Taxes and the Labor Supply of the Stars*

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Abstract

Do high taxes cause superstars to work less? We test this hypothesis using complete data on Hollywood movie stars' labor supply from 1927 to 2014. Changes to marginal tax rates in high tax brackets have no significant effect on the number of films a movie star makes each year. However, in years with high taxes stars produce more highly rated movies with award-winning directors, potentially substituting prestigious films for pecuniary gains.

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> When I was in the movies, I would reach the point each year when, after the second movie, I'd be in the 90 percent bracket, so I wouldn't make any more movies that year. And it wasn't just me. Bogart and Gable and others did the same thing.
>
> Ronald Reagan, 1981 (cited by Bartlett, 1981)

The effect of income taxes on labor supply is a central component in the relationship between taxation, economic efficiency, and redistributive equity (Piketty et al., 2014; Saez et al., 2012). Policy debate has often focused on the effect of taxation on the highest income workers (Scheuer and Werning, 2017), yet research on this topic has until now been divided between studies using aggregate macroeconomic data over long periods (e.g., Mertens and Montiel Olea 2018; Goolsbee 1999), or microeconomic data from short time intervals around specific tax regimes (Showalter and Thurston, 1997). Perhaps as a consequence, previous studies find a wide range of estimates. We present the first long-run microeconomic estimates of the effect of income taxation on labor supply by focusing on a single type of worker: Hollywood movie stars.

The labor supply of movie stars present a unique insight into the impact of taxation for several reasons. First, they are among the highest earning workers, ensuring that changes to the top marginal tax rates are salient. Second, their individual labor supply is well-documented on public databases, with data available for the entire career of each actor. This allows us to observe individual-level labor market behavior of high earners from 1927-2014 – essentially the entire history of the modern American income tax regime. Finally, most actors – virtually all since the 1960s – are freelance workers, and thus able to adjust their labor supply more flexibly than other workers.

We employ multiple approaches to account for the potential correlation between Hollywood wages and the annual marginal tax rate. In our main specification, we control for actor fixed effects and macroeconomic variables to capture industry-wide shocks, in same spirit as Mertens and Montiel Olea (2018). We complement this with analyses using supporting cast performers as a control group. Our data allow us to estimate the effect of taxes on both the quantity – number of films – and composition – making "prestige" films – of actors' labor supply. We find little evidence of a strong relationship between the amount of labor supplied by movie stars. However, movie stars appear in more "prestige" films when taxes are high.

Our results contribute to the broader literature on the effect of taxation on labor supply and taxable income, which thus far have yielded mixed findings. As surveyed by Keane (2011) and Saez et al. (2012), estimates of the elasticity of labor supply vary widely, depending on the econometric approach and the data used to measure labor supply and wages. Estimating the effect of taxable income is similarly complicated by the existence of avoidance and timing responses (Slemrod, 1995; Neisser, 2021). Much of this earlier work used structural approaches, with the exception of Eissa (1995), who estimates a diff-in-diff specification and finds relatively large elasticities of female labor

supply in response to the major tax cuts of the 1980s. In recent work, Mertens and Montiel Olea (2018) and Zidar (2019) focus on a set of tax reforms identified by Romer and Romer (2009) to have been exogenous with respect to the state of the economy at the time. Using state-level employment data, Zidar (2019) shows that the effect of tax shocks is heterogenous across income groups: states with more exposure to tax cuts for low-income groups experience more employment growth than states exposed to tax cuts for high-income groups. However, using the same set of tax reforms, Mertens and Montiel Olea (2018) estimate larger elasticities of reported income for high-income individuals than for low-income individuals.

In examining the effect of taxes on the composition of labor supply, we also complement research that document clear shifts in income earning behavior in response to changes in the tax system, in particular via the timing and mode of compensation (Goolsbee, 2000). This literature captures the possibility that individuals may change the type of work they do in subtler ways, trading off pecuniary and non-pecuniary forms of compensation. In our setting, movie stars might work for lower pay in a higher quality film, with the goal of increasing the performer's prestige while sacrificing financial gain. Several recent examples illustrate this trade-off: George Clooney accepted a salary of $3 to write, direct, and star in "Good Night, and Good Luck"–a film later nominated for 6 Academy Awards. Similarly, Jonah Hill accepted the SAG-AFTRA minimum wage for the opportunity to work with academy award winning director Martin Scorsese on "Wolf of Wall Street" (Heidenry, 2018).

Finally, we contribute to a large economic literature on the film industry, surveyed by McKenzie (2012). Prior research on the compensation and labor supply of movie stars has focused largely on the terms of their contracts with studios. Chisholm (1997) finds that more experienced and higher appeal stars are more likely to receive share contracts relative to fixed wages. Hanssen and Raskovich (2020) show that vertical integration during the studio era increased investment by studios into their contracted stars. Cespedes et al. (2019) show that property value declines cause local motion picture industry workers to shift from participating in big-budget, quality films to lower quality productions, although these effects are absent for the wealthiest movie stars. De Pater et al. (2014) study the interacting effects of age and gender on movie stars' compensation between 1968 and 2010. In one of the few economic studies of historical Hollywood worker compensation, Bridgman (2017) shows that performers and executives at more globally integrated studios received higher pay.

