP}{GDP}\right)} \right\}^t = 1 - \left\{ 1 - \frac{s_y \left[\left(\dfrac{A_t}{A_0} \right)^{\frac{1}{t}} - 1 \right]}{\left(\dfrac{GDP_t}{GDP_0} \right)^{\frac{1}{t}}} \right\}^t$$

Where SS_t = the final-year social savings as fraction of GDP, s_y = the share of spectator entertainment expenditure in GDP and t = the number of years.

The counterfactual growth rate was 0.060 percent per annum, the intensive growth contribution 0.037 percent. The difference could be due to three factors. First, our estimates (as explained in Appendix B) carry a certain degree of imprecision,[41] although it is unlikely that this could explain the entire difference. The counterfactual price, for example, needs to be reduced by as much as 28 percent (to 27 cents per spectator-hour) for social savings to equal accumulated intensive growth. Second, we have disregarded the potential increase in the quality of a spectator hour.[42] If we use the 0.95 percent a year minimum increase discussed in

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[40] Expression (19) is a formalization of the methodology used by Crafts (2004b).

[41] For example, the share of entertainment output in overall GDP is available for the years 1929-1938. The average share for 1900-1938 has been obtained by weighted averages for (1900+1929) and (1929-1938). Since precise data for the period before 1929 lack, it could have been the case that the share was somewhat higher during that period.

[42] Only the joint amount with which the quality of *both* filmed and surviving live entertainment spectator-hours increased. This cancels out in the social savings calculation, but remains in the time series. From the demand perspective, given rising consumer opportunity costs, both needed to increase (section I; Becker, 1965). On the

section 2, social savings are only 1.4 times the intensive growth. The quality increase needed for equalization, however, is 3.5 percent per annum. If the data were perfect, any differences between social savings and TFP-growth could potentially reflect unmeasured general quality increases in real output.[43] Third, we have disregarded international trade and attributed all services of inputs to the US market. This may have somewhat underestimated actual TFP-growth, although it is unlikely that this was enough for equalization, because film production used only a small share of all labour and capital (see Appendix A).

IV. Discussion

Since cinema was a new technology that industrialized entertainment—just as, for example, steam power industrialized the textile industry—it is worthwhile to compare it with new industries during the British industrial revolution. Entertainment's GDP-share (c. 0.7 percent) was about a seventh of both the cotton industry's and canals and railways' GDP-share between 1780 and 1860 and was similar to the iron industry's GDP-share in 1800. Entertainment's TFP-growth was several times higher than that for cotton (2.6 percent annually), iron (0.9 percent), canals and railways (1.3 percent) and shipping (2.3 percent) (D. N. McCloskey 1992).

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supply side, the surviving live entertainment probably also underwent substantial quality change, given the doubling capital/labour ratio.

43

(21) $$\frac{\Delta u}{u} = \frac{1}{s_y}\left(\frac{\Delta GDP}{GDP} - \frac{\Delta GDP_{SS}}{GDP}\right) - \frac{\Delta A}{A}$$

(22) $$\left(\frac{u_t}{u_0}\right)^{\frac{1}{t}} - 1 = \frac{1}{s_y}\left[\left(\frac{GDP_t}{GDP_0}\right)^{\frac{1}{t}} - \left(\frac{GDP_t - SS_t}{GDP_0}\right)^{\frac{1}{t}}\right] - \left[\left(\frac{A_t}{A_0}\right)^{\frac{1}{t}} - 1\right]$$

Where the left-hand term measures the annual percentage quality increase per unit of output. *u* = quality, s_y = industry share of GDP, SS = social savings, GDP_{SS} = counterfactual 1938 GDP (GDP-SS).

High TFP-growth has been associated with the adoption of General Purpose Technologies (GPTs), 'a technology that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many Hicksian and technological complementarities' (Richard G. Lipsey, 1998; Crafts, 2004a). GPT's initial impact on productivity growth is typically minimal; it may take between 40 and 120 years to become substantial. Film technology possessed some GPT-properties: it had much scope for improvement, was improved in steps and became widely used both nationally and internationally: almost every town came to have at least one cinema. Likewise, cinema probably had its largest productivity impact only after thirty to forty years, with the introduction of talking pictures from 1927. The uses of film technology, however, as well as complementarities, remained largely constrained to spectator entertainment, and this limited cinema's growth impact compared to GPTs.

Nonetheless, comparing cinema's growth impact with that of GPTs gives some insight into its significance (table 10). Entertainment's GDP-share was lower than that of GPTs, except early British steamships. Yet TFP-growth and the intensive growth share were higher than any other GPTs. Few industries experienced growth so intensively. Only fin-de-siècle British railways came close. Nevertheless, because of its small size, the total growth contribution of film technology is smaller than that of GPTs.

Cinema's social savings were often higher than those reported for GPTs or derived from GPTs' TFP-growth using expression (20). They were below those of ICT, roughly equal to those of railways and higher than those of British steam (table 10). The high social savings were possible because the extreme intensity of growth compensated for the small expenditure share. Without the sharp drop in prices resulting from the efficiency increase, this share might have been far higher. The fact that spectator entertainment could only be consumed at both a monetary cost and the opportunity cost of a precisely fixed amount of time, combined with the 24-hour limit of a day (Gary Becker, 1965, 1993), may have constrained the effect of falling prices by limiting sales growth.

To gain insight into an industry's growth impact, social savings are expressed as fraction of national social savings generated over the same period, using expression (20) with national values:

(23)

$$Growthimpact = \frac{SS_{industry\,t}}{SS_{national\,t}} = \frac{1-\left(1-\frac{s_y \frac{\Delta A_{industry}}{A_{industry}}}{1+\frac{\Delta GDP}{GDP}}\right)^t}{1-\left(1-\frac{s_y \frac{\Delta A_{national}}{A_{national}}}{1+\frac{\Delta GDP}{GDP}}\right)^t} = \frac{1-\left\{1-\frac{s_y\left[\left(\frac{A_{industry\,t}}{A_{industry\,0}}\right)^{\frac{1}{t}}-1\right]}{\left(\frac{GDP_t}{GDP_0}\right)^{\frac{1}{t}}}\right\}^t}{1-\left\{1-\frac{\left[\left(\frac{A_{national\,t}}{A_{national\,0}}\right)^{\frac{1}{t}}-1\right]}{\left(\frac{GDP_t}{GDP_0}\right)^{\frac{1}{t}}}\right\}^t}$$

National US social savings amounted to 37 percent of GDP in 1938 relative to 1900 technology. To produce the same output using only technologies available in 1900, the US would have needed additional inputs to the value of over a third of actual GDP. Motion pictures accounted for 5.6 percent of these national social savings.[44] This growth impact was lower than that of GPTs (except for early British steamships)

[44] As the TFP-growth of motion pictures and potentially many other services, is not generally fully included in the presently available national TFP-growth rates, nationally aggregated social savings were probably substantially higher in reality. For this reason motion picture social savings were added to 1938 national social savings, and then divided by them, to arrive at its share of 5.6 percent. If the social savings of more under-examined services will be added in the future, motion picture's share will go down, but the aggregate share of services will go up, of course.

because of entertainment's low GDP-share and the high national social savings. If the latter were the average of the national social savings during the emergence of other GPTs, entertainment would have accounted for 11.1 percent of social savings, higher than many GPTs. If entertainment's GDP-share were equal to the GPT-average, it would have accounted for 17.1 percent of social savings. If both were changed, entertainment would account for 25.2 percent of national social savings, lower only than ICT in the late twentieth century.[45]

A new technology's share in national social savings can potentially quantify the extent to which it is a GPT. This growth impact assessment takes account of both intensive growth and industry size and scales this to economy-wide efficiency gains. Given the latter's size during the late twentieth century, the threshold for becoming a GPT may have moved upwards over time.

If the intensive growth contribution of other service industries has also been underestimated, these findings suggest that national TFP-growth may actually have been higher than previously estimated. Cinema's extraordinary TFP-growth may be related to it being more of a 'Narrow Purpose Technology' (NPT) than a GPT. Other NPTs, especially those connected to service industries, might sometimes show a similarly high TFP-growth, if output is properly measured. Technologically, NPTs inherently might have enabled larger efficiency growth because the innovations could be tailored to one industry, while makers of GPTs had to keep them generally employable, aimed at the lowest common denominator to an extent that depended on customization costs relative to profit margins. Financially, the competition for capital investment posed by GPTs, may have resulted in NPTs to need at least a comparable expected return on investment. Thus per definition NPTs should have

[45] National social savings account for 28 percent of the total effect, GDP-share for 59 percent; the joint effect for 13 percent.

larger TFP-growth than GPTs to attract entrepreneurial investment.[46] Motion pictures notably were the tenth most profitable industry in the US in the 1930s (Huettig, 1941) and had been developed by capital provided by the stock market and by investment banks such as Goldman, Sachs, J. P. Morgan and entrepreneurial families such as the DuPont and Loew families, who certainly faced GPTs as alternative investment options (Bakker, 2005).

