Trade, Endogenous Quality, and Welfare in Motion Pictures

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Trade benefits consumers and producers, and the effects of trade can operate through product quality: larger markets can have greater investment and therefore higher quality products. We explore this channel in the movie industry, where quality is produced exclusively with sunk costs, these sunk costs are high, and international revenue is important. We develop a structural econometric model of the global movie market, which we use to document that half of world consumers' – and virtually all of US consumers' – gains from trade operate through quality. We also analyze the counterfactual impact of the elimination of European film subsidies.

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In the usual way that economists and policymakers think about trade, the benefit of importing is that consumers in the importing country get access to a wider variety of products. The benefit of exporting accrues to domestic sellers, who generate higher profits by selling their products to a larger population of consumers. So, for example, when Hollywood movies are made available in France, French consumers have access to Hollywood fare as well as domestic French cinema and US film producers gain additional revenues. While all of this is true, it misses an important feature of products made with investments in sunk costs. With large sunk costs, an enlarged market can lead to larger investments in products and therefore higher quality products.[1] Thus an important additional benefit of trade operates through the endogenous quality channel as consumers both at home and abroad can have access to higher quality goods than they would otherwise have without trade.

The movie industry is an auspicious context for exploring this phenomenon for a variety of reasons. First, quality is produced primarily with sunk costs in this industry, and these endogenous sunk costs are high. Major US movie releases cost an average of nearly $100 million dollars per film, and US producers spent about $20 billion on film production in 2007, nearly two thirds of the world total. Second, international revenue is needed to finance current US investment levels as most of Hollywood movies' box office revenue is generated outside the United States. In 2009, domestic revenue for major US releases was $10.6 billion while foreign revenue was $19.3 billion, making it appear likely that US and foreign consumers of big-budget movies experience substantial benefits from the quality investments made possible by trade.

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[1] See Sutton (1991). We note at the outset that for us, as for Sutton, the term, "quality" simply means whatever determines the level of demand. Our use of the term is separate from its aesthetic connotations in common usage which, we understand, are particularly strong for cultural products such as movies and music.

The goal of this paper is to develop a model of the world movie market, which we put to two uses. First, we quantify the gains from trade and measure the portion of these gains operating through investments in quality. To the best of our knowledge, we are the first to quantify the components of trade's benefit operating through the endogenous quality channel. Second, we use the model for policy simulation. Various public policies around the world seek to affect the movie industry by subsidizing production costs, in part to correct a perceived market failure arising from the under-provision of movies highly valued by small national audiences (see Spence (1976)). For example in Europe one-third of the roughly $5 billion annual film investment is financed with government subsidies. We simulate the impact on both consumer and producer welfare in Europe and elsewhere from removal of these subsidies.

We estimate a structural model of movie demand using data on movie-specific box office revenue and country-year data on ticket prices and per capita income. Our data include 6,672 movies in 14 countries over the years 2005-2009, which allows us to estimate country-by-movie specific preferences, so that a French viewer (e.g.) can value any particular French movie differently from a U.S. viewer. We then combine measures of product quality derived from demand estimation with direct data on movie investment – production budgets for major releases – to estimate the quality production function for movies. We use the production function estimates in conjunction with the demand model to develop an expression for each country's profits, which depend on both its own movie budgets and the budget levels chosen in other countries. We solve for a Nash equilibrium in investment – and associated surplus measures – which serves as the model's baseline. We then re-solve the model to estimate country-specific changes in consumer and producer surplus under the counter-factual policy regime.

We find that movie trade benefits consumers everywhere. For consumers outside the US, roughly half of the gain from trade stems from increases in product quality. Almost all of trade's benefit to US consumers operates through the higher quality of US movies made possible by trade. Trade's impacts on producers are more varied. Trade helps US producers but hurts producers elsewhere. For the most part, movie investment in one country is a strategic substitute for investment elsewhere. There are exceptions: for example, the optimal Hollywood response to increased investment in much of Europe or the UK is an increase in investment.

We find that the elimination of European film subsidies would reduce European film investment, harming European consumers and producers while aiding US producers. Because reduced European investment would prompt reduced US investment, US and world consumers would suffer slightly as well from the elimination of European subsidies. More generally, we find that allowing for idiosyncratic consumer taste for movies is important for both the demand model estimates and the flexibility of the comparative statics. Models that rule out systematic taste heterogeneity for movies promote a finding of strategic substitutes by eliminating terms related to strategic complementarity, as we show in the appendix.

The paper proceeds in five sections after the introduction. Section 1 provides facts about world movie trade to substantiate the basic idea of the model: a) that the large US investment in movies produces higher product quality in the eyes of US and foreign consumers, and b) that the current level of investment is made possible only by both domestic and foreign revenue. Section 1 also discusses major policy interventions in the movie market as well as literature relevant to the current project. Section 2 presents our model of the world movie market, including a model of movie demand, a production function for movie quality as determined by budget levels, and our equilibrium notion. Section 2 also discusses a key determinant of the model's comparative statics, whether movie investment in one country is a strategic substitute or complement for investment in another. Section 3 describes the main data sources and presents some patterns in the trade data. Section 4 presents the model estimates. Section 5 describes the results of the simulation exercises, including a) estimates of the strategic investment relationship among various country pairs, b) calculation of both the gains from trade and the portion operating through quality, and c) a counterfactual simulation of the elimination of European film subsidies.

I. Trade and Investment in Motion Pictures

This section provides background in the forms of a) the magnitude of investment and international revenue, b) the relationship of box office revenue to total industry revenue, c) a discussion of policy interventions in world movie trade, and d) the existing literature.

1. Investment and International Revenue

As with other recorded media products – music, books, newspapers – the quality of movies is determined by expenditures on sunk costs. Around the world, investments in sunk costs on movies differ substantially. When compared with the rest of the world, the US motion picture industry spends a large amount making movies, both overall and on a per-movie basis.

There are two different measures of aggregate movie budgets circulated in the movie industry. The Motion Picture Association of America reports the average budgets of its members' movies. These members are the major studios and they collectively release roughly 200 movies per year. For example, the MPAA in 2005 reported that the average cost of producing a member movie was $96.2 million. Members released 198 movies in 2005 leading to an overall investment in US movies that was just over $19 billion in 2005.