1 Data

1.1 Film and Tax Data Sources

Our primary source of data on performers' labor supply is the Internet Movie Database (IMDB). For each film and TV show in the database, IMDB records the order actors appear in the credits, the genre of the movie, its language, the director, and country of production. For most well-known performers, IMDB has data on the date and place of their birth. We drop movies in which the genre is labeled as "short", or "documentary", and TV appearances in which performers play themselves (e.g. interviews). We exclude the years 1942-1945 from the data due to many performers' service in the US military. The number of films included in our dataset is highly correlated with the American Film Institute's (AFI) comprehensive list in the years before 1960, then diverges as we include films made abroad by American actors, and films first released on home video and television which are not included in the AFI (see Appendix Figure 2).

To focus our analysis on American actors, we select only those performers who have made over 90% of their movies in English, *or* who have produced at least 20 movies in English and less than 25% of their movies in a non-English language. We then exclude any remaining American-born actors who have made less than 20% of their films in the US, or foreign-born actors who have made less than 40% US-produced films. This criterion is conservative–for example it excludes Marlene Dietrich, who made 73% of her movies in English. Performers are included in the dataset beginning in the year they first appeared in a movie or TV show, and ending 10 years after their final production or at the time of their death if this is earlier. This captures virtually all opportunities performers might have take a role–fewer than 5% of observations consist of actors who returned to film after a gap of more than 10 years.

We collect historical data on Federal income tax from the Tax Foundation, California state income tax from the State of California Franchise Tax Board, and Social Security and Disability tax information from the Social Security Administration. When applicable, we select the tax brackets for a "single" individual. Although many movie stars are married, their spouses are frequently also high income individuals (e.g. other movie stars) and thus their marginal tax rate is the same as if they were single. We adjust for changes in taxation due to surcharges, as in Mertens and Montiel Olea (2018).

1.2 Who are Movie Stars?

Since IMDB records data on (virtually) all actors and actresses, we use two criteria to designate which performers are "stars", and thus potentially subject to the highest marginal tax rates. The

first takes advantage of annual polls of movie theater owners, in most years published as the *Quigley Top Ten Money Making Stars Poll*. For all years between 1913 and 2013, theater owners were polled on which performers were most likely to drive ticket sales. For most years the top 25 were listed, and we consider a performer to be a "star" in a given year if they are included in that year's Quigley list, or in a list in any of the three preceding years.

Our second definition of stardom relies on box-office returns collected from the site Ultimate Movie Rankings (UMR).[1] Starting in 1926, UMR publishes the domestic box office returns from the most popular movies that came out in that year. For each performer, we sum the box office returns of all movies in which that performer appeared in the top 3 credit positions over the past 3 years (not counting the current year). We then rank all actors according to this metric, and designate the top 50 of them in each year as "stars". [2] Qualitative results are not highly sensitive to which measure of stardom we employ, and for our baseline results we combine the measures. We limit the data to the set of years in which both measures are available: 1927 to 2014.

This definition identifies 563 performers as movie stars between 1927 and 2014 (excluding 1942-1945) with an average of 53 stars per year (std. dev. 8.2). 29% of movie stars are women, with a mean age of 44 years for men, 34 for women. The mean (median) movie star experiences 14.3 (12) years of stardom, though this varies widely, with a standard deviation of 10.1 years. The star with the longest career is Katharine Hepburn, who enjoyed 48 years of stardom and won 4 Oscars–the most of any performer. On average, movie stars make 2.2 films per year (std. dev. 1.6), though in 12% of years they made no films at all. Conversely, only 7% of non-TV films included any movie star on the cast, though prior to 1960, before direct-to-video movies, 16% of films featured a star.

In contrast to our detailed labor supply data, we have limited information about movie stars' income. Bridgman (2017) provides, to our knowledge, the only systematic earnings data from the early/mid 20th century. Using US Treasury lists of the highest earners, Bridgman recovers the salaries of 1,125 top-paid film performers from 1934-1947. Of these, 49.5% are designated stars in our data, earning an average $3.3 million annually (2021 dollars). Consistent with the narrative evidence, these stars were taxed heavily: their marginal tax on the the last dollar earned averaged 74%.[3] More recently, $20 million per film has become the "industry standard" for top stars, with others earning well into the low millions.[4] We use the $3.3 million tax bracket to identify the

[1] www.ultimatemovierankings.com

[2] Our definition of movie star is similar to Ravid (1999) and to Hanssen and Raskovich (2020).

[3] The data contain may interesting cases. Reagan's claim to be in the 90% tax bracket was accurate in 1947 when he earned $169,750. Including California state tax, his total marginal tax on the last dollar of income was 96%. Conversely, in 1934, Shirley Temple earned only $23,064 (1934 dollars) despite being ranked the 8th most popular movie star. However, by 1936 her parents had negotiated a much higher rate, and she earned $121,122 with her mother reporting an additional $68,666.

[4] https://variety.com/2021/film/news/biggest-movie-star-salaries-daniel-craig-dwayne-johnson-1235043305/

marginal tax rates for movie stars; results are robust to substituting the highest marginal tax rate in a given year.

Assuming that the $3.3 million marginal tax rate is the relevant rate for movie stars potentially introduces measurement error for those stars whose marginal tax rate may be different. However, we argue that these effects are likely to be minor. In 77 out of the 88 years of our data, $3.3 million is in the highest tax bracket, eliminating measurement error for higher earners. Conversely, the median lower bound of the tax bracket containing $3.3 million is $683,794.70, so this marginal tax rate would be relevant even for a movie star earning substantially less than $3.3 million. Finally, even if movie stars' true marginal tax rates were observed in the data, the progressive tax system implies that any cross sectional variation in tax rates would likely be correlated with unobservable individual characteristics that also affect the labor supply of the performer. Using time series variation in a tax rate from a fixed tax bracket eliminates this "blatant" (Keane, 2011) source of endogeneity.