This paper's findings also nuance the assumptions of the Baumol (1967, 1985) model, which divides an economy in a stagnant sector (certain services) and a progressive sector (such as manufacturing). The model makes four assumptions: the difference between 'progressive' and 'stagnant' activities are inherent in their technological structures; all outlays other than labour costs are ignored; wages in the stagnant and the progressive sector move up and down together; wages in both sectors increase when productivity in the progressive sector increases. This paper suggests that inherent technological differences are limited, given the sharp increase in the live capital/labour ratio in the face of competition by cinema (i.e. the 'stagnant' sector is not stagnant); that given the former, capital costs can not be ignored; that wages in the 'stagnant' sector are substantially lower than in progressive one (although their distribution may be different). The fourth assumption can not rejected by this paper's findings. However, the wages in the 'stagnant' sector grew hardly faster than national wages, while those in the progressive sector increased twice as fast.

Based on the assumptions, Baumol makes four propositions: in the stagnant sector costs will rise without limit; in the progressive sector they remain constant; the stagnant sector will tend to vanish in competitive circumstances; if output shares are held fixed, all labour goes to the

[46] If profits depend on efficiency gains that are not fully and/or not immediately imputed into prices.

stagnant sector eventually; if so then growth rates decline. This paper's findings show that, in this period, costs per unit of output declined in both sectors; and that the 'stagnant' sector indeed tends to vanish in competitive circumstances. They do not contradict the last two propositions, although empirically they did not happen in spectator entertainment before 1940.

V. Conclusion

This paper has five main conclusions. First, in the early twentieth century, spectator entertainment experienced a phenomenal output growth hidden by a massive fall in prices because of sharp TFP-growth. Consumption increased from 3 to 54 spectator-hours per capita, prices fell from 61 to 10 real cents per spectator-hour, expenditure rose from 2 to 5.6 real dollars per capita and TFP grew over five percent per annum for forty years.[47] Intensive growth was primarily caused by an industrialization process in which motion pictures automated, standardized and made tradable live entertainment. First, the cheaper, lower value-added entertainment was automated away by silent films, then the high value-added metropolitan entertainment by talking pictures.

Second, the surviving live entertainment cannot be characterized as completely stagnant because it showed some TFP-growth and adjustment of factor quantities and prices. Its capital-labour ratio surged and reached a similar level as that of motion pictures, conform the Solow model. Third, a simple n-dimension agglomeration benefit model hypothetically suggests that urbanization-induced scale effects may only explain a small part of TFP-growth in the new sector (cinema), but

[47] The aggregate quantity consumed increased nearly 30 times, from 249 million spectator-hours in 1900 to over seven billion by 1938, while expenditure increased almost five times, from 151 to 721 million constant dollars.

potentially all of TFP-growth in live entertainment. Within the wider economy, these effects were potentially asymmetric in that they probably affected services more than manufacturing.

Fourth, spectator entertainment had a not insignificant impact on national economic growth. Its social savings amounted to 2.2 percent of 1938 GDP, and it accounted for nearly two percent of GDP-growth and over three percent of national TFP growth between 1900 and 1938. This contribution was somewhat lower than, but not unlike that of other new activities. Industry social savings as share of national social savings are a useful comparative indicator of a new technology's growth impact, as it reflects both GDP-share and TFP-growth and scales to economy-wide efficiency gains. It can potentially quantify the extent to which a technology is a general purpose technology (GPT) or not. Cinema's growth impact was 5.6 percent, lower than that of nearly all GPTs, often several times. It was lowered partially because of the high national social savings, driven by a broad wave of innovations between 1900 and 1938, and because long-run price elasticity was ultimately bounded by the time-cost of entertainment and the 24-hour limit to a day. Modern ICT's impact was five to six times as large as that of cinema, and in the same ballpark as earlier high-impact GPTs.

Fifth, mark-ups and wage data show that motion pictures had a substantial effect by reducing industry mark-ups by 0.61 percent per annum, suggesting that in the long-run, they increased both static and dynamic efficiency. Real wages in motion pictures increased by two percent annually (twice the national average) in the face of prices that fell by over four percent a year, suggesting that workers were able to capture some of the Schumpeterian rents.

The implications of these findings are, first, that certain service industries are not per definition stagnant, but, in the face of market forces, can potentially be subject to similar or even higher productivity growth than agriculture and manufacturing.[48] Second, inadequate output measurement may hide a substantial part of this growth. Current productivity estimates may therefore understate national productivity growth. Motion pictures made a substantial contribution to the general surge in TFP-growth in services identified by Alexander Field (2003; 2006) for the interwar period, and this surge may therefore have been even higher. Third, even the surviving old-technology parts of certain services are not necessarily stagnant, but can show TFP-growth and have to undergo substantial changes in production technology and structure in order to survive, even though their relative share can decline sharply.

Other services may exist that experienced similar productivity growth, the observation of which could also be obscured by inadequate output measurement and industry/market definition. One thinks, for example, of the effect of household appliances on domestic servants (Sue Bowden and Avner Offer, 1994), of pharmaceuticals on patient-days in hospital or quality-adjusted years of life and of telecommunications on postal and messenger services. Contrary to the index case of the textile industry, in many of these services industrialization came as a thief in the night. Exceptional output growth was accompanied by sharply falling prices that limited the growth of expenditure shares, by rapid industry growth that made the decline in traditional employment more relative than absolute, and by a shift to product innovations that obscured industry/market definition. Measuring productivity only in the traditional sector of these industries often shows a productivity slowdown, but this approach is like using the output of the independent village tailor to claim that productivity growth in the textile industry has been stagnating since

[48] See also Clive Lee's (1994) historical overview of British services. Lee concludes that services' poor productivity performance at some point in time 'was not an eternal constant, to be built into grim forecasts of the end of growth'.

1750. Spectator entertainment might be the prime example of a group of industrialized services that together have sharply increased productivity and output. The happenings of the early motion picture industry therefore may give insight into the shape of technological change in many service industries to come.

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Tables:

Table 1. *Prices, capacity, sales potential, estimated "price elasticity" and "consumer surplus" for various types of theatrical entertainments, Boston, 1909.*

	Price	Capacity	Sales	Percentage of		"Price elasticity of demand"			Consumer surplus		CS/Rev.
	$	seats	$	Capacity	Sales	arc	informal	Loglog	$	%	%
Opera	2.00	13,590	27,180	2	10	-2.41	-3.86	-0.30	19,230	17	71
First-class theaters	1.00	111,568	111,568	14	42	-2.41	-1.45	-0.30	55,784	48	50
Popular theaters	1.00	17,811	17,811	2	7	-0.96			8,906	8	50
Stock houses	0.75	21,756	16,317	3	6		-1.08	-1.42	2,720	2	17
Vaudeville houses	0.50	45,744	22,872	6	9	-0.61	-0.82	-1.42	5,718	5	25
Burlesque houses	0.25	80,700	20,175	10	8	-0.48	-0.96	-1.42	10,088	9	50
Vaudeville and moving pictures	0.15	79,362	11,904	10	4	-0.48	-0.99	-1.42	3,968	3	33
Moving-picture theaters	0.10	402,428	40,243	52	15	-1.76	-1.23	-1.42	10,061	9	25
Total	0.35	772,959	268,070	100	100	-1.07	-0.53	-0.78	116,473	100	43
All live entertainment	0.67	330,850	221,875	43	83	-1.17			104,428	90	47
Motion picture entertainment	0.10	442,109	46,195	57	17	-1.76			12,045	10	26

Notes: Capacity = the weekly seating capacity as estimated by the Boston committee (venue capacity times number of performances).

Sales = sales potential, when all seats are sold at the listed prices.

Arc elasticity = between respective price and the next price down.

Informal elasticity = based on best tangents to demand curve at datapoint, using mixed log-lin, polynomial and power curves at various stretches of the demand curve.

Loglog elasticity = based on constant elasticity log-log model split for two parts of demand curve to get best fit (R^2=0.998 and 0.945).

CS = Consumer surplus = area above price line and under hypothetical demand curve for the respective stretch of the curve. For opera, the intercept at q=0 is set at $4.83, the price that equalizes "upward and downward" arc elasticity for opera.

Rev. = Revenue.

Source: calculated from data from Boston Committee 1909, as mentioned in Garth S. Jowett, 1974.

Table 2. *TFP-growth in the US spectator entertainment industry, 1900-1938, in percent per annum.*

	Total	Disaggregated	
		Live technology	Film technology
Output	9.19	-1.24	12.86
Capital	5.04	-0.53	
Labour	2.98	-2.40	
Growth due to inputs	3.49	-1.93	5.40
TFP	5.70	0.69	7.46
Capital productivity	3.95	-0.71	
Labour productivity	6.03	1.18	
Capital/labour ratio	2.00	1.91	

Source : Appendices A and B.