Screen Digest provides movie production statistics for both the US, Europe, and Japan using a broader set of movies. In 2007, for example, they report that the US produced 656 movies at an average cost of $31.0 million per movie for a total investment of $20.3 billion.[2] As Table 1 shows, the Screen Digest data indicate that worldwide investment in movie production was $32.3 billion in 2007. Of this amount, nearly two thirds ($20.3 billion) was spent in the US. Other countries with relatively high investments in movies include Japan ($2.0 billion), the UK ($1.5 billion), France ($1.6 billion), Germany ($1.1), Spain, ($0.6), Italy ($0.4), Canada (1.0) and South Korea (0.5).

On a per-movie basis, using the Screen Digest data, the US outspends other countries by a substantial margin. In 2007 the average US movie budget was $31 million, compared with $12.8 million in the UK, $14.7 in New Zealand, $9.1 million in Germany, $8.7 million in Canada, and $7.2 million in France. Regardless of the data source used, it is clear that US investment is large relative to the movie investment of other countries, both per movie and overall.

High US investment has been facilitated in part by innovative movie marketing practices. As Waterman (2005) argues, US producers pioneered the price-discriminatory practice of releasing movies in a sequence of exhibition “windows,” first showing films in theaters, then releasing them for rental and home video purchase, later releasing them to pay television, and finally to free television. By exploiting this strategy earlier than other countries, the US

[2] The MPAA figure for 2000 = $16.2 billion overall and $10.8 billion including only production costs. Hence the Screen Digest figure includes only production costs.

producers were able to justify larger investments in movie budgets which, in turn, have made US movies appealing in foreign markets as well.

Much of the revenue that US movies generate comes from abroad. According to the MPAA, its members' movies earned $10.6 billion at the US box office – and an additional $19.3 billion abroad - in 2008. Our data demonstrate this point as well both for US repertoire as well as the repertoires of many other countries. While we describe our data in detail below, the last column of Table 1 provides some preliminary evidence. For this table we assign each 2008 movie to an origin country based on its first listed country of origin. We then aggregate both domestic and foreign (actually, sample-wide) box office revenue by origin country. The table shows, for example, that US repertoire generated $17.5 billion in box office revenue in 2008, 52 percent of which was generated outside the US. Other countries – notably the UK, Australia, and Hong Kong – generated even larger shares of their revenues abroad: 85, 84, and 83 percent, respectively. Many countries generate a third or more abroad: France, China, Spain, and others.

2. Box Office Revenue, Total Revenue, and Investment

In this section we make two points. First, we show that foreign revenue is necessary for covering production costs. If we total our estimates of the studios' net proceeds from domestic box office, home video, and various forms of television, we arrive at roughly $14 billion for 2000, a year in which total production costs for MPAA movies exceeded $16 billion. Second, we document, to the extent that data allow, the relationship between what we do observe, box office revenue, and the overall revenue remitted to the studios from all revenue sources, which we cannot observe. Worldwide box office revenue in 2000 was roughly $13.8 billion. By contrast, the studios' proceeds from box office, DVD, and television was (very) roughly $20-$25 billion. Arriving at these conclusions requires a brief digression into motion picture accounting.

According to Vogel (2007) and Dale (1997), roughly a third of domestic box office revenue is remitted to the studio. Roughly half of box office receipts are retained by the exhibitor, and a third of the remainder (one sixth overall) is retained by the distributor. Distributors retain slightly more when distributing US movies in foreign markets, 40 percent rather than a third (Dale, 1997). Vogel (2007) estimates that US studios get $0.31 per dollar of domestic box office revenue. Thus, of the $7.7 billion in domestic box office revenue in 2000, the studios received $2.4 billion. Of the $13.8 billion in international box office, the studios received roughly $5 billion.

Epstein (2010) emphasizes the large and growing roles of both home video (sales and rental of tapes and now DVDs) and television. Based on confidential MPAA data, he reports DVD sales of $13.1 billion in 2000.[3] Vogel (2007, p. 152) reports that of a $30 retail price, the studio retains $8-$10. Thus, the studios' proceeds from domestic home video in 2000 was roughly $3.5 to $4.4 billion. (Later in the decade – in 2004 – domestic home video revenue peaked at $22.8 billion and has since declined). According to Eurostat (2003), worldwide home video sales totaled $24 billion in 2000. As a rough approximation – using Vogel's estimate of the studio proceeds – it appears that the studios received about $7 billion in worldwide proceeds from home video.

Data on television revenue are the most difficult to obtain. Epstein (2010) reports worldwide 2000 television revenue of $15.5 billion. Inferring the domestic profit from that gross

[3] See http://www.edwardjayepstein.com/MPA2007.htm, accessed May 12, 2010.

figure requires deductions for distribution fees, as well as a translation from a worldwide figure to a US figure. Dale (1997, p. 319) reports that for both pay and free television, distributors takes a “30-40 percent distribution fee plus marketing and distribution costs” which, in the case of free television, are “minimal.” Putting the studio share of television revenue at two thirds, this suggests that the studios’ net proceeds from television in 2000 were $10.3 billion.

These calculations lead us to our two conclusions. First, the studio proceeds from domestic revenue sources are about $14 billion for 2000. Given that US production costs exceed these revenues, we infer that international revenues are needed to finance current investments. Second, studio proceeds from worldwide activities appear to total about $22 billion (5+7+10) in a year when worldwide box office was almost $14 billion. Hence, as a rough approximation, it appears that studio proceeds are about 1.5 times box office revenue. This translation is important for us because we observe only theatrical box office, while profits actually depend on overall revenue in relation to costs.

A strong correlation between box office and DVD revenue across title provides justification for assuming proportionality between box office and total revenue. Because movies are sold to broadcasters in bundles, there is essentially no evidence on movie-level television revenue. We do have some movie-level DVD revenue data on the 100 top-grossing DVDs for each year, 2007-2009, based on US sales, from http://www.the-numbers.com/, which we matched with box office revenue from Box Office Mojo. For matching titles, the correlation between domestic box office and domestic DVD sales is 0.76, as Figure 1 shows.[4]

3. Policy Interventions

[4] Not all titles match, as the DVDs include some perennial sellers originally released much earlier (The Jungle Book), as well as some movies released only to DVD (such as the BBC series Planet Earth).

One of the major ways that policy affects movie trade is via state subsidies, which are extensive in Europe. Table 2 describes these subsidies. In 2004 European film production totaled $4.8 billion (according to Screen Digest, 2009), and subsidies accounted for nearly a third of the total investment of $1.6 billion. In absolute terms the French spend the most on subsidies: just under half of their $1.3 billion film investment in 2004 was financed by the state. Germany provides the second largest subsidy: just above a third of their $0.7 billion film investment in 2004 came in the form of subsidies. The UK and Italy provided the next two largest in absolute terms, accounting for 10 and 32 percent of those countries' 2004 film investments, respectively.