1.3 Supporting Cast Performers

While our main analysis focuses on movie stars, in some specifications we control for trends in the film industry by comparing the labor market performance of movie stars with a control group consisting of lower paid performers. We define this group as all performers who have had named roles in over ten movies over their entire careers, but have not been listed in the top three credits positions in more than one movie. Henceforth we refer to this group as "supporting cast".[5] This control group excludes a large group of performers who have not reached the professional level of Hollywood movie stars but are more successful than the supporting cast members. These "almost stars" are a very heterogeneous group, making identifying their income tax bracket challenging. We also exclude all performers in IMDB who performed in fewer than ten films over their entire careers, since these workers are likely to be less attached to the film industry.

By all accounts supporting cast members earn far less than movie stars. The Screen Actors Union (SAG-AFTRA) minimum wage was $3,575 per week for July 2020 through May 2021, though "background actors" without speaking parts and performers in low budget movies may earn less.[6] In general, supporting actors do not work on films the entire year–in our data the average actor of this type made 2.54 movies per year, conditional on any film output in that year. Assuming that

[5]These supporting cast are typically lower profile performers than actors who are nominated for Academy Awards in the "best supporting actor" category. Only 2 performers are initially categorized as supporting cast, then later movie stars–we drop these individuals.

[6]As an alternative measure, in May 2021 the Bureau of Labor Statistics reported a median hourly wage of $36.98 for actors in the Independent Performers industry, and $24.63 for actors working in the Motion Picture and Video industry.

supporting actors work for eight weeks on each film, the SAG-AFTRA minimum would generate an income of $72,644. This income is similar to the minimum wage under the first SAG contract signed in 1937: $25 per day, or $67,101 per year in 2021 dollars. We consider this $72K income when identifying the marginal tax rate of the supporting cast, but also consider alternative tax brackets around $40,000 and $125,000 for robustness.

1.4 Film Quality

As discussed above, taxation of income may affect not only the *amount* of labor supplied, but also the *type* of labor–specifically the quality of the films in which a movie star appears. We take two approaches to measuring a film's quality. First, we construct several measures of the ex-post observed quality of each film, based on 1) whether it is ranked in the top based on critical reviews on Metacritic, 2) whether it is included in the Criterion Collection, a set of 1510 titles selected as "important classic and contemporary films", and 3) IMDB user ratings, which are more broadly available. However, performers likely find it difficult to forecast the ex-post quality of each film at the time they make their decision. To quantify ex-ante observable film quality, we follow Cespedes et al. (2019) and generate an indicator for whether the director of a film has previously won an Academy Award. If actors choose films at least partly in order to enhance their reputations as high quality actors, the quality of the director is a clear signal of the prestige of the film.

2 Analysis

Our analysis is based upon the benchmark model of static labor supply (Keane, 2011). Within year t, performers make films until the marginal benefit of working in an additional film falls below opportunity cost. We assume that the marginal benefit is a function of the after-tax payment per film and a multiplicative shock ϵ_i, and that this relationship can be solved for a unique value of the labor supply N_{it}:

$$N_{it} = f\left(\left(1 - \tau_t\left(W_{it}, N_{it}\right)\right)^{\beta_1} W_{it}\epsilon_{it}\right) \tag{1}$$

We include the β_1 term to parameterize the elasticity of performers' labor supply with respect to taxes; the goal of our empirical exercise is largely to test the value and significance of this parameter.

Assume that the film industry pays wage $W_{it} = \exp\left(\beta_0 + w_t + \omega_i\right)$, where $\beta_0 + w_t$ is the market rate payment per film, and ω_i captures the salary differences between performers. Further assume that movie stars' compensation is sufficiently high that their tax rate on the marginal film does not depend upon film output and is equal to $\bar{\tau}_t$. Substituting these definitions into Equation 1 and

taking the natural logarithm of both sides yields the familiar static labor supply model,

$$\ln N_{it} \quad = \quad \beta_0 + \beta_1 \ln\left(1 - \bar{\tau}_t\right) + \omega_i + \left(w_t + \ln \epsilon_{it}\right) \tag{2}$$

where the ω_i term is an individual fixed effect and β_1 is the Marshallian elasticity of labor supply with respect to income (Keane, 2011). This formulation reveals the main threat to identification of our model: the wage that stars receive for films (which is part of the error term in this model) may be correlated with the annual marginal tax rate. The relationship between the film industry and the business cycle has been the subject of some debate. While Hollywood was famously unaffected by the Great Depression, Orme and Vogel (2020) find that film revenues varied slightly with GDP and unemployment from 2000-2019. We therefore control for these and other macroeconomic variables in our analysis.