Table 3. *Key production function variables for the US entertainment industry, 1900 and 1938.*

		All entertainment		Live entertainment		Film
Variable	Unit	1900	1938	1900	1938	1938
K/L	$/pyedu	250	529	250	512	532
MPL	s-h/pyedu	156	1,889	156	353	2,094
MPK	s-h/$	0.203	1.032	0.203	0.192	1.147
TRS	$/pyedu	749	1,587	749	1,536	1,595
w/r	$/pyedu	767	1,831	767	1,842	1,825
w/r/TRS	1	1.02	1.15	1.02	1.20	1.14
p	$/s-h	0.608	0.102	0.608	0.374	0.096
w	$/pyedu	95	193	95	132	202
r	$ per $ of K	0.123	0.106	0.123	0.072	0.111
Est. alpha		0.25	0.25	0.25	0.25	0.25
		Cobb-Douglas determination of w and r				
CD-w		92	168	92	110	176
CD-r		0.1265	0.1219	0.1265	0.0860	0.1264
		Cobb-Douglas determination of alpha				
CD-alpha		0.246	0.224	0.246	0.218	0.226
CD-alpha/est. alpha		0.98	0.90	0.98	0.87	0.90

Notes:

MPL = The marginal product of labour.

MPK = The marginal product of capital.

TRS = The Cobb-Douglas technical rate of substitution [a/(1-a)*K/L].

w/r = The wage/rental ratio.

alpha = the capital factor elasticity (Y=AK^alphaL^(1-alpha))

pyedu = person-year-of-education (1938 equiv.)

s-h = spectator-hour

$ = constant dollars of 1938

The Cobb-Douglas determination of w and r calculates what r should be given w and vice versa to make TRS equal w/r.

Dollars have been deflated to 1938 dollars using the consumer price deflators in Mitchell 1998.

Source : see table 1 and appendix B.

Table 4. *Price dual TFP-growth estimates for the U.S. spectator entertainment industry, 1900-1938.*

	Total	Disaggregated	
		Live technology	Film technology
Annual growth 1900-1938 (%)			
Real price	-4.58	-1.27	-5.74
Rental	-0.41	-1.42	
Wage	1.89	0.88	2.01
Price change due to inputs	1.31	0.31	1.67
Dual TFP Growth	5.89	1.58	7.41
With Cobb-Douglas determined r			
Real price	-4.58	-1.27	-5.74
Rental	-0.10	-1.01	
Wage	1.89	0.88	2.01
Price change due to inputs	1.39	0.41	1.74
CD-dual TFP growth	5.97	1.68	7.48
CD-Dual/Dual TFP growth	1.01	1.06	1.01
Primal TFP growth	5.70	0.69	7.46
Dual/Primal TFP growth	1.03	2.28	0.99
CD-Dual/Primal TFP growth	1.05	2.43	1.00
Markup	-0.19	-0.88	0.05
1938 values / 1900 values (1900 = 100)			
Price 1938/ price 1900	17	62	11
Markup 1938/Markup 1900	93	71	102
Wage 1938/wage 1900	203	140	213
Rental 1938/rental 1900	86	58	89
TFP 1938/TFP 1900	881	181	1512

Notes : Wages and prices deflated with Mitchell's (1998) consumer price deflators, before 'real' price and wage growth is computed (i.e. this is the growth relative to consumer prices). Wage growth rate is computed based on average real wage per person-year of education (pyedu). For comparison: national real unskilled hourly wages grew by 0.87 percent per pyedu per annum, total national hourly wages grew by 0.98 percent per pyedu per annum. The markup is calculated using expression (12) in the text.

Source : Appendices A and B; national wages: unskilled: Williamson, 2006; all: USDC 1975.

Table 5. *Growth contribution of the US entertainment industry, 1900-1938.*

	Primal	Dual
Growth capital (% p.a.)	5.037	
Profits/GDP (%)	0.075	
Extensive growth contribution	0.004	
Growth TFP (% p.a.)	5.697	5.892
Output/GDP (%)	0.653	
Intensive growth contribution	0.037	0.038
Total growth contribution	0.041	0.042
Real GDP growth (% p.a.)	2.26	
Caused by entertainment (%)	1.81	1.87
Explained by extensive growth entertainment (%)	0.17	
Explained by intensive growth entertainment (%)	1.64	1.70
Extensive growth/all growth	9	9
Intensive growth/all growth	91	91

Note : output/GDP: the average of 1900 and 1938 ratios is used.

Source : Entertainment data: appendix A. 1900 and 1938 nominal GDP and real GDP-growth: EHnet.

Table 6. *Contribution of the entertainment industry to US national TFP-growth, 1900-1938.*

	Primal	Dual
National TFP growth (% per annum)	1.14	
TFP-growth film industry (% per annum)	5.70	5.89
TFP-growth entertainment industry (% per annum)		
Entertainment TFP/national TFP-growth (index)	501	518
Share in GDP 1900 (%)	0.47	
Share in GDP 1938 (%)	0.84	
Average share entertainment in GDP (%)	0.65	
(annual increase in share (% per annum))	1.54	
National TFP-growth explained by entertainment (%)	3.27	3.38

Note : National TFP-growth is weighted average of 1870-1913 and 1913-1950 (Maddison).

Source : Appendices; Maddison 1995: 255.

Table 7. *Hypothetical estimates of agglomeration effects on spectator entertainment TFP-growth, U.S., 1900-1938.*

	Total	Live technology	Film technology
Annual growth 1900-1938 (%)			
Population in cities >25,000	2.59	2.59	2.59
TFP explained by 2-dimensional agglomeration effects	1.30	1.30	1.30
TFP explained by 3-dimensional agglomeration effects	1.73	1.73	1.73
Geometric average	1.50	1.50	1.50
Percentage of primal TFP growth explained	26	218	20
Percentage of dual TFP growth explained	26	95	20
Average	26	133	20

Notes:

Two-dimensional effects: inputs only increase with the square root of the output increase.

Three-dimensional effects: inputs only increase with the cubic root of the output increase.

Source : urbanization figures from Mitchell and Flora.

Table 8. *Estimate of social savings generated by the US motion picture industry, 1938.*

		Actual				Counterfactual	
	Unit	Film	Live-ent.	Total	% GDP	Total	% GDP
Aggregate							
Consumer expenditure	$million	663	58	721	0.8	2,634	3.1
Quantity consumed	million sp-hrs	6,883	155	7,038		7,038	
Average price	$/sp-hr	0.096	0.374	0.102		0.374	
Labour							
Employment	pyedu	1,785,340	267,500	2,052,840		12,146,748	
Wage bill	$million	360	35	395	0.5	1,605	1.9
Average wage/pyedu	$	202	132	193		132	
Capital							
Capital	$million	949	137	1,086	1.3	6,221	7.2
Cost of capital	$million	80	8	88	0.1	460	0.5
Capital consumption	$million	28	2	30			
r	%	11.1	7.4	10.6		7.4	
Gross profit margin	%	12.1	14.4	12.3		17.4	
Corporate profits		39	0.4	39			
Factor endowment and productivity indicators							
Output/pyedu	sp-hrs/pyedu	3,855	579	3,429		579	
Revenue/pyedu	$	371	217	351		217	
Output/capital	sp.-hrs./$	7.3	1.1	6.5		1.1	
Capital/pyedu	$/pyedu	532	512	529		512	

Notes: sp-hr = spectator-hour, pyedu = one employee times national average years of education.

Source : Appendix A and B.

Table 9. *The effect of social savings on GDP-growth and the intensive growth contribution.*

	Primal	Dual
Real GDP growth (%)	2.261	
Counterfactual real GDP growth (%)	2.201	
Joint intensive contribution (%)	0.005	
Net counterfactual real GDP growth (%)	2.196	
Reduction in growth rate (%)	0.065	
Reduction/intensive contribution film techn	199	169

Note: last line: intensive contribution = 100.

Source : Appendix B; Maddison, 1995.

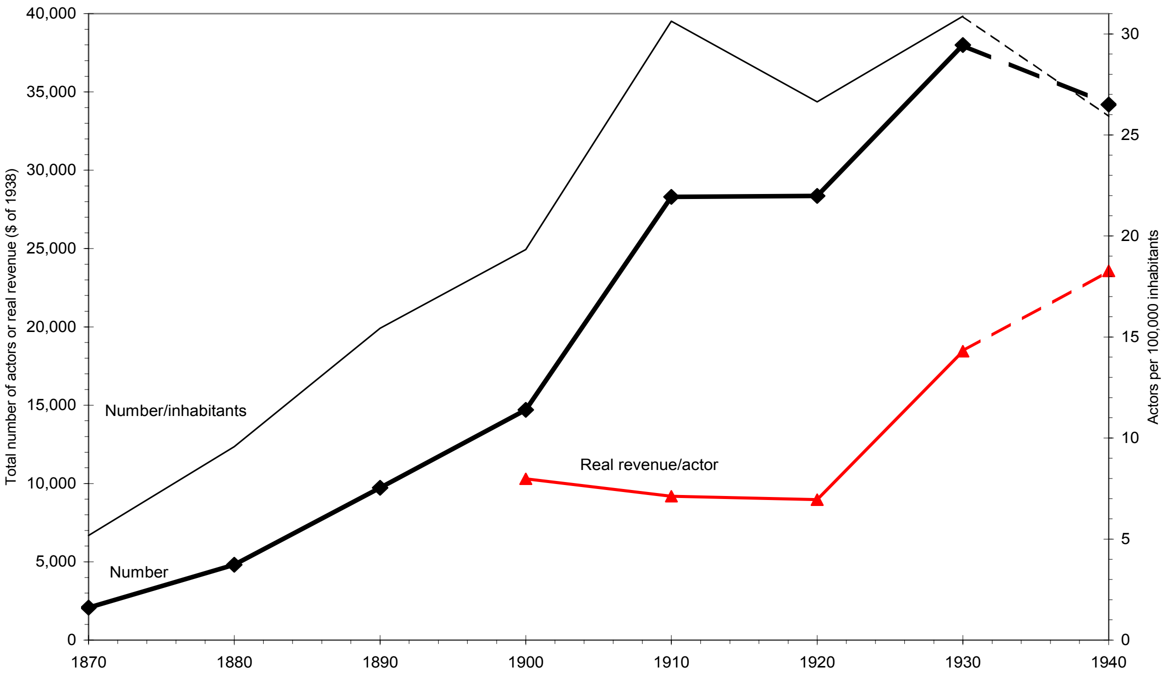
Table 10. *The growth contribution of cinema technology and that of general purpose technologies (GPTs) at various intervals, 1830-2000.*