Rationales for these subsidies include both economic and cultural factors. According to the European Commission (in a discussion of its Creative Europe initiative), "Europe needs to invest more in its cultural and creative sectors because they significantly contribute to economic growth, employment, innovation and social cohesion. Creative Europe will safeguard and promote cultural and linguistic diversity and strengthen the competitiveness of the cultural and creative sectors."[5]

4. Existing Literature

Perhaps because aspects of its performance are readily observed there is a substantial scholarly literature on the film industry. Waterman has written extensively on many aspects of the movie industry, including features relevant to trade such as the "cultural discount," the extent to which movies from one country appeal to consumers elsewhere. Much of this work is summarized in Waterman (2005). DeVany (2003) has written extensively on the determinants of

[5] See http://ec.europa.eu/culture/creative-europe/index_en.htm.

movie revenues. Einav (2007) analyzes the release timing game; and Einav and Orbach (2010) study the puzzle of uniform box office prices. Davis (2006ab) and Chisholm and Norman (forthcoming) describe spatial competition and in the exhibition market. Gil (forthcoming a, b) provides analyses of vertical issues in movie making.

There is also a growing body of empirical work on trade in cultural products. Studies include Hanson and Xiang (2008), Disdier et. al (2010)'s gravity model estimates, and Ferreira and Waldfogel (forthcoming). Because of the importance of endogenous sunk costs in movies, this work is related to Sutton (1991), as well as Berry and Waldfogel (2010). Related, movies embody the preference externalities examined in Waldfogel (2003).

Methodologically, this work is related to research documenting the the welfare benefit of new products (Petrin (2002) and Goolsbee and Petrin (2004)). Finally, this work is related to other empirical industrial economic research examining product choices by consumers in different national markets, such as Goldberg (1995) and Verboven (1996).

II. The Model

This section presents our models of demand and supply for the movie industry, as well as equilibrium. We posit a logit, nested logit, and non-separable nested logit model for movie demand.

1. Demand

The choice sets of movies vary both across countries and over time and not all movies produced each year are available in all countries. Defining J_c as the set of movies available in country c (with C total countries), we index movies by j ($j=1,\ldots,J_c$, $c=1,\ldots C$) and we suppress the time subscript. We assume that every consumer decides in each month whether to see one movie in the choice set J_c or to consume the outside good (not seeing a movie at a theater). Specifically, every month every consumer i in country c chooses j from the $J_c + 1$ options that maximizes the conditional indirect utility function given by:

$$u_{ij} = \beta_0 + \alpha p_c + \varphi y_c + \xi_{cj} + \epsilon_{ij} = \delta_{cj} + \epsilon_{ij},$$

where β_0 reflects taste for movie theater patronage, α is the marginal utility of income, p_c is the price of a movie ticket in country c, y_c is per capita income in country c, and φ measures how tastes for movies vary with income. ξ_{cj} is the unobserved (to the econometrician) quality of movie j from the perspective of country c consumers and can differ across countries for the same movie (so *Avatar* e.g can have different quality to US vs French consumers). ϵ_{ij} is a taste draw that is distributed Type I extreme value and is independent across both consumers and choices.

With outside good utility δ_{c0} normalized to 0 for all $j \in J_c$ the market shares are given by $s_{cj} = \frac{e^{\delta_{cj}}}{1+\sum_{l=1}^{J_c} e^{\delta_{cl}}}$. Inverting out δ_{cj} from observed market shares as in Berry (1994) yields

$$ln(s_{cj}) - ln(s_{c0}) = \delta_{cj} = \beta_0 + \alpha p_c + \varphi y_c + \xi_{cj}.$$

with δ_{cj} linear in the average country-level ticket price, per capita income, and ξ_{cj}.[6] Movie quality δ'_{cj} as measured by demand is then price-adjusted δ_{cj}:

$$\delta'_{cj} = \delta_{cj} - \alpha p_c = \beta_0 + \varphi y_c + \xi_{cj}.$$

In this model one might wish to instrument price because ξ_{cj} may be correlated with p_c.

[6] We observe country-specific market shares. This allows us to have the country-specific movie tastes for each product.

a. Nested Logit

A well-known drawback of the logit model is that it assumes that $(\epsilon_{i0,}\epsilon_{i1,}\ldots,\epsilon_{iJ,})$ are independently drawn across the J_c+1 choices. Full independence of individual tastes precludes the possibility that consumers differ in their taste for watching movies at a theater. If consumers have heterogeneous tastes, then estimated demand elasticities and substitution patterns from the logit model will be biased, and this in turn will bias estimates of competitive response and of consumer and producer welfare (Berry et. al (1995), Petrin (2002), Goolsbee and Petrin (2004)).

One way to allow consumers to differ in their tastes is to put a random coefficient on the intercept of the utility function:

$$u_{ij} = \beta_{i0} + \alpha p_c + \varphi y_c + \xi_{cj} + \epsilon_{ij},$$

where β_{i0} represents a consumer-specific taste for movies relative to the outside good. In this setup strong (weak) taste for one movie implies strong (weak) taste for other movies.

The nested logit model provides a computationally simple way to allow for this type of random coefficient.[7] Nested logit posits utility

$$u_{ij} = \delta_{cj} + \zeta_i + (1-\sigma)\epsilon_{ij}$$

where for consumer i ζ_i is common to all movies and has a distribution function that depends on σ such that if ϵ_{ij} is distributed extreme value, then $[\zeta_i + (1-\sigma)\,\epsilon_{ij}]$ is also extreme value.[8] When

[7] It does not require the use of simulation-to-integrate to estimate market shares for different posited parameter values.

$\sigma=0$, the model resolves to the simple logit and ζ_i - the consumer-specific systematic movie-taste component - plays no role in the choice decision. As σ approaches one, the role of the independent taste shocks $(\epsilon_{i0,}\epsilon_{i1,} \dots, \epsilon_{iJ,})$ is reduced to zero, implying consumer tastes – while different for any consumer i across movies – are perfectly correlated within consumer i across movies.