As an alternative strategy to address this potential source of bias, we employ a difference-in-differences type estimator that uses supporting actors as a control group. Let $\mathbb{I}_i^\star$ be an indicator variable equal to 1 if performer i is a star, and suppose movie stars earn a time-vary wage premium of σ_t. If supporting actors face a marginal tax rate of $\underline{\tau}_t$, then we estimate,

$$\ln N_{it} = \left[\tilde{\beta}_0 + \tilde{\beta}_1 \ln\left(1 - \underline{\tau}_t\right) + w_t\right] + \tilde{\beta}_1 \ln\left(\frac{1 - \bar{\tau}_t}{1 - \underline{\tau}_t}\right) \mathbb{I}_i^\star + \omega_i + \left[\sigma_t \mathbb{I}_i^\star + \ln \epsilon_{it}\right] \tag{3}$$

The first term in brackets is time-variant, but can be absorbed with annual fixed effects. The second measures the effect of relative marginal taxes on stars' relative output, and the final term in brackets is the error term. These estimates rely on the orthogonality between σ_t, the wage premium the movie stars enjoy over supporting cast members, and the log ratio of marginal tax rates between stars and supporting cast. While this orthogonality condition may be weaker than that of Equation 3, this model embodies the assumption that stars' and supporting actors elasticity of labor supply with respect to taxation is the same.[7] This equivalence may not hold–either because stars' labor supply elasticity is more influenced by sorting across different types of movies (Scheuer and Werning, 2017), or because the amount of labor entailed in making a movie differs for supporting actors. Thus we argue that this diff-in-diff model supplements, but does not replace our baseline fixed effects specification.

An important historical feature of the film industry is the rise and fall of the Hollywood Studio system. From the late 1920's through the 1950's, Hollywood was dominated by 5 "major" studios–vertically integrated firms that combined talent management, film production, distribution and

[7] Even if this assumption holds, the elasticity estimated from the diff-in-diff model is only equivalent to the Marshallian elasticity in Equation (2) if the income effect is the same between movie stars and supporting actors (Blundell and MaCurdy, 1999).

screenings. Studios typically hired performers on long-term contracts specifying the salary of the performer and the number of films to be produced each year. In their study of casting during this period, Hanssen and Raskovich (2020) emphasize that the contracting system frequently constrained the labor supply decisions of stars, and may have weakened any relationship between labor supply and tax rates. The studio system began to decline with the 1948 *Paramount* Supreme Court decision limiting vertical integration, and was largely over by the end of the 1950's. While no exhaustive data on contracts exists, in 1950, 17 out of 25 of the *Quigley Poll* stars were under contract to a studio; by 1960 only 6 of the *Quigley* top 25 stars had contracts.

Consistent with this transformation of the industry, our analysis allows the effect of taxation on performers' labor supply to differ after 1960, by which point the large majority of actors were freelance workers. We modify Equation 2 to include an interaction term between net income and the post-studio era, $\mathbb{I}(Post1960)$:

$$\ln N_{it} = \beta_0 + \beta_1 \ln(1-\bar{\tau}_t) + \beta_2 (\ln(1-\bar{\tau}_t) \times \mathbb{I}(Post1960)) + \omega_i + (w_t + \ln \epsilon_{it}) \quad (4)$$

The coefficient on this interaction allows us to test for heterogeneity in the elasticity of labor supply once virtually all actors are freelance workers. Similarly, we modify Equation 3 to include an interaction between the relative tax rates between stars and supporting actors, and the post-1960 indicator.

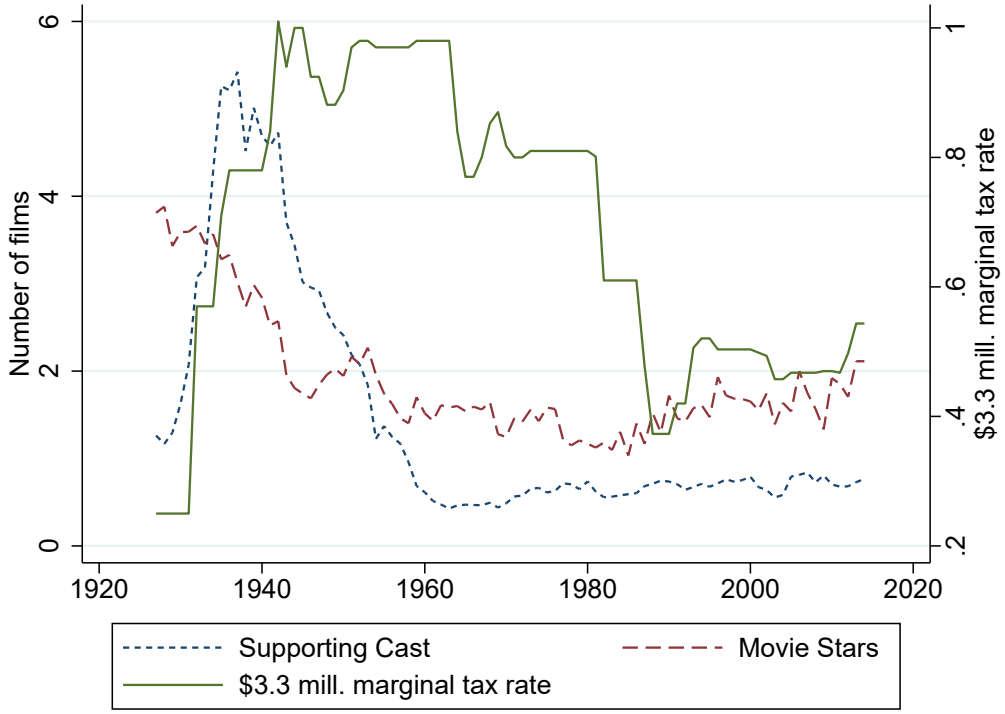
In practice, we cannot estimate the models presented above using OLS due since the number of films that a performer makes, N_{it} is frequently equal to 0. We therefore use Poisson PMLE in all specifications.