			Lag	GDP-	Growth of		Growth contribution			Social savings			National growth	
				share	TFP	K/L	Int.	Ext.	Total	Industry		National	TFP	GDP
		interval	(years)	%	(%)	(%)	(%)	(%)	(%-point)	(% GDP)	(%NSS)	(% GDP)	(%)	(%)
Film technology	US	1900-1938	25-40	0.7	5.7	2.0	91	9	0.04	2.2	5.6	36.8	1.14	2.41
Railways	US	1840-1890								1.5	10.0	15.0	0.34	4.76
	UK	1830-1850		1	1.9	22.8	13	88	0.16	0.4	2.9	13.7	0.75	1.88
	UK	1850-1870		4.0	3.5	5.9	54	46	0.26	2.6	19.0	13.7	0.75	2.39
		1870-1910		6.0	1.0	0.4	86	14	0.07	2.3	11.8	19.7	0.56	1.70
Steam	UK	1850-1870	80	1.8	3.5		50	50	0.12	1.2	8.8	13.7	0.75	2.39
		1870-1910	80-120	2.7	1.7		64	36	0.14	1.8	9.1	19.7	0.56	1.70
Steamships	UK	1850-1870		0.7	1.6	9.7	33	67	0.03	0.2	1.6	13.7	0.75	2.39
		1870-1910		3.4	1.6	4.5	50	50	0.10	2.1	10.7	19.7	0.56	1.70
Electricity	US	1929-1948	40		4.6									
ICT	US	1974-1990		1.4			40	60	0.68	4.1	69.8	5.9	0.39	3.17
		1991-1995		1.9			47	53	0.87	1.6	60.5	2.6	0.68	3.13
		1996-2001		2.5			43	57	1.79	3.7	93.2	3.9	0.83	3.50

Notes : Lag = rough estimate of time between innovation and productivity impact. Int. = intensive. Ext. = extensive. %NSS = percentage of industry social savings of total national social savings. Social savings are those in final year as percentage of final year GDP. Social savings for UK railways 1870-1910, UK steamships 1850-1910 and US ICT 1974-2001, as well as national social savings have been calculated from the intensive growth contribution and real GDP-growth using equation (19) from the text. GDP-share of steam has been calculated by doing the obverse.
ICT = information and communication technologies.
Sources : US Railways: Fogel (1962:196) (multiplied by 1.5 to include passenger social savings). UK Railways: Crafts (2004), quoting Hawke (1970) and Foreman-Peck (1991). Steam and steamships: Crafts (2004). US electricity data is the geometric average of 1919-1929-1941-1948 growth intervals from Kendrick (1961), as reported in Field (2003). ICT: Crafts (2004).
National TFP growth for US 1900-1938 from Maddison (1995), for the UK from Crafts 2003. US 1974-2001 is a rough estimate at 2/3 of the non-farm business sector TFP reported in Crafts (2003).
National US and UK GDP growth from EH.net.

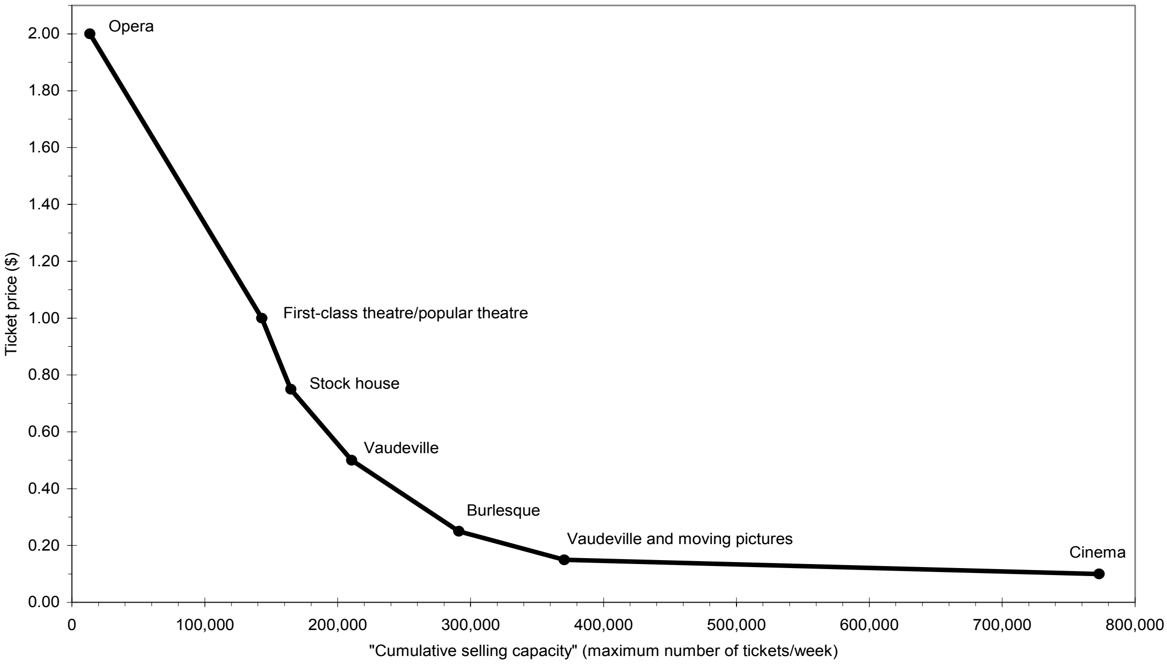
Figures:

Figure 1: Number of Actors and Actresses and Real Revenue per Actor/ Actress in the US, 1870-1940.



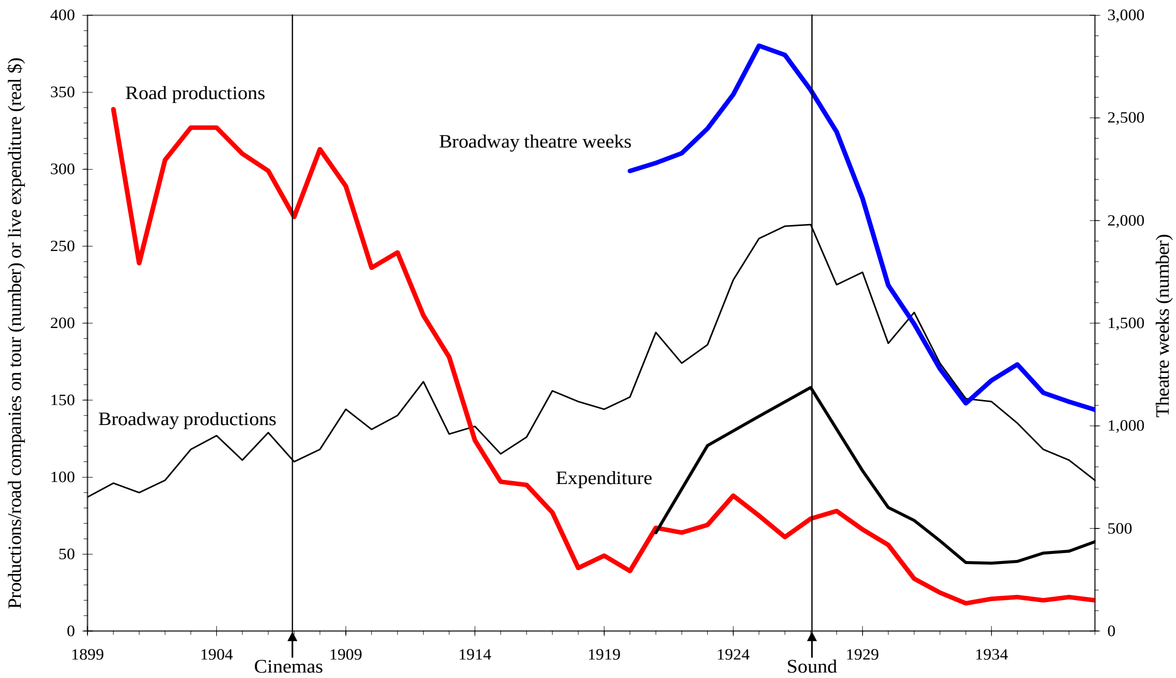
Note: the 1940 data is a lower-bound estimate, because 1940 census figures for actors/actresses are not comparable with the 1930 census (Alba M. Edwards, 1943). In 1930 37,993 persons were classified as actor or actress, in 1940 only 19,232. The fact that 1940 census classified persons by the work they were doing during one particular week in March, may have had particularly an effect on the number of actors/actresses. To arrive at a very conservative estimate, it has been assumed that, had the 1930 classification been used, employment would only have decreased by ten percent, yielding a 'comparable' number of 34,194. It is likely that the real comparable number was very much lower.
Source: US Census, 1870-1940; United States Department of Commerce, *Historical Statistics*; Appendix B.