Intuitively, identification of σ is driven by how the total inside share of movies changes as the number of movies in the choice set varies. When σ is close to one, the total inside share will not vary much with the number of movies, as additional movies simply cannibalize other movies' shares.[9] At the opposite extreme, with $\sigma=0$, is the logit model, where some consumers of the outside good will always substitute to a new movie when it is added to the choice set.[10]

The estimating equation for the nested logit is linear in the same arguments as the logit and has a new explanatory variable which is the product's share among inside goods $\ln(s_j/(1-s_0))$:

$$ln(s_{jc}) - ln(s_0) = \beta_0 + \alpha p_c + \varphi y_c + \sigma ln(s_{jc}/(1-s_{0c})) + \xi_{cj}.$$

with σ the coefficient on the new explanatory variable. It will be positive if variation in a good's share relative to the total inside share $(1 - s_{c0})$ explains $\ln(s_{cj}/s_{c0})$ conditional on the other

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[8] The formula for the market share of good j is $s_{cj} = \frac{e^{\delta_{cj}/1-\sigma}}{(D_{J_c}^{\sigma}+D_{J_c})}$, where $D_{J_c} = \sum_{l=0}^{J_c} e^{\delta_{cj}/1-\sigma}$.

[9] For any given set of product qualities σ determines how the total inside good share of movies changes as the number of products increases. Denoting the inside share as $s_I^J = \frac{\sum_{l=1}^{J} e^{\delta_l}}{1+\sum_{l=1}^{J} e^{\delta_l}}$, the change in the inside share that arises from adding a J+1th good with quality δ_{J+1} to the choice set is given by

$$\Delta s_{Inside} = s_I^{J+1} - s_I^J = \frac{D_J^{\sigma} D_{J+1} - D_{J+1}^{\sigma} D_J}{(D_J^{\sigma}+D_J)(D_{J+1}^{\sigma}+D_{J+1})}.$$

On the interval $\sigma \in [0,1)$, $\Delta s_{inside}(\sigma)$ is everywhere positive and decreasing in σ.

[10] In the logit case $\Delta s_{Inside} = \frac{e^{\delta_{J+1}}}{D_J \; D_{J+1}}$ which is always positive.

explanatory variables. The new regressor is a function of quantities and thus like price is also endogenous. Price adjusted movie quality δ'_{cj} is now given as:

$$\delta'_{cj} = \delta_{cj} - \alpha p_c - \sigma ln(s_{cj}/(1 - s_{c0})) = \beta_0 + \varphi y_c + \xi_{cj}.$$

b. Nested Logit with Non-Separability

One shortcoming of the nested logit specification is that it is not able to accommodate rotations in the demand curve due, for example, to advertising.[11] Specifically, a separable demand error does not allow unobserved advertising to affect the marginal utility of income. We know that advertising budgets, while omitted from our measured budgets, are about half as large as observed production budgets in the US (Vogel, 2007). If unobserved advertising rotates the demand curve, then our standard IV approach is no longer consistent because the instrumented price is correlated with the demand error, which now includes an interaction term between price and the error.[12]

We explore this extension in the movie demand data here by estimating a nested logit specification that allows price to interact with the demand error. We generalize the nested logit utility specification to include an interaction term between price and the demand error:

$$ln(s_{jc}) - ln(s_0) = \beta_0 + \alpha p_c + \varphi y_c + \sigma ln(s_{jc}/(1\text{-}s_{0c})) + \xi_{cj} + \lambda p_c \xi_{cj}.$$

This allows unobserved factors to both shift and rotate the demand curve.

2. Supply: the Production of Quality

[11] A large empirical literature demonstrates that advertising can both shift and rotate the demand curve. See Pakes' (1987) review of Mueller (1986).
[12] Gandhi, Kim, and Petrin (2011) show an example in which price elasticities increase by 60% when the demand framework is generalized to allow for non-separable errors.

While our demand side estimates depend in no way on the supply side model, we require a characterization of supply in order to conduct our counterfactuals. In principle, film producers have two margins of adjustment. They can make more movies, or they can spend more on the movies that they make. Our model below makes the simplifying assumption that budgets are the only margin employed, an assumption that is consistent with our historical data.[13] This assumption also allows us to sidestep the problem of how to model the quality of as-yet non-existent goods, a generic problem that has not yet been solved in the literature.

Each year the movie industries of each country invest in slates of movies. We posit that the quality of the movies depends in part on the size of the production budgets. Using the estimated price-adjusted qualities from the demand system as the dependent variable, we recover the production relationship by relating δ' to observed budgets and controls:

$$\delta'_{cj} = \gamma \log(B_j) + \mu_c + \mu_t + \epsilon_{cj}$$

where γ is the return to budget investment and the fixed effects for destinations and time are given as μ_c and μ_t, respectively. In principle this equation could include a dummy for country of origin as well, but in practice our data on movie-level budgets are predominantly from the US. While we restrict γ to be common across destination countries, with sufficient data we could allow γ to be indexed both by importing and exporting country. Movie budgets may be endogenous, and we describe instrumental variables strategies in the empirical section.

3. Nash Equilibrium and Revenue Weights

[13] For example, in the United States, the total budget on major MPAA releases has grown from $35 million to $100 million per film in constant 2005 dollars between 1980 and 2005, while the number of releases has been roughly stable (see Figure 2).

Define $r_{cj}(\delta'_{cj}(B_j), \delta'_{-cj}(B_{-j}))$ as the revenue from movie *j* in destination country *c*, where we explicitly note its dependence on the qualities of all movie available in country *c*. That is, r_{cj} depends on the size of *j*'s budget as well as the size of all other movies' budgets. The worldwide profit for movie *j* is then its revenue in all countries less its budget:

$$\sum_{c=1}^{C} r_{cj}\big(\delta'_{cj}(B_j), \delta'_{-cj}(B_{-j})\big) - B_j.$$

In practice – and as discussed above – box office is one of three major revenue sources, along with home video and television. Because we do not observe all of these, we need to estimate the relationship between box office revenue and producers' net proceeds from all sources. We do this by allowing for a producer-specific scale factor W_j, so $r_{cj} = W_j r'_{cj}$, where *r'*( ) contains only box office revenue. Total profits for movie j are given by

$$\sum_{c=1}^{C}\big[W_j r'_{cj}\big(\delta'_{cj}(B_j), \delta'_{-cj}(B_{-j})\big) - B_j\big],$$

We then use the first-order conditions for profit maximization to estimate these weights.