3 Results

3.1 US Tax Regimes and Movie Performer Labor Supply

Are marginal taxes correlated with movie stars' labor supply? Figure 1 provides a initial glimpse into this question. The dashed and dotted lines present the average number of films made each year by movie stars and supporting actors (according to the two definitions proposed above), and the solid line plots the marginal tax rate in the $3.3 million bracket during that year (combining California and Federal taxation). The data contain substantial variation in both taxation and film output, but the pattern is inconsistent with a straightforward relationship between tax rates and film performers' output over the whole time period. The major tax increases in the 1930's and 1940's seem consistent, at least over a 10-year time horizon, with a strong negative response to increased taxes. Movie stars' labor supply drops from 3-4 films per year in the early 1930's to fewer

Figure 1: Film Output and Marginal Tax Rates



Film data from IMDB.com; tax data from Tax Foundation, SSA, and State of California, for the period 1927-2014. Dashed and dotted lines shown the unconditional mean number of films made in each year by movie stars and supporting actors, as defined in the Sections 1.2 and 1.3. Solid line shows the marginal tax rate on income earned in the $3.3 million tax bracket, including income, social security, and state tax.

than 2 by 1950. Supporting actors follow a similar pattern, but their declines during the period of high taxes are not as large relative to baseline. However, after 1960, this negative relationship disappears. The 1964 tax cuts have no visible effect on star's film output, nor do the reforms of the early 1980s. In contrast, tax cuts in 1986 do seem to be correlated with an increase in productivity in the following year, but this increase persists even after taxes rise again in 1993. Supporting actors' average labor supply is almost constant during this period.

3.2 Estimating the Effect of Income Taxation on Labor Supply

Table 1 presents the results of Poisson regressions of the number of films produced on the $3.3 million marginal tax rate. A positive β_1 coefficient on the net marginal tax rate is consistent with higher taxes decreasing labor supply. In Column 1, we present the "naive" regression equivalent of the data displayed in Figure 1, with no other control variables. Consistent with the figure,

there is a significant positive effect of net income on film production prior to 1960, and a much smaller insignificant effect in later years. Column 2 includes controls for performer fixed effects, the time-varying performer characteristics based upon De Pater et al. (2014) (age, age^2, age×female, age^2×female, number of past roles, number of past starring roles), and annual controls for the state of the US economy from MeasuringWorth (Johnston and Williamson, 2022), based upon those used in Mertens and Montiel Olea (2018) (inflation rate, real GDP, S&P 500 index, short-term Fed. rate, unemployment). Including these controls substantially alters the coefficient on marginal taxes, making it insignificant and negative in absolute value prior to 1960, and very close to 0 after 1960.

In Column 3, we change the outcome variable to be the number of movies made beyond the first two movies.[8] This focuses our analysis on Reagan's initial critique of the progressive tax system: that it discourages performers from making more than two films per year because the third and subsequent films would be taxed at the highest marginal tax rates. Once again we find no significant effect of taxation on stars' labor in either the studio or post-studio period.

[8] Formally, it is equal to $\max(Movies - 2, 0)$.

Table 1: Performer Film Output

	Only Movie Stars			Stars and Supporting Actors	
	Number of films	Number of films	Films > 2	Number of films	Films > 2
	(1)	(2)	(3)	(4)	(5)
Net $3.3 mill. marginal tax	0.228***	-0.056	-0.070		
	(0.024)	(0.042)	(0.110)		
Net $3.3 mill. marginal tax	-0.192***	0.077	0.161		
$\times \mathbb{I}(Post1960)$	(0.032)	(0.054)	(0.152)		
Net tax ratio($3.3mill, $72k)				0.005	0.226
$\times \mathbb{I}(MovieStar)$				(0.107)	(0.220)
Net tax ratio($3.3mill, $72k)				0.055	-0.031
$\times \mathbb{I}(MovieStar) \times \mathbb{I}(Post1960)$				(0.125)	(0.264)
Aggregate economic controls		X	X		
Performer controls		X	X	X	X
Performer F.E.		X	X	X	X
Year F.E.				X	X
P-value: post-1960 effect	0.137	0.524	0.326	0.336	0.141
Outcome variable mean	2.179	2.179	0.686	1.150	0.454
Observations	4482	4482	4482	153029	153029

All outcome data from IMDB between 1927 and 2014. Columns 1-3 use the sample of individual performers identified as movie stars; the sample in columns 3-4 includes both movie stars and supporting actors, as defined in Section 1. Outcome variable in columns 1, 2 and 4 is the annual count of movies made, column 3 and 5 outcome variable is $\max(2 - Movies, 0)$. Net $3.3 mill. marginal tax is defined as $1 - \tau$, where τ is the sum of Federal income, payroll, and California state tax on the 3.3 millionth dollar earned. Net tax ratio is the ratio of net marginal tax on the $3.3 millionth and $72 thousandth dollar.

Standard errors clustered by performer and year. $*p < 0.10, **p < 0.05, ***p < 0.01$

While these results cast doubt on the link between taxation and stars' labor supply, they may not capture all economic shocks that affect both marginal taxation as well as the film industry. To control for these annual trends in filmmaking, we expand the sample to include the supporting actors, as defined in Section 1.3. Columns 4 and 5 of Table 1 show the results of this difference-in-differences analysis, in which we replace the explanatory variable with the ratio of high and low marginal taxes, and include annual fixed effects instead of the time-variate aggregate economic controls. We again find little evidence of a relationship between taxation on labor supply of movie stars relative to supporting actors–effects on total movies made are very small in magnitude both before and after 1960. Effects on the number of films made greater than 2 are larger, but imprecisely estimated.