Figure 2: Ticket Price versus Cumulative Ticket-Selling Capacity for theatrical Entertainment Venues in Boston in 1909 ($ and maximum number of tickets per week).



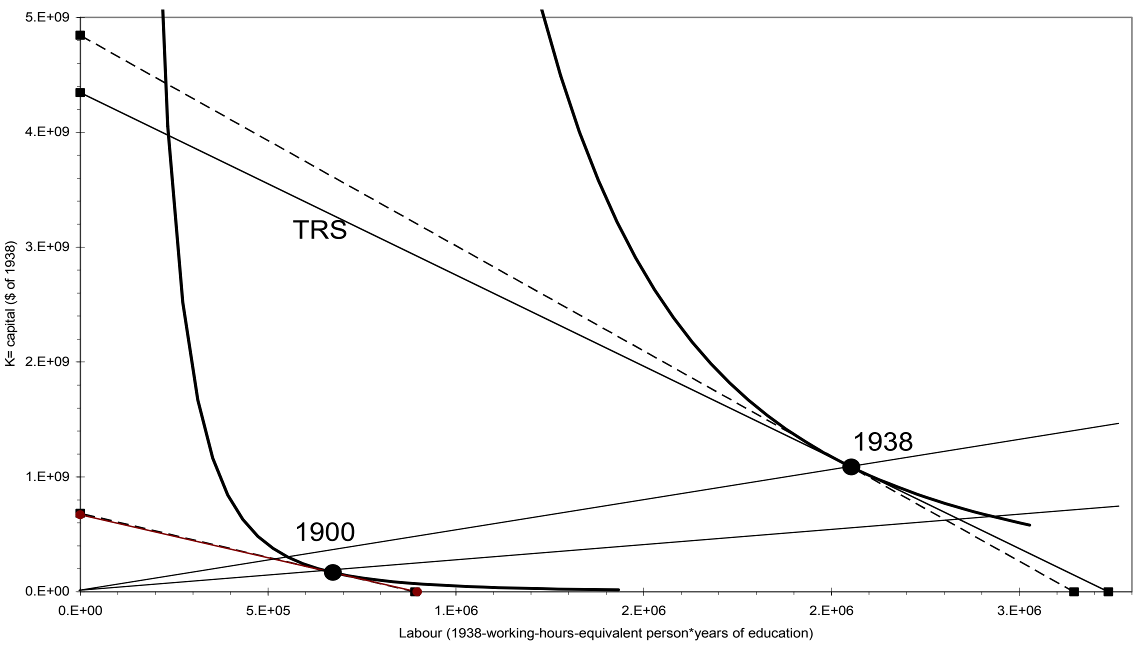
Sources: Table 1; compiled from Boston Committee, 1909, as mentioned in Garth S. Jowett, 1974.

Figure 3: Indicators of US Live Entertainment Production (number of road productions on tour, Broadway productions, Broadway theatre weeks and real expenditure), 1899-1938.



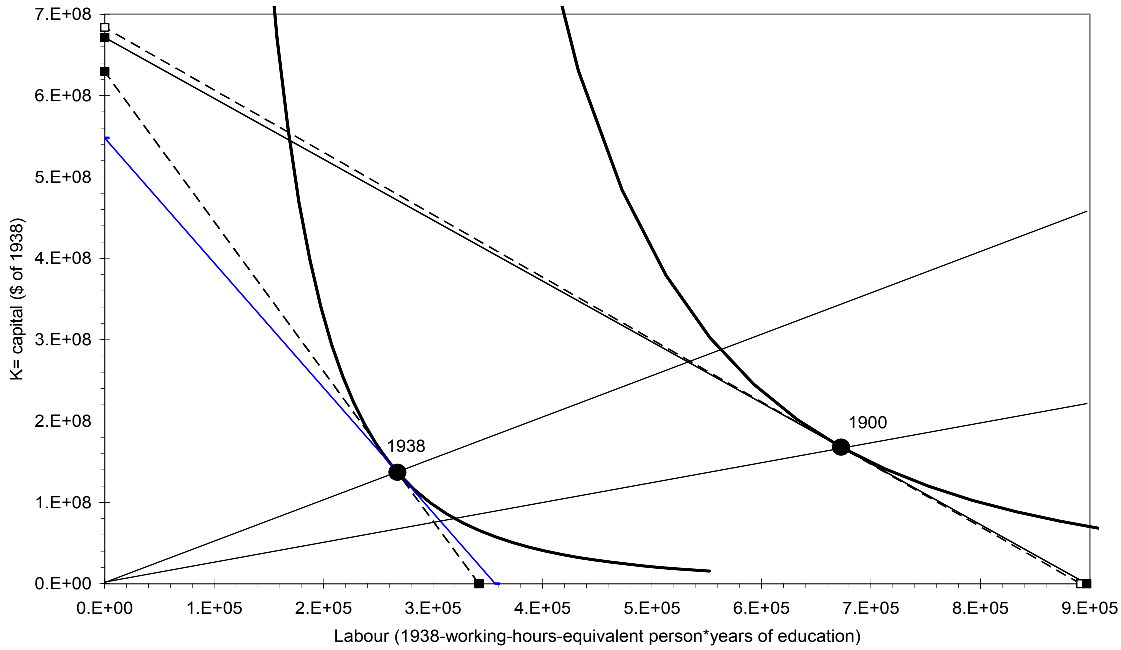
Notes: road productions: this is the average of the total number of companies on tour in April and in December, as listed in *Variety*. Real expenditure: this it total consumer expenditure in millions of 1938 dollars, deflated by the consumer price index from B. R. Mitchell, 1998.
Source: Bernheim, 1932; McLaughlin, 1974: 271-280, US Department of Commerce, 1975.

Figure 4: Cobb-Douglas Production Function for US Spectator Entertainment, 1900 and 1938.



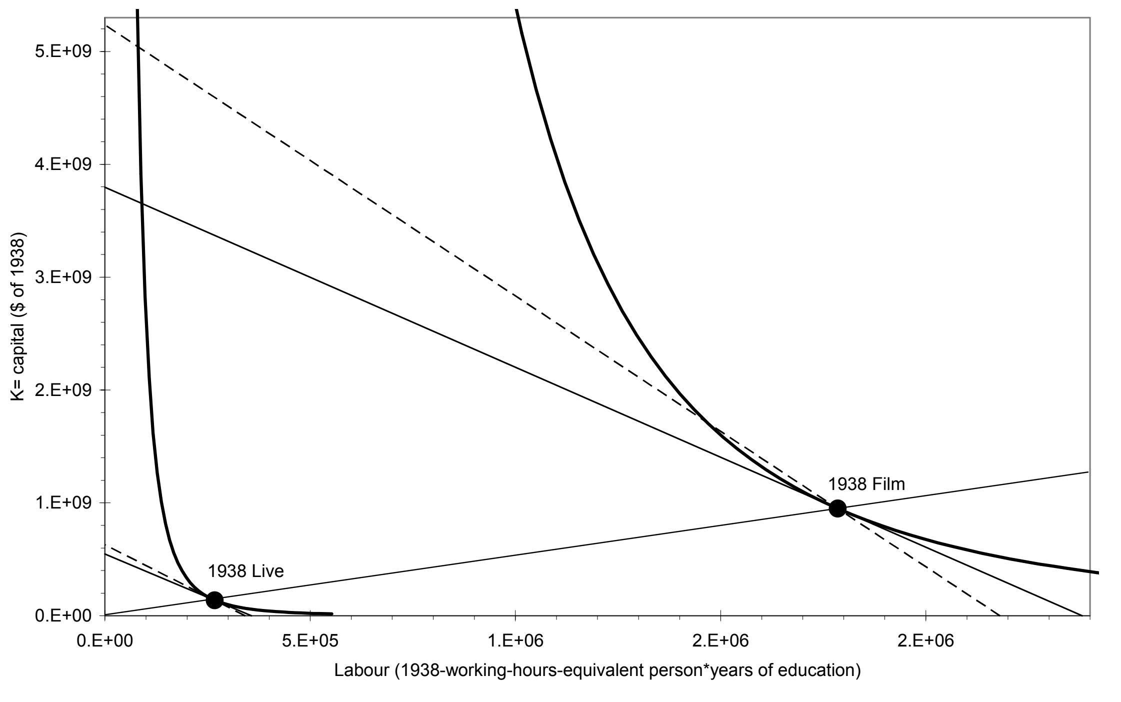
Notes: The lines tangent on the Cobb-Douglas functions are the technical rate of substitution. The solid lines are the Cobb-Douglas rates of substitution, (a/(1-a)*K/L, the dotted lines are the technical rates of substitution calculated with independently estimated wages and rentals (w/r). Thus the difference within each pair of lines reflects the degree to which the data estimates differ from the Cobb-Douglas model.
The two lines through the origin and through data point 1900 and data point 1938, respectively, are the capital/labour ratios, of course.
Source: See Appendix A and B.