Producers typically have multiple products. For a decision maker responsible for a set of movies *F*, profit from box office revenues is given by:

$$\sum_{j\in F}\sum_{c=1}^{C}\big[W_j r'_{cj}\big(\delta'_{\mathrm{cj}}(\mathrm{B_j}), \delta'_{-\mathrm{cj}}(\mathrm{B_{-j}})\big) - \mathrm{B_j}\big].$$

Given the ticket price and market size in each country, along with the preferences of consumers for the set of products , we assume that firms compete Nash in budgets, and we solve for the W_j's that satisfy the Nash equilibrium conditions at the box office revenues and budgets in the data. We then use these estimated values of W_j in the profit functions for policy counterfactuals. For our policy counterfactuals we can modify either the revenue or budget function (or both) and resolve for the new Nash equilibrium.

a. Strategic Substitutes and Strategic Complements

Changes in budgets across the counterfactuals will be determined in part by the collective competitive investment responses of players to one another, as in Bulow, Geanakoplos, and Klemperer (1985). In our context a player is an entity controlling budgets for a set of movies, and the competitive response of player 1's budget to changes in player's 2 budgets will depend on how the derivative of player 1's profits Π_1 with respect its budget B_1 changes as player 2's budget B_2 changes:

$$\frac{\partial}{\partial B_2}\left(\frac{\partial \Pi_1}{\partial B_1}\right)$$

If it is positive (negative) then investment decisions are strategic complements (substitutes), as increases in player 2's budget increase (decrease) the marginal profitability of an extra dollar of investment by player 1, leading player 1 to respond with more (less) investment. As we show in the appendix, ruling out idiosyncratic heterogeneity in tastes for movies, as the simple logit model does, tends to bring about a finding of strategic substitutes by eliminating terms related to strategic complementarity. Specifically, the more highly correlated are consumer tastes across movies – a higher σ in our setup – the easier it is to steal market share from competitors by increasing one's own movie quality.

III. Data

The basic data for this study are the market shares of 6,672 movies in 14 distinct countries between 2005 and 2009, for a total of 16,189 movie-country-year observations. In addition we observe ticket prices and per capita income by country and year, not at the level of the individual movie. The market shares are derived from box office revenue data which in turn were obtained from Box Office Mojo (boxofficemojo.com). The ticket price data, along with data on overall country film investment are obtained from Screen Digest.

Movie-level budget data for 770 major releases (and 5,223 movie-country observations) are obtained from www.thenumbers.com, which reports estimates of production budgets for major films.[14] Data on European film subsidies in 2004 are obtained from Cambridge Econometrics (2008).

Before turning to the modeling, the simple tabulations from the data are of some interest. Tables 3 and 4 show patterns of world trade in movies in 2008. Table 3 shows where each origin country sells its repertoire. Table 4 shows the national origins of each destination country's consumption. These two tables answer the respective questions, "who buys my repertoire?" and "whose products do our consumers like?" that are central to the way that, say, trade policies would affect equilibrium trade patterns.

For example, Table 3 shows that domestic markets are important outlets for all repertoires. Domestic sales account for three quarters of sales for the repertoires from Brazil, France, Germany, India, Italy, Japan, Mexico, South Korea, and Turkey. The Anglophone countries (Australia, the UK, and US) are different: domestic sales account for half of US sales and under a fifth of Australian and UK sales. Those repertoires instead achieve substantial sales

[14] Budget data are also reported at boxofficemojo.com. Both data sources report production budget information for only a subset of movies. It appears to be essentially the same subset.

in the other Anglophone countries, chiefly the US. They also obtain atypically high shares of their sales in other countries.

Table 4 shows which repertoires consumers in each destination market choose. Two patterns are clear. First, there is a home market effect: the main diagonal entries are large. Countries with particularly large apparent preferences for domestic product include India (77 percent), Japan (59), Turkey (52), and the US (90). Second, Anglophone countries' – especially the US and the UK – have high market shares everywhere. France, too, has relatively high market shares, particularly in Europe.

The information in Tables 3 and 4 is interesting and provides some hints about how counterfactual policies might affect welfare outcomes. It is clear that consumers in many countries would be made worse if they lost access to US movies. It is also relatively clear that US consumers would not suffer much from loss of access to foreign movies. But the raw data cannot provide estimates of the welfare impact of the lower investment level that would prevail without trade. Hence the need for an explicit model simultaneously endogenizing all countries' investment decisions.

IV. Empirical Implementation

Table 5 reports estimates of the demand models and Table 6 includes the implied elasticities. We include each country's average income as an explanatory variable to capture unobserved heterogeneity in tastes that is correlated with income, as suggested by McFadden (1982). Estimates of the coefficient on price and the inside share along with the market shares of each movie are sufficient to calculate the quality δ' of each movie in each market.

We have two types of instruments that we use for price and the inside share. The literature has made wide use of the assumption from Berry et. al. (1995) that product characteristics are exogenous. In our setting under this assumption the total number of movies is a valid instrument so we use the log of the number of movies released in each country-year.[15] We also use the Hausman (1994)-style instruments, where prices in other locations are valid instruments if they reflect common worldwide cost shocks to making movies like changes in technology.[16] We use functions of the average ticket price in other countries as instruments for the home-country price. Finally, in some of the specifications we treat price as exogenous because it is the average price across movies and not the movie- specific price.

The first column reports the simple logit model with price assumed to be exogenous. As Table 6 indicates, the implied mean (median) movie-level price elasticity of demand is -2.25 (-2.43) and the implied overall price elasticity for movies when considered together (the inside elasticity) is -1.87 (-2.00). Columns (2) and (3) of Table 5 report the nested logit estimates with price assumed exogenous and the inside share instrumented with the BLP instrument (2) and the Hausman instrument (3) respectively. The estimates are markedly different from the simple logit, but they are very similar across these two specifications. The price coefficient is about 60% of its logit magnitude (-0.17 and -0.18) and the substitution parameter (σ) is highly significant and close to one (0.795 and 0.821), indicating a high degree of substitutability of among movies. The consequence for the demand estimates relative to the logit model is that the resulting mean movie-level price elasticities are much higher in absolute value, at -5.42 in both specifications, while the inside share elasticities are slightly lower. Thus the nested logit models

[15]Recall that identification of the idiosyncratic taste parameter is related to how inside shares change and the number of movies available in a market changes

[16] If there are worldwide demand shocks like international advertising campaigns that are correlated with price and affect demand then this instrument will be correlated with the demand error.

suggest that there is a set of consumers with very strong preferences for going to the movies, but who are readily willing to substitute between movies in response to small increases in one movie's price holding other movies prices constant.