These results show little evidence of a strong link between tax rates and performers' labor supply. Table 2 investigates this relationship further, focusing on alternative specifications and tests within the sample of only movie stars. Column 1 reproduces our baseline results from Table 1, while Column 2 limits the sample to female performers. We find no heterogeneous effects on women. In Column 3 our outcome is an indicator variable equal to one if a performer acts in more than 2 films in a given year, conditional on having acted in any films at all. This specification presents an alternative test of Reagan's claim in the opening quote, and eliminates any ambiguity arising from performers who may have retired, but still appear in the data. Although standard errors are large, we find no evidence of a positive relationship between taxation and making a third movie–indeed the coefficient on tax rate is marginally negative prior to 1960. Column 4 modifies the estimator to first differences instead of fixed effects, focusing on the short-term relationship between taxation and actors' labor supply. Results are noisier, but if anything suggest a more negative relationship between net income and film production. Finally, in Column 6 we follow Mertens and Montiel Olea (2018) and limit the variation to the set of tax changes identified by Romer and Romer (2010) (R&R) as driven by exogenous political shocks, rather than economic circumstances. We retain the first-differenced estimator, limiting the sample to only years with an exogenous tax change. Since all but one of these changes take place after 1960, we limit the sample to the post-studio period. While this selection criteria limits the sample size considerably, it does not generate significant evidence of an effect of tax rates on the number of films made by movie stars.

Table 2: Performer Film Output

Outcome	Number of films		Third Film	Number of Films		
Estimator	F.E.	F.E.	Condl. Logit	F.E. - lagged	F.D.	F.D
	(1)	(2)	(3)	(5)	(6)	(7)
$3.3 mill. marginal tax	-0.056	-0.067	-0.271	-0.027	-0.154	
	(0.042)	(0.070)	(0.168)	(0.043)	(0.115)	
$3.3 mill. marginal tax	0.077	0.025	0.448**	0.043	0.134	0.091
$\times \mathbb{I}(Post1960)$	(0.054)	(0.116)	(0.217)	(0.057)	(0.140)	(0.139)
Aggregate economic controls	X	X	X	X	X	X
Performer controls	X	X	X	X	X	X
Performer F.E.	X	X	X	X		
P-value: post-1960 effect	0.524	0.642	0.207	0.731	0.826	
Outcome variable mean	2.179	1.983	0.359	2.184	-0.176	-0.170
Sample	All	Actresses	Movies > 0	All	All	R&R (2010) tax changes
Observations	4482	1289	3659	4419	4420	622

All outcome data from IMDB between 1927 and 2014. All columns use the sample of individual performers identified as movie stars, as defined in Section 1. Outcome variable in columns 1-2 and 5-7 is the annual count of movies made. Column 3 outcome is an indicator for >2 films made, conditional on any film production by the performer. Outcome variable in column 4 is a weighted sum of labor on films, with weights according to role size as described in section 3. Columns 1,2, 4 and 5 present results from a fixed effects estimator; marginal tax is lagged 1 year in column 5. Column 3 is estimated using conditional logit. Columns 6 and 7 are estimated with first differenced data; in column 7 the sample is restricted to years with exogenous tax changes identified by Romer and Romer (2010). Net $3.3 mill. marginal tax is defined as $1-\tau$, where τ is the sum of Federal income, payroll, and California state tax on the 3.3 millionth dollar earned.

Standard errors clustered by performer and year. $*p < 0.10, **p < 0.05, ***p < 0.01$

In Appendix Tables 4 and 5 we examine the robustness of these results to alternative definitions of movie stars and alternative tax rates. Results are very similar in a sample of only US-born performers. Recoding performers as movie stars for 10 years (versus 3 in the baseline) after they are last identified as stars (either by *Quigley* or box office success) does not affect the results, nor does basing stardom solely on the *Quigley Poll* or box office returns. Similarly, modifying the tax bracket to the highest tax bracket in a given year has no qualitative effect on the findings. Finally, re-estimating our diff-in-diff specification assuming that supporting actors earn either $40K or $125K

per year leaves results essentially unchanged.

3.3 Other Aspects of Labor Supply

Finding a null effect of taxation on film production is consistent with the prior findings of Cespedes et al. (2019), who find no effect of housing wealth on the simple count of films made by both Hollywood performers. However, a possible confounding factor in Table 1 and the simplified model of labor supply presented above, is that performers may choose to work on films for both pecuniary and non-pecuniary reasons. If, as suggested by the examples cited above, performers value their reputation for appearing in high quality films, then they may respond to higher income taxes by altering their mix of films toward higher quality productions.

Table 3 considers these alternative dimensions of labor supply using data on TV shows and the quality of film productions.[9] Columns 2-6 examine measures of the quality of films produced by a performer in a given year. In Columns 2 and 3 we use expert film reviews, first measured by share of films included in the Metacritic top 1000 films list, and second by inclusion in the Criterion Collection of "important" films. In each case we normalize the number of quality films by the total number of movies a performer produced in that year. We find mixed results–actors make films that receive higher Metacritic reviews during periods of their careers with higher taxes. The effect is particularly strong before 1960, but remains significant afterwards. Conversely, we find no effect on inclusion in the Criterion Collection.