Figure 5: Cobb-Douglas Production Function for US Live Entertainment, 1900 and 1938.



Notes and sources: see figure 4.

Figure 6: Cobb-Douglas Production Function for US Spectator Entertainment, Disaggregated by Live and Film Technology, 1938.



Notes and sources: see figure 4.

Appendix A: Estimating TFP-Growth

This section briefly discusses the data estimates made to calculate TFP-growth, the estimation of factor elasticities, value of human capital and the effect of international trade.

I. Data Estimates

Since the sectoral data are at times sparse and incomplete, especially for 1900, approximate estimates had to be made in some cases. Appendix B lists in detail how these estimates were arrived at. Most of the 1938 data is from the US Department of Commerce, the US Bureau of Labor Statistics and the Bureau of Economic Analysis (1977). The 1900 labour data are calculated from census figures, the 1900 consumer expenditure data is arrived at by combining the US Department of Commerce 1909 expenditure data with John Owen's (1970) growth rates on real US consumer expenditure on recreation. The 1900 price and capital estimates are based on expert estimates of theatre historians and the contemporary trade press and directories. They have been made as conservatively as possible, by rounding them up or down in the direction that would diminish TFP-growth and social savings between 1900 and 1938, not unlike the way Robert Fogel (1964) estimated the social savings of US railways.

II. Factor Elasticities

For motion pictures, between 1929 and 1947 the share of wages in national income was 0.78 on average and for other amusements and recreation 0.81 (table A-1). The latter category comprised far more than live entertainment, which was just a small share of it, but further disaggregated national income data are not available. The 1930s data suggests a labour elasticity of about 0.80, but this value was affected considerably by the depression, which decreased the income share of capital. The shares in 1929 and 1930 and in the 1940s warrant a somewhat lower estimate of long-run income-share of 0.70.

For 1900, unfortunately no industry national income figures are available. If we multiply the employment with average national wages (as opposed to wages of entertainment workers), we arrive at a labour share of industry revenues of 0.66 in 1900, versus 0.52 in 1938. Given the estimated 1929-1947 capital costs and taking into account the effect of the depression it does not seem unreasonable to assume that the factor price of capital was 0.15 in 1900. Using 1900 benchmark estimates (Appendix B)—the labour share was then 0.81 in 1900. Both estimated suggest that the share of labour was somewhat higher in 1900 than in the 1930s. An average share of 0.75 for the whole period therefore does not seem unreasonable.

Table A-1: *National income generated by the motion picture industry and 'Amusements and recreation' and factor income shares.*

	NI	Compensation of Employees	Capital	Corporate profits	Other capital income	L/NI
Motion pictures						
1929	440	310	130	59	71	0.70
1930	438	313	125	51	74	0.71
1931	361	307	54	2	52	0.85
1932	194	241	-47	-83	36	1.24
1933	210	227	-17	-40	23	1.08
1934	283	253	30	2	28	0.89
1935	329	282	47	13	34	0.86
1936	391	317	74	29	45	0.81
1937	437	360	77	33	44	0.82
1938	426	346	80	39	41	0.81
1939	434	353	81	41	40	0.81
1940	448	353	95	51	44	0.79
1941	513	386	127	78	49	0.75
1942	652	425	227	155	72	0.65
1943	830	477	353	253	100	0.57
1944	882	531	351	246	105	0.60
1945	929	573	356	238	118	0.62
1946	1129	703	426	304	122	0.62
1947	1046	719	327	224	103	0.69
Average						0.78
Amusements and recreation - except motion pictures						
1929	379	323	56	1	55	0.85
1930	336	299	37	-9	46	0.89
1931	268	256	12	-20	32	0.96
1932	177	191	-14	-30	16	1.08
1933	154	161	-7	-23	16	1.05
1934	197	176	21	-9	30	0.89
1935	211	180	31	-5	36	0.85
1936	253	205	48	2	46	0.81
1937	305	239	66	5	61	0.78
1938	266	216	50	2	48	0.81
1939	288	230	58	4	54	0.80
1940	310	246	64	9	55	0.79
1941	368	270	98	18	80	0.73
1942	388	281	107	18	89	0.72
1943	436	291	145	34	111	0.67
1944	507	337	170	42	128	0.66
1945	613	384	229	71	158	0.63
1946	816	524	292	93	199	0.64
1947	797	566	231	64	167	0.71
Average						0.81

NI = national income
Other capital income = proprietors' income, rental income, net interest.
L/NI = share of wages in national income.
All values in current dollars.
Source : Bureau of Economic Analysis 1977.

III Quality and Quantity of Human Capital

The over-all average quality of US labour increased substantially between 1900 and 1938. Education, for example, improved from 6.38

years to 10.03 years per worker.[49] Further, with the film industry's ageing labour quality probably improved, because of an increasing number of employees who had been trained on the job. Since this is rather difficult to measure, the national increase in labour quality is used as a lower bound proxy. The labour force is then measured in person-year-of-education, which is a full-time equivalent employee times the average years of education. In 1938, one employee represented ten person-years-of-education.

The quantity of labour used also changed. The average working week decreased from 60.2 hours in 1900 to 44.4 hours in 1938 (Frederic Dewhurst, 1955). It is difficult to assess whether similar changes took place within the entertainment industry. During the years 1948-1954, for example, employees in the motion picture industry worked only 82-93 percent of the national average working hours (U.S. Bureau of Economic Analysis, 1977), but admittedly, this was a period of turmoil and decline. For other amusements and recreation the figure was a steady 10-11 percent more than the average (Dewhurst, 1955). With the current data, we can only assume that working hours decreased in line with the national average. The 1900 quantity of labour, as expressed in the number of persons working in the industry, is therefore divided by 1.36 to arrive at the 1938 equivalent.

IV. <u>International Trade</u>

The net dollar revenues from US films abroad should be included in the national income, as calculated by the Bureau of Economic Analysis. Industry output, however, has been calculated by dividing domestic revenues by price. It is difficult to do this for export revenues, because precise data lack and also because ticket prices varied substantially

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[49] Calculated by geometric interpolation from the benchmark years 1890, 1913 and 1950. Maddison (1995): 37, 253.

across the world. If one assumes that about a third of US box office revenue went to distributors and one uses the expert ballpark estimate that the Hollywood studios' foreign earnings were about one third to one quarter of domestic revenues, then foreign income in 1938 would be about 1/9th to 1/12th of domestic expenditure, between $55 and $74 million.

The final output generated abroad, however, uses mainly foreign labour and capital and these are not included in the US figures. The only US share would be those from employees working in film production, about 33,000 in 1938, and those in international distribution, relatively negligible. Given the number of assumptions to be made, it seems most appropriate to ignore the foreign issue. Given that, for US producers, those foreign spectator-hours had marginal costs approaching zero, that the US economy did not consume that additional output, and given that that the dollars received for it were national income, it does not seem unreasonable to exclude foreign output. It will certainly make our TFP-estimate more conservative.

Appendix B: Data Used For The Estimates[50]

This appendix provides the sources for the estimates on labour, capital and output. Since the available data are sparse, approximate estimates had to be made in some cases. The estimates have been made transparent and replicable by stating all the steps. They also have been made as 'conservative' as possible; they have been rounded up or rounded down in the direction that would diminish overall TFP growth between 1900 and 1938. For 1900 estimates for prices, labour and capital will have a downward bias, those for output an upward bias and vice-versa for 1938.

Table B-1 gives an overview of all the data used and estimates made.

I. Entertainment in 1900

A. Labour in 1900

1. The US census lists 57,777 persons classified under entertainment. These are only management and creative inputs, not the practical workers that worked in the entertainment industry.
2. In the 1910 census, which contains a disaggregated breakdown of these categories, 15.89 percent of the persons above were listed under classifications that largely involve non-theatrical entertainment, and which were not present in the 1900 census. It is simply assumed that this percentage was the same in 1900, we arriving at 0.8411 x 57,777 = 48,596 persons classified under entertainment.
3. In 1930, for the first time, both practical workers classified in the census under entertainment (Census of Population, 1930) and practical workers working in entertainment but classified in the census under other industries (US Bureau of Economic Analysis,

[50] This paper's estimates differ in five respects from those of Gerben Bakker (2004): the current paper takes into account the changes in hours worked; it has better price estimates based on more precise data; it has better capital data; and, finally, it is more accurate in the data on total consumer expenditure and in the size of the total entertainment labour force in 1938.