In the fourth column of Table 5 we treat both price and the inside share as engodenous using both types of instruments. Column 5 treats both as endogenous and uses the approach described in Gandhi, Kim, and Petrin (2011) to allow for possible interactions between price and unobserved (to us) advertising. In both cases the coefficients and implied elasticity estimates are similar to columns 2 and 3. We use the demand estimates in column (2) for our counterfactuals, but we note that the estimates in the subsequent columns are very similar.

2. The Quality Production Function

A key relationship in our model is the link between budgets and quality. We have country-specific measures of each movie's quality (δ') from the demand model, and we have budget data on 770 major releases (mostly from the US). Figure 3 presents the relationship between quality and log budget, separately for four major destination markets, derived from the nested logit model. The relationships are positive, indicating that movies with higher production budgets tend to have higher perceived quality. We have 4,221 observations for which we observe the identity of the studio making the movie. We use this subset for analysis.

Our simplest quality production function relates our measure of movie quality to the log production budget of the movie. We include year dummies to account for the fact that the sample contains movies from different years (and that input prices may be changing over time). We also include destination dummies, allowing for the possibility that audiences in different countries like the largely US movies in the sample to different extents. The resulting coefficient on log budget, in column (1) of Table 7, is 0.160 (se=0.0042).

We would like to control for non-budget aspects of the movie quality. One possible determinant of quality is the identity of the studio producing the movie. Different studios may have different movie-making acumen, which would give rise to different quality for a given level of budget. Different studios may also have different distribution capabilities, which would generate different revenue – and therefore implied quality – than others. When we include a studio fixed effect along with year and destination fixed effects, the coefficient on log budget changes slightly, to 0.162 (see column (4)).

We are concerned that budgets may be endogenous. For example, movies based on a better concept may attract both larger audiences and greater investment, which could be mistaken for a causal relationship between investment and quality. To get a causal estimate of the parameter γ we need a source of variation in budgets that is not contaminated by movie quality. For this we appeal to the idea that studios that are flush with cash will invest more, an idea reminiscent of a robust empirical relationship in corporate finance.[17] We also posit that studios that spent large budgets in the previous year may be constrained in their current year spending. Thus we instrument a studio's current movie budgets using its revenues and budgets from the previous year.

Column (2) reports a first-stage regression of log budgets on last year's revenue and budgets for the studio. Including year and destination effects but not studio fixed effects, the revenue coefficient is positive, which accords with our prior. However, the lagged budget

[17]See Fazzari, Hubbard, and Peterson (1988) and the large related literature.

coefficient is also positive, which is inconsistent with our prior. The resulting IV estimate of the log budget coefficient, in column (3), is 0.171.

Column (5) reports a first-stage regression of log budgets on last year's revenue and budgets for the studio, including studio fixed effects, generating a positive and significant lagged revenue coefficient and a negative and significant lagged budget coefficient. The resulting IV estimate of the log budget coefficient, in column (6), is 0.189. Hence, all of these specifications yield rather similar estimates of the log budget coefficient, between 0.16 and 0.19. We proceed with the column (1) estimate.

We observe movie-specific revenue in each sample country but we observe movie-specific budgets only for the major releases, most of which are from the US. For the remainder of the world, we observe aggregate annual country investment in movies. We adapt our implementation accordingly by modelng the decision making at the level of eleven groups of countries: the Australia, China, France, Germany, Italy, Japan, South Korea, Spain, the UK, the US, and a composite rest-of-the-world. This has two implications. First, we model counterfactual quality as the following functions of budgets:

$$\delta'_{cj}(B_j) = \delta'_{cj0} + \gamma \log{(B_j/B_{j0})}.$$

For us, the sets of movies are the movies from each of the 11 origin regions. Thus, we model as observed quality (δ'_{cj0}) plus the percent change in budget for that origin country (α) times the common production function parameter linking investment to quality (γ). Second, the weights *W* that translate box office revenue into producer revenue are also calculated at the level of the origin region.

V. Model Simulations

1. Baseline Simulation

Before turning to the counterfactuals, we first calculate the weights *W* that translate box office revenue into studio proceeds. As discussed above, overall studio proceeds are roughly 1.5 times box office receipts. If we observed all costs in the budget data, and if we observed all of the world's box office revenue, then we would expect *W*'s of roughly 1.5. Our actual data deviate by covering only production budgets but not marketing. According to Vogel (2007), ads and prints together add about 50 percent to total costs for major US releases. Thus, for the US, we expect *W* to be about 2.25; and the *W* we estimate for 2008 is 1.84.

Weights for other countries may deviate for a variety of reasons. First, the extent of advertising costs – and therefore the extent to which observed budgets understate actual budgets – may deviate across repertoires. If the US advertises more, then we would expect smaller weights elsewhere. Second, repertoires may differ in the revenue generated in home video and television per dollar in the box office. For example, if US repertoire were aired on international television more than the reverse, then foreign weights would be lower than the US weight, all else equal. For six of our 11 countries we find weights below the US's 1.84 (Australia: 0.55; France: 1.18; Italy: 1.08; Mexico: 1.01; South Korea: 0.84; and the United Kingdom: 0.40). Third, because we only observe box office revenue for 14 countries and not the entire world, we are missing some of theatrical box office for those repertoires. For example, Germany is the only German-speaking countries in the sample; because we lack Austrian and Swiss box office, we are understating German revenue, which may explain its higher weight of 3.42.[18]

2. Estimates of Strategic Substitutes or Complements

Along with the direct impact of market size, an important mechanisms for the quality channel is the optimal response of movie investment in one country to changed movie investment elsewhere or, in short, whether different countries' investments are strategic substitutes or complements. Before turning to policy counterfactuals, we calculate these effects directly. To this end, we perform simulations in which we increase the investment in one country's motion pictures by one percent and then let other countries' investments optimally adjust in a simulation that holds the first country's investment constant at one percent above its baseline value. We perform this exercise for investment increases in five countries: the US, France, Germany, the UK, and China. Table 8 reports results.

We calculate standard errors of these and remaining simulation statistics by bootstrapping via the following procedure. Define β as the demand model parameters. The baseline demand model in column (2) of Table 5 gives us the estimated distribution of β. We take draws from this distribution. Given a draw β_i, we can calculate the vector of movie qualities $\delta'(\beta_i)$; and we obtain the production function parameter γ_i by regressing these qualities on log budgets and destination and year fixed effects. Given these estimates, we can calculate a draw-specific set of weights (*W*) as well as draw-specific policy simulations. We repeat this exercise 50 times to

[18] The remaining weights we infer for 2008 are: China: 2.26; Japan: 3.28; and rest-of-world: 2.28.

obtain distributions of the statistics of interest. Standard errors of these statistics are reported in the tables that follow.