Columns 4 and 5 use ratings on the IMDB website as the outcome variable. Many, though not all, films on the site are rated by users, and we retain all films with more than ten ratings. Results, within this selected sample, are also suggestive of a financial/prestige trade-off: average IMDB ratings are lower for films made in lower tax years, though this is only significant after 1960. Effects are stronger for the rating of the highest-rated IMDB movie made by a star within a given year. This is consistent with a pattern in which stars always make a few "blockbuster" films each year, but if taxes are high they may produce a "prestige" 2nd or 3rd film, since taxation would make the financial returns from this film less rewarding. The final column examines whether actors choose films with Academy Award winning directors. Unlike our other measures of quality, which are only realized ex-post, the director of a film is observable when the performer chooses to take a part in a film. Thus movie stars may be more able to select quality films by screening prestigious directors (Cespedes et al., 2019)–consistent with this theory, we find that during periods of high taxes stars

[9] Sample sizes of the specifications in this table differ from the previous tables due to the fact that many stars appear in zero films identified as high quality by our measures. These observations are "separated" in the Poisson pseudo-MLE, using the terminology of Silva and Tenreyro (2010), and thus dropped from the sample. Switching to OLS restores the sample size but does not affect the statistical significance and sign of the results.

make relatively more films with Oscar-winning directors (both pre- and post 1960).

Table 3: Performer Film Output

	(1) TV episodes	(2) Share Metacritic Top 1000	(3) Share Criterion Collection	(4) Mean IMDB rating	(5) Best IMDB rating	(6) Share AA-winning director
Net $3.3 mill. marginal tax		-0.481***	0.116	-0.006	-0.008**	-0.283***
		(0.142)	(0.143)	(0.004)	(0.004)	(0.073)
Net $3.3 mill. marginal tax	0.050	0.175*	0.086	-0.003	-0.005*	0.007
$\times \mathbb{I}(Post1960)$	(0.096)	(0.099)	(0.121)	(0.003)	(0.003)	(0.053)
Aggregate economic controls	X	X	X	X	X	X
Performer controls	X	X	X	X	X	X
Performer F.E.	X	X	X	X	X	X
P-value: post-1960 effect		0.039	0.330	0.030	0.002	0.000
Outcome variable mean	1.603	0.059	0.054	6.564	6.945	0.231
Observations	1996	2009	1479	3867	3867	3596

All outcome data in columns 1, 4-6 from IMDB between 1927 and 2014. All columns use the sample of individual performers identified as movie stars, as defined in Section 1. Outcome variable in columns 1-2 and 5-7 is the annual count of movies made. Column 3 outcome is an indicator for >2 films made, conditional on any film production by the performer. Outcome variable in column 4 is a weighted sum of labor on films, with weights according to role size as described in section 3. Columns 1,2, 4 and 5 present results from a fixed effects estimator; marginal tax is lagged 1 year in column 5. Column 3 is estimted using conditional logit. Columns 6 and 7 are estimated with first differenced data; in column 7 the sample is restricted to years with exogenous tax changes identified by Romer and Romer (2010). Net $3.3 mill. marginal tax is defined as $1 - \tau$, where τ is the sum of Federal income, payroll, and California state tax on the 3.3 millionth dollar earned.

Standard errors clustered by performer and year. $*p < 0.10, **p < 0.05, ***p < 0.01$

Conclusion

Contrary to the claims of some observers, including former movie star and President Ronald Reagan, we cannot reject the null hypothesis that there is no relationship between the marginal tax rate on high income brackets and the number of films produced each year by movie stars. This null effect is robust to the use of supporting actors as a control group to capture industry-wide trends that might be correlated with tax rates. Conversely, movie stars do appear to change the composition of the films they make during periods of high taxes. Reviews of a stars' films, and well as their collaborations with academy-award winning directors, are both positively correlated with the taxes paid on movie stars' income. This pattern suggests that when taxes are high performers substitute "prestige" films which may raise a performer's status within the industry formore remunerative "blockbuster" films .

These unique features of the Hollywood film industry raise the question of the degree to which

results from the film industry might generalize to other high-income workers. While every sector has distinctive institutions, we argue that the frictions to adjustment present in the film industry are, broadly, of the same nature as those in other jobs. Similarly, while movie stars may have been pioneers in tax evasion, other high income workers appear to have followed quickly in their footsteps. Indeed, in many ways film performers have more freedom to adjust their labor supply in response to taxes than, for example, corporate executives.

Our results highlight the importance of extending the analysis of labor supply beyond hours and participation, to include both human capital and non-pecuniary rewards of labor. Just as young workers may respond less to changes in wages due to incentives to accumulate human capital (Keane, 2011), movie stars seem to take advantage of high tax periods to develop a reputation as "quality" actors when the opportunity cost of doing so is low. Whether higher taxes might increase welfare through reallocation of acting talent to high quality films is a question we leave to future researchers and film critics.