1977) are available. Therefore this year will be used as a benchmark year. The census contained 203,251 persons working in spectator entertainment (249,177 – 6,097 aviators – 10,718 'keepers of pleasure resorts, race tracks etc.' – 29,129 'keepers of billiard rooms, dance halls, skating rinks etc.' = 203,251 persons). 31.1 percent of these had practical occupations. If we make the bold assumption that this percentage was the same in 1900, we arrive at (57,777/68.9)*100 = 70,532 persons working in the industry in 1900.

4. Data on workers classified in other industries but working for the entertainment industry are only available from 1930. Using the same method as will be used to calculate 1938 labour (see below), we arrive at 71,122 live entertainment fte in 1930, making a total of entertainment fte of 153,000 for film and 71,122 = 224,122 fte, suggesting that 20,871 persons, or 10.3 percent of the census total, were classified under non-entertainment occupations. Assuming that this percentage was the same in 1900, we arrive at 1.1026 * 70,532 = 77,774 persons working in the entertainment industry in 1900.

5. This is a rough estimate, and sources lack to make a more precise estimate. Yet, the directions and the magnitude of the findings are not that sensitive for an estimation error of say plus or minus 10,000 persons (see text).

Table B1. *Productivity indicators for spectator entertainment in the US, 1900 and 1938.*

	Total	Disaggregated	
	Live + Film	Live technology	Film technology
Labour (1938 pyedu)			
1900	672,773	672,773	
1938	2,052,840	267,500	1,785,340
Capital ($)			
1900	168	168	
1938	1,086	137	949
Sold output (mln sh)			
1900	249	249	
1938	7,038	155	6,883
Expenditure (mln 1938$)			
1900	151	151	
1938	721	58	663
Price (1938$)			
1900	0.608	0.608	
1938	0.102	0.374	0.096
Labour productivity (sh/(pyedu))			
1900	370	370	
1938	3,429	579	3,855
Capital productivity (sh per 1000$)			
1900	1,484	1,484	
1938	6,479	1,131	7,251
Labour costs ($/pyedu)			
1900	95	95	
1938	193	132	202
Capital Costs ($ per $ of K)			
1900	0.1235	0.1235	
1938	0.1057	0.0717	0.1105
Capital factor income in millions			
1900	16.79	16.79	
1938	88.03	8.03	80.00
Labour factor income (wage bill)			
1900	63.70	63.70	
1938	395.43	35.34	360.09
Capital consumption			
1900	4.50	4.50	
1938	29.93	1.93	28.00
Creative input productivity (sh/p)			
1900	6,599		
1938	100,945		
Creative inputs (number)			
1900	37,752		
1938	69,724		
Revenue per creative input ($)			
1900	4,013		
1938	10,341		
Revenue/(pyedu) ($)			
1900	225	225	
1938	351	217	371
Capital/(pyedu)			
1900	250	250	
1938	529	512	532
Urbanisation (million persons living in cities >25,000)			
1900	20	20	20
1938	52	52	52
Population			
1900	76	76	76
1938	130	130	130
Output/cap.			
1900	3.3	3.3	
1938	54.2	1.2	53.0
Exp/cap			
1900	2.0	2.0	
1938	5.6	0.4	5.1

Note: all amounts at 1938 prices; p = pyedu= person*years of education (national average); sh = spectator-hour (see text).

Sources : Appendix B; average years of education: Maddison, 1995.

B. Wages in 1900

For 1900, the national average wages (from Dewhurst, 1955) have been used, as reliable industry wages series are not available.

C. Consumer Expenditure in 1900

1. Entertainment expenditure in 1909 was $167 million (US Department of Commerce, 1975) which amounts $260.937 million in 1938 dollars, using the consumer price deflators in Mitchell (1998). All amounts that follow are changed into 1938 dollars using these same deflators.

2. This figure is back-projected to 1901 by using Owen's growth rates for real total consumer expenditure for 1906-1913 (7.99 percent) and 1901-1906 (5.85 percent) (Owen, 1970), yielding an expenditure of $155.930 million in 1901.

3. This figure is then further back-projected by assuming 1900-1901 had at least half the growth rate (to make the estimate more conservative) as 1901-1906, yielding 1900 expenditure of $151.499 million (in 1938 dollars).

4. A rough cross-check is made by taking the average household expenditure on 'amusements and vacations' from the US Commissioner of Labor Survey (as reported in Bakker, 2001). This was 1.1 percent. It is then assumed that half of this, 0.55 percent, was spent on spectator entertainment. Using the 1917/1919 expenditure on spectator entertainment (Bakker, 2001), of 0.63 percent, it is tentatively assumed that in 1900, on average 0.59 percent of labour income was spent on spectator entertainment. If we take the share of labour income in national income in 1900 to be 0.54 (Rosenbloom, 2005), we arrive at consumer expenditure on spectator entertainment in 1900 of $66 million, which is $112 million dollars of 1938. This rough estimate

confirms that estimate (3) is in the right ballpark, but about a quarter lower, and thus may lead to underestimating productivity growth.

5. Since (3) is the more careful estimate, and also the more conservative one (i.e. the one that would tend to over-estimate productivity in 1900 and thus lower the TFP-estimate, estimate (3) is taken.

D. Prices in 1900

1. It is difficult to obtain reliable estimates of entertainment prices in 1900, but one for high-quality live entertainment in 1913 is $2 per ticket (Poggi, 1968: 71). In the 1900s, also lower priced live entertainment existed and cheaper tickets. Robert C. Allen (1980: 296), for example, found that standing place tickets for vaudeville ranged from 15 to 50 cents, while Felicia Hardison Londré and Daniel J. Watermeier (1998: 265) describe how low-priced resident stock theatre companies emerged between 1900 and 1920, whose prices usually varied between ten and thirty cents, and rarely exceeded 75 cents. Glen Hughes (1951: 305) writes how an early vaudeville theatre in the 1880s charged 10 cents for standing places and 15 cents for seats. Using rough estimates like these, and assuming ticket prices rose in line with inflation during the 1900s, we arrive at an average price of $1.25 for the most expensive live entertainment, $0.35 for the entertainment in between, and $0.20 for the cheapest live entertainment in 1900. These are deliberately lower bound estimates, to make our calculation more conservative.

2. It is then assumed that in the most expensive places, a performance lasted 2.5 hours, in the intermediate places 2 hours, and in the cheapest places 1.5 hours. Combining this with (1) yields

average prices per spectator-hour of 50, 17.50 and 13.33 cents, respectively.

3. Given that no systematical price data is available, an estimate has to be made. It is assumed that in 1900, about half of all tickets sold was for 'first-class' live entertainment. Using contemporary sources, Londré and Watermeier (1998: 185) identify 1,700 theatres nation wide available for touring and about 1,000 unlisted theatres. If it is assumed that the unlisted theatres were of a lower quality and charged lower admission prices, this would yield a ratio of 63 percent. To keep our estimate conservative, we set the ratio at fifty percent, and assume that this ratio was the same for the vaudeville, burlesque, and others theatrical entertainments. We then simply assume that another 25 percent of tickets were for intermediate entertainment, and another 25 for the cheapest form of entertainment.

4. Correcting for differences in output, the weight of the three forms of entertainment becomes then 58.82 percent (0.5*2.5/(0.5*2.5+0.25*2+0.25*1.5)), 23.53 percent and 17.65 percent respectively.

5. Combining (2) and (4) we arrive at an average price per spectator-hour in 1900 of (0.5882*50) + (0.2353*17.50) + (0.1765*13.33) = 35.88 cents in 1900 prices. This amounts to 60.81 cents in 1938 dollars.

6. Particularly good data on spectator entertainment prices and quantities for the period when cinemas already were omnipresent enables us to check whether the estimate above is roughly in the right ballpark. The data is for Boston in 1909, is reported in Gart S. Jowett (1974), and is based on an investigation by the Boston Committee on Amusements (see also table 1 and figure 2 in the main text). It contains ticket prices and estimated ticket-selling

capacities for each category of spectator entertainment, from opera, at $2.00 a ticket to cinema, at $0.10 a ticket. If we ignore the two lowest priced categories, motion picture theatres (52 percent of total capacity) and theatres showing ‘vaudeville and motion pictures’ (10 percent of total capacity, price $0.15), we arrive at weights of 49 percent for high-priced entertainment (opera, first-class and popular theatre), 23 percent for medium-priced entertainment (‘stock houses’ and ‘vaudeville houses’) and 28 percent for low-priced entertainment (‘burlesque houses’), with average ticket prices of $1.10, $0.58 and $0.25, yielding an average ticket price of 76.25 cents and an average duration (using the durations mentioned in (4) above) of 2.105 hours. This results in an average current ticket price of 35.27 cents. This price is nearly equal to the current 1900 price of 35.88 cents. In real terms, the price is somewhat lower, 53.43 cents of 1938. If both our estimates would be entirely accurate (a big if) then this would suggest that during the 1900s, the live entertainment price decreased with 1.43 percent per annum relative to all other prices, leaving the nominal price unchanged. This does not seem unreasonable, given the increasing competition of cinema from 1905 onwards. Given that by 1909, about three to four years after the first cinemas emerged, 52 percent of Boston capacity existed of cinemas, an average price of 35.27 cents in the face of strong cinema competition suggests that the price could have been far higher in 1900.