The first column of Table 8 shows how the various countries respond to a one-percent increase in US investment (an increase of almost $63 million dollars). All countries respond by decreasing their investment levels, and seven of these responses are statistically significant. At the high end, UK investment decreases by roughly ten cents per dollar of US increase, while German and French investment decline less per dollar of US increase. The second column of Table 8 shows that a one percent French increase (about $10 million) has a statistically significant impact on the rest-of-world investment. The German one-percent increase (almost $7 million) causes a $0.13 million US increase, as well as a similar-sized decrease for the rest-of-world. A one-percent UK increase (almost $5 million) gives rise to large and significant reductions in French and German investment (20 and 10 cents per dollar of additional UK investment) as well as a large positive US response (more than 1:1). Finally, a one-percent increase in Chinese investment ($2.5 million) brings about a small increase in Japanese investment as well as a larger reduction in rest-of-world investment.

A few features of the results in Table 8 are notable. First, most entries are negative indicating strategic substitutes, meaning that for most countries the optimal response to increased investment elsewhere is to reduce one's own investment. Some exceptions to this pattern are the US-German and the US-UK investment responses, where the optimal response to elevated German and UK investment is increased US investment and vice versa. In the appendix we derive the closed-form formulas for the nested logit models for whether products are strategic complements or substitutes.[19] They suggest that country-pairs that have higher market shares in common countries are more likely to be strategic complements. From Table 4 we can see this is true for the US and Germany and for the US and the UK, particularly in Germany and the UK.

3. The Gains from Trade

We quantify the changes in consumer and producer surplus when we move from observed trading patterns to autarky. The first-order effect of the market expansion due to trade is to unambiguously increase movie budgets.[20] Table 9 illustrates that eliminating trade leads budgets to plunge in every country, and the decreases are particularly large for countries currently generating substantial revenue outside their home markets.[21] For example, the US and UK budgets fall by over 75% when we move from free trade to autarky.

As emphasized earlier, the loss to consumers from restricting trade has two components. The first is the conventional aspect arising simply from not having foreign movies in their choice set. The second, in our setup, is an additional cost arising from endogenous decreases in equilibrium investment when producers cannot sell their movies abroad.[22] The combined effects are reported in column 2, and they show that consumers everywhere are worse off largely because of the loss of U.S. movies. In particular the effects are biggest in those countries that are the biggest demanders of them (e.g. Australia and the UK experience per capita reductions in consumer surplus of $11.00 and $7.18, respectively).

[19] We verified that the direct US response to higher German and UK investment is also positive with simulations raising German or UK investment by one percent and allowing a US response while freezing all other countries at initial values.
[20] There are also second-order effects on investment coming from the fact that most goods are strategic substitutes. This works to dampen investment but these effects are second-order.
[21] The exception is Mexico which has a very small and statistically insignificant increase.
[22] Put another way, we can decompose the gains from trade implicit in Table 9 into two parts: 1) the change in welfare from making the autarky product set available worldwide, and 2) the change in welfare from endogenously adjusting budgets from their autarky levels for the worldwide market.

We can decompose the gains from trade – analogously, the losses from autarky – into two parts. The first part is the effect of moving from autarky to free trade in the products with their autarky investments levels. The second part is the effect of moving from trading the autarky products to trading the products with their free-trade investment levels. Decomposing these gains into their two components, we find that for most countries roughly half the gains come from having the autarky-quality-level movies traded, while the other half comes from the increase in the quality of movies when free trade is allowed. The shares of the gains arising from trading the autarky level products are 61.5 percent for Australia, 42.5 percent for China, 36.9 percent for France, 47.4 percent for Germany, 42.0 percent for Italy, 26.7 percent for Japan, 51.9 percent for Mexico, 36.1 percent for South Korea, and 56.4 percent for the United Kingdom. The US is an exception: all but 5 percent of US consumers' gains operate through the increase in quality of U.S. movies when budgets rise to take advantage of trade.

The effect of trade on exporters is less clear-cut when consumer perceptions of quality vary dramatically across the exporters. While exporters gain greater market access, they also face potentially stiffer competition, and the latter effect dominates all countries except the U.S. because of the higher perceived quality of U.S. movies by world consumers. Put another way, Table 9 shows that non-U.S. producers prefer autarky because they are able to contract their budgets dramatically and still generate high revenue in their captive domestic markets. This arises because of the inelastic demand for movies regardless of the average quality level (see Table 6). Total welfare goes up slightly in almost all non-U.S. countries as producers gain while consumers lose.

The U.S. is the exception. Despite a huge additional investment when the world moves to free trade, the dramatic gain in foreign sales makes the U.S. the lone producer that strongly prefers free trade to autarky. Overall, the losers from free trade are non-U.S. producers while all others - U.S. producers and all of the world's movie consumers – gain.

4. The Effect of European Subsidies

We can use our model to quantify the impact of the European cinema subsidies. In particular, we can ask two questions. First, what are the impacts of the subsidies? And, second, are they successful? That is, do they correct a market failure by aiding in the provision of movies with revenue below costs but total benefit, inclusive of consumer surplus, above costs (Spence, 1976).

As Table 10 shows, the direct impact of the elimination of the European subsidies is a substantial reduction in European film investment. Reduced investment makes these films less attractive, and both producer surplus and consumer surplus fall in the subsidizing countries. US investment also falls in the no-subsidy equilibrium. Because the US imports little, the main impact of the subsidies on US consumers operates though reduced US investment, and US consumer surplus declines by $32.5 million, or by about $0.11 per capita. US producer surplus, on the other hand, rises as Hollywood movies become more appealing in Europe relative to unsubsidized European fare.

European consumers suffer a loss in surplus due to both reduced US and domestic investment. Most of the loss in European consumer surplus stems from reduced domestic investment. While US consumers lose $0.11 per capita from the reduced quality of movies in the no-subsidy equilibrium, French consumers lose $0.94 per capita. Hence, most of the French consumers' losses stem from the direct loss of the subsidies (and not the equilibrium impacts operating through US investments). Impacts are similar in other European countries.