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Appendix

Table 4: Alternative Definitions of Movie Stars

	(1) Baseline	(2) US-Born stars only	(3) 10 Years Retrospective	(4) *Quigley* Poll only	(5) Box Office Earnings Only
\$3.3 mill. marginal tax	-0.056	-0.066	0.010	-0.044	-0.081
	(0.042)	(0.048)	(0.048)	(0.044)	(0.060)
\$3.3 mill. marginal tax	0.077	0.076	0.032	0.087	0.105
$\times \mathbb{I}(Post1960)$	(0.054)	(0.065)	(0.059)	(0.058)	(0.076)
Annual Controls	X	X	X	X	X
Actor Characteristic controls.	X	X	X	X	X
Performer F.E.	X	X	X	X	X
P-value: net post-1960 effect	0.524	0.799	0.095	0.267	0.467
Outcome variable mean	2.179	2.170	1.670	1.932	2.304
Observations	4482	3616	7539	2984	3042

All outcome data from IMDB between 1927 and 2014. Column 1 uses the baseline sample of individual performers identified as movie stars. Column 2 modifies the definition of movie star to include all performers listed in *Quigley* in the past 10 years for whom the past 10 year box office returns are in the top 25. Column 3 bases the definition of movie star solely on the *Quigley* data. Column 4 bases the definition of movie star solely on box office returns. Net \$3.3 mill. marginal tax is defined as $1 - \tau$, where τ is the sum of Federal income, payroll, and California state tax on the 3.3 millionth dollar earned.

Standard errors clustered by performer and year. $*p < 0.10, **p < 0.05, ***p < 0.01$

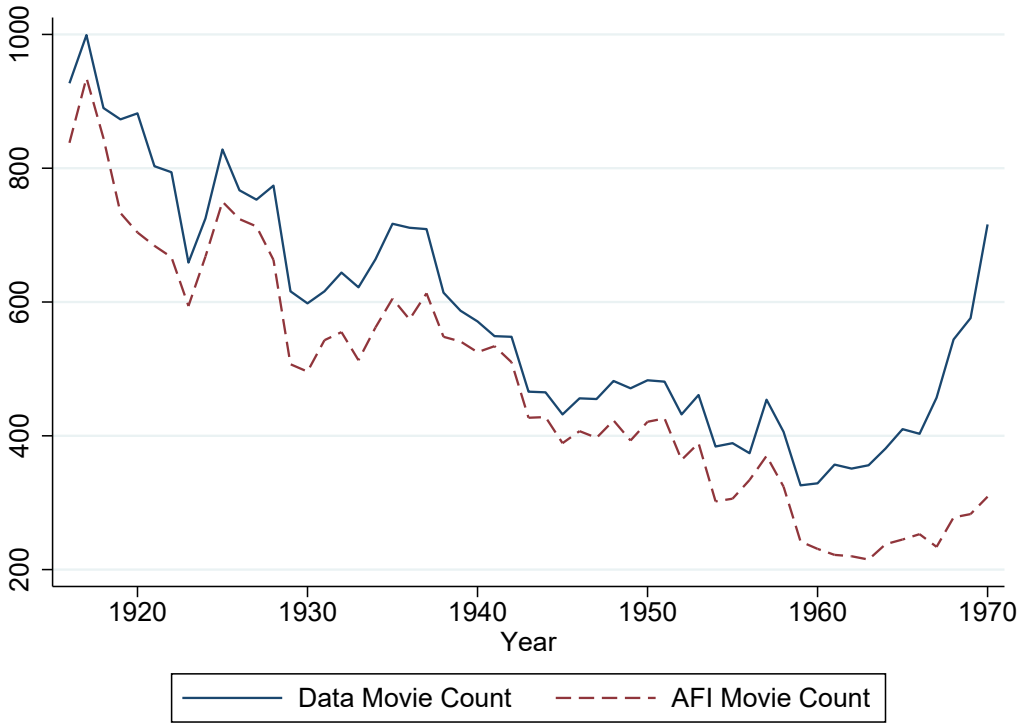
Table 5: Alternative Tax Rates

	Only Movie Stars		Stars and Supporting Actors	
	\$3.3 mill. bracket	Top income bracket	\$40K supporting bracket	\$125K supporting bracket
	(1)	(2)	(3)	(4)
Net marginal tax	-0.056	-0.060*		
	(0.042)	(0.031)		
Net marginal tax	0.077	0.076		
$\times \mathbb{I}(Post1960)$	(0.054)	(0.047)		
Tax ratio$\times \mathbb{I}(MovieStar)$			-0.020	0.019
			(0.099)	(0.116)
Tax ratio$\times \mathbb{I}(MovieStar)$			0.100	0.048
$\times \mathbb{I}(Post1960)$			(0.117)	(0.131)
Aggregate economic controls	X	X		
Actor characteristic controls	X	X	X	X
Performer F.E.	X	X	X	X
Year F.E.			X	X
P-value: net post-1960 effect	0.524	0.643	0.209	0.285
Outcome variable mean	2.179	2.179	1.150	1.150
Observations	4482	4482	153029	153029

All outcome data from IMDB between 1927 and 2014. Columns 1-2 use the sample of individual performers identified as movie stars; the sample in columns 3-4 includes both movie stars and supporting actors, as defined in Section 1. Net marginal tax is defined as $1 - \tau$, where τ is the sum of Federal income, payroll, and California state tax. In column 1 taxes are set at the level for the 3.3 millionth dollar bracket, in column 2 taxes are set at the level of the highest income tax bracket in each year. Net tax ratio is the ratio of net marginal tax on the \$3.3 millionth and the tax bracket for supporting actors. In column 3 the supporting actor tax bracket is set at \$40K, in column 4 it is set at \$125K.

Standard errors clustered by performer and year. $*p < 0.10, **p < 0.05, ***p < 0.01$

Figure 2: Unique Films Per Year



Solid line shows the annual count of movies from IMDB.com used in the analysis sample. Dashed line shows the annual count of movies listed in the American Film Institute Catalog. Data from 1918 to 1970.