7. Although the data analyzed under (6) suggests that our 1900 price estimate reported under (5) may be somewhat on the low side, the price estimate under (5), of 35.88 cents, or 60.81 cents in 1938 dollars is kept, to keep the estimate of TFP-growth conservative.

E. Capital in 1900

1. Exact data on capital invested in the entertainment industry in 1900 is not available. The number of theatres was estimated to be 2,700 in 1905; 1,700 first-class listed theatres and about 1,000 others (Londré and Watermeier, 1998). A different estimate for 1910 arrived at 1,520 first-class listed theatres (Bernheim 1932). It is thus estimated that in 1905 the total number was 2,700 and that on top of this, 1,000 vaudeville theatres existed, and 1,000 other entertainment venues, yielding a total of 4,700. It is then assumed that between 1900 and 1905 the number of venues grew at the rate of the real expenditure on recreation (5.58 percent per annum) found by Owen (1970). This yields 3,537 venues in 1900.

2. Because no systematic data is available, based on anecdotal historical construction costs and acquisition data for individual theatres from the theatre history literature (see bibliography) a rough and ready ballpark estimate was made that the capital needed to build an average theatre in 1900 was about $35,000.

3. It is assumed capital will depreciate in fifty years and that in 1900, the average age of an entertainment venue was ten years, given the boom in entertainment expenditure towards the end of the 19th century. This yields an average depreciated invested capital per theatre of $28,000, and a total invested capital of $99.036 million, amounting to $167.857 million in 1938 dollars.

F. Cost of Capital in 1900

1. This is calculated as (capital factor income + capital consumption)/(capital stock + capital consumption).

2. Since no reliable industry data on capital income exist, an estimate had to be made; capital income been set at ten percent of stock, slightly higher as in 1938, given the effect of the depression,

and capital consumption at the same percentage as in 1938 (2.7 percent of stock). This yields a cost of capital of 0.1235, or $20.69 million.

II. Entertainment In 1938

A Labour in 1938

Cinema:

The US Historical Statistics (US Department of Commerce, 1975: 840) show 178,000 full-time employment equivalent (fte) for the film industry. The National Income and Product Accounts (Bureau of Economic Analysis, 1977: 206), however, show 171,000 fte for motion pictures in 1938. The difference appears to be that the Historical Statistics also include “active proprietors of unincorporated businesses devoting the major portion of their time to the business”. It is not unlikely that these amounted to 7,000 fte, given that about 15,000 cinemas existed. The higher figure is chosen as it seems more reliable and would make our estimate more conservative.

Cinema Wages:

From same source as above (Bureau of Economic Analysis 1977); $2,023 per annum per fte.

Live Entertainment:

1. US Department of Commerce (1975) shows 212,000 fte, while the National Income and Product Accounts show only 163,000. Both refer to “Amusements and Recreation, except motion pictures”. Again, given the probably lower degrees of industrial concentration in these kind of activities, it would not be unlikely that the difference was made by owner-managers. Again, the higher figure is chosen.

2. The problem then arises that this figure aggregates several other activities with live entertainment and that disaggregated figures are not available. Using the disaggregated consumer expenditure figures for 1938, including spectator sports, clubs, and commercial participant entertainment (U.S. Bureau, 1977: 337), and not weighing clubs and fraternities, we arrive at an upper bound estimate of live entertainment revenue share in 'Amusements and Recreation' of 58/361 = 16.07 percent. Assuming that live entertainment has the same revenue/labour ratio as other recreation, we arrive at 34,061 fte. This figure is not out of line with the 1930 and 1940 census figures, when adjusted for the pronounced dip in live entertainment expenditure during the 1930s.

Live Wages:

From same source as above: only available at the level of 'Amusements and Recreation' as a whole; $1,325 per annum per fte. If we exclude film production, for legitimate theatre, wages may have been substantially higher than those of cinema.

Cinema + Live:

Total employment then was 178,000+34,061 = 212,061 fte.

B. Consumer Expenditure in 1938

This was $721 million, $663 million for cinema and $58 million for other spectator entertainment (US Department of Commerce 1975: 854-855).

C. Prices in 1938

Cinema:

1. According to the *Film Daily Yearbook*, in 1938 the average price of a cinema ticket was 23 cents (as quoted in Harold L. Vogel,

2004: 500). However, this estimate is not very precise (making the actual price vary between 22.5 and 23.5 cents, and it is unclear how it is arrived at).

2. More careful estimates for 1935 and 1939 prices have been made by Michael Conant (1960: 4), using data from the Department of Commerce and the Bureau of Labor Statistics. He arrives at nominal prices of 24.9 cents in 1935 and 26.5 cents in 1939, which translate into 25.67 and 26.768 constant cents of 1938. Using the 1935-1939 real growth rate we arrive at an average price of 26.489 cents in 1938. This price is taken as it is the most reliable and highest (most conservative) estimate.

3. The average duration of a cinema performance is taken to be 2 hours and 45 minutes, which is a conservative estimate, as most US theatres showed double features and of course shorts. This yields an average price per spectator-hour of 9.632 cents.

Live:

1. Since the total number of live entertainment admissions is not given with the expenditure data, the average price cannot be calculated exactly. Therefore, an estimate of the average price is being made on information from the trade press.

2. For Broadway, reliable time series of top-ticket average price are available from 1926-1965, for both ‘straight shows’ and musicals (Moore, 1968: 151). In 1938, they were $3.22 and $4.16 respectively.

3. From 1949 onwards, also time-series on the average Broadway ticket prices are available (Moore, 1968: 151). Over this period, the range of the ratio top/average price for straight shows and musicals are 1.16-1.52 and 1.18-1.47, respectively. To keep the price estimate conservative, here the highest ratios are used to calculate average Broadway ticket prices for 1938. This yields

$2.12 and $2.83 as average ticket prices. To make the estimate even more cautious, the average price for musicals is discarded.

4. It is then assumed that the average ticket price of all other live entertainment in the US was a third of the Broadway ticket price, 0.33 * 2.12 = $0.70, which is again conservatively low.

5. It then is assumed Broadway tickets accounted for 1/10 of all ticket sales in the US and other live entertainment for 9/10. ("Broadway" is here taken to represent most metropolitan entertainment, such as in Boston, Chicago, Los Angeles, etc.). This yields an average ticket price for live entertainment of $0.842.

6. It is then assumed that a live performance lasted 2 hours and 15 minutes on average, which yields an average price of $0.3742 per spectator-hour.

Cinema and Live:

1. Total spectator-hours sold for cinema were 663,000,000/0.09632 = 6883.3 million, and for live entertainment 58,000,000/0.3742 = 155 million, making a total of 7038.3 million. The average price then, is (0.9780*$0.09632)+(0.0220*$0.3742)= $0.10244 per spectator-hour.

D. Capital in 1938

1. In a detailed study William I. Greenwald (1950: 228) calculated capital value for 1944 based on statistics of the US Bureau of Internal Revenue. He arrives at $1552 million invested in the motion picture industry, and $303 million invested in other live entertainment.

2. Because of the depression, in 1938 the industry was running below capacity. If we assume that one quarter of the growth rate in motion picture and live entertainment admissions between 1938 and 1944 (6.1 and 13.3 percent annually, respectively) was

accommodated by improved capacity utilization, we arrive at 1938 capital of $949.3 million for motion pictures and $136.9 million for live entertainment, yielding a grand total of $1086 million, all in 1938 dollars.

E. Cost of Capital in 1938

1. This is calculated as (capital factor income + capital consumption)/(capital stock + capital consumption. To calculate the cost of capital, proprietors' income, rental income, corporate profits, net interest are taken from the Bureau of Economic Analysis (1977), amounting to $80 million, and to this depreciation ($28 million) is added. We then arrive at a cost of capital of 108/1086 = 9.94 percent (cents per dollar).

2. To check this finding, the resulting 1938 value for the motion picture industry, 0.1105, is compared to the value in 1937, reported in a contemporary work (Huettig, 1944: 100, which bases itself on a survey by the Securities and Exchange Commission). This value was 0.1067, while the value for 1937 we can calculate from the national income and products accounts was 0.1045. The two values are close enough to make the value used credible. Based on an analysis SEC and Bureau of Internal Revenue surveys, Huettig also notes that the motion picture industry in 1937 was the tenth most profitable US industry in terms of return on investment, and the 45th most profitable industry in terms of the absolute dollar amount of profits (Huettig, 1944: 56-57, 99-101).

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