These losses to consumers provide some evidence of the cultural benefit of the subsidies. Yet, the directly quantifiable economic impacts of the European subsidies – consumer and producer surplus – fall substantially short of their costs. As Table 2 shows, France spent $640 million on subsidies in 2004. Complete withdrawal of this magnitude of subsidies leads to a 75 percent reduction in investment which, in turn, causes a $250 million loss in French producer surplus and a $58 million loss to French consumers lose. Thus, the French spend about $640 million to generate $325 in additional consumer and producer surplus. Patterns for the other European countries are similar.

Determining whether the European subsidies are successful is challenging. European cinema subsidies have both cultural and economic rationales. For example, the European Union's Media 2007 "programme for the support of the audiovisual sector" seeks to "preserve and enhance Europe's cultural and linguistic diversity and its cinema and audiovisual heritage, guarantee public access to it and promote intercultural dialogue." The program also seeks to "boost the competitiveness of the European audiovisual sector in an open and competitive market that is propitious to employment."[23]

While the subsidies do increase consumer and producer surplus in European countries – and are therefore effective in some sense - their quantifiable benefits fall short of their costs. Of course, consumer and producer surplus show only the benefits revealed by purchase behavior. To the extent that, say, cultural preservation is valuable but does not affect purchase decisions, consumer and producer surplus will understate the subsidies' benefits.

[23] http://europa.eu/legislation_summaries/audiovisual_and_media/l24224a_en.htm

VI. Conclusion

We develop a parsimonious model of the global movie industry consisting of consumer response to movies, producers' quality investment decisions, and an equilibrium condition for producers' investment decisions. The model allows us to quantify the gains from trade and to assess the portions of the gains operating through quality investments. We also use the model to assess the impact of European subsidies on the world movie market.

We have two major findings. First, the quality channel is important for evaluating the effects of trade in this product. Trade benefits consumers everywhere and harms producers outside the US. The quality channel is important to consumers: roughly half of the gain to consumers outside the US operates through quality, and quality investment produces almost all of the benefit that US consumers experience from trade. Second, the quality channel is also important to the way that policies affect welfare. Our policy simulation of the elimination of European cinema subsidies shows non-surprising harms to European consumers and producers. Perhaps more surprising, the reduced European investment reduces US investment, which harms US consumers. The continued use of subsidies in Europe, along with other trade restrictions such as China's 20-film annual import cap, give rise to a need for an ability to analyze the welfare impacts of trade in motion pictures. We hope this model provides a step in this direction.

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Table 1: Movie Production and Foreign Revenue Share

Country	number	budget ($mil)	investment ($mil)	foreign percent (2008)
India	1164	0.2	221	8.3%
United States	656	31	20,336	51.8%
Japan	407	5	2,039	6.8%
China	402	1.1	454	37.4%
France	228	7.2	1,646	34.3%
Russian Federation	200	na	na	9.0%
Spain	172	3.5	595	55.5%
South Korea	124	4.2	517	3.5%
Germany	122	9.1	1,104	24.3%
Italy	121	3.5	428	12.2%
Brazil	117	1.5	180	27.2%
United Kingdom	117	12.8	1,495	84.8%
Argentina	80	0.9	75	36.5%
Mexico	70	1.5	103	28.1%
Thailand	54	1	55	16.0%
Hong Kong	50	6.3	315	82.5%
Philippines	47	0.4	16	0.6%
Turkey	43	2	85	11.2%
Hungary	41	0.9	35	3.8%
Austria	32	2.6	82	57.6%
Belgium	32	4.2	135	71.9%
Poland	31	1.7	51	6.0%
Australia	30	7.6	229	84.4%
Taiwan	30	0.7	20	7.6%
Malaysia	28	0.4	12	2.7%
Sweden	28	2.5	71	18.0%
Netherlands	26	3.8	100	5.8%
Denmark	24	3	72	23.2%
Norway	22	2.4	53	4.6%
Greece	20	0.8	16	3.0%
Czech Republic	18	1.5	27	22.2%
Finland	17	1.5	26	46.3%
Portugal	15	1.6	24	64.4%
South Africa	15	2.3	34	0.1%
New Zealand	12	14.7	177	44.8%

Sources: Screen Digest, various issues, movie production. Author calculations for foreign share of origin repertoire revenue.

Table 2: European Film Investment and Government Subsidies, 2004

country	investment ($mil)	subsidy $mil	share subsidized
Austria	57.9	34.6	59.8%
Belgium	74.9	30.1	40.2%
Czech Republic	14.0	2.4	17.0%
Denmark	79.7	44.9	56.3%
Estonia	2.8	4.0	142.9%
Finland	25.6	17.5	68.4%
France	1,303.5	640.1	49.1%
Germany	702.7	254.0	36.1%
Greece	15.0	7.5	50.0%
Hungary	10.3	24.9	241.5%
Ireland	75.6	14.3	18.8%
Italy	353.7	112.5	31.8%
Latvia	0.8	1.4	171.9%
Lithuania	0.8	1.4	171.9%
Luxembourg	3.7	4.9	131.8%
Netherlands	85.1	50.4	59.2%
Poland	16.2	4.4	27.0%
Portugal	29.9	22.3	74.4%
Slovakia	2.2	0.0	0.0%
Slovenia	6.1	2.9	47.1%
Spain	392.0	89.9	22.9%
Sweden	78.4	69.8	89.0%
UK	1,486.6	147.9	9.9%
Europe Total	4,817.5	1,581.8	32.8%
USA	14,716.0		
Japan	1,562.2		
Canada	336.5		
Korea, S	297.9		
China	136.3		
World Total	22,765.8		

Notes: Sources for budgets is “Global Film Production Falls: Key Territories Hold Firm but World Production Levels Drop Off.” Screen Digest, July 2009, p. 205. Source for European subsidies is Cambridge Econometrics, “Study on the Economic and Cultural Impact, notably on Co-productions, of Territorialisation Clauses of state aid Schemes for Films and Audiovisual Productions.” A final report for the European Commission, DG Information Society and Media, 21 May 2008, p. 25.

Table 3: Where Does Origin Repertoire Sell, 2008?

	Destination														
Origin	Australia	Brazil	China	France	Germany	India	Italy	Japan	Mexico	South Korea	Spain	Turkey	UK	US	total
Australia	18.7%	0.1%	0.9%	8.3%	8.7%	14.1%	0.2%	0.1%	2.5%	2.7%	9.1%	0.7%	7.6%	26.4%	100.0%
Brazil	.	79.4%	.	2.3%	.	.	1.8%	.	12.2%	0.0%	2.7%	0.1%	1.5%	.	100.0%
China	1.4%	.	69.4%	0.3%	.	.	.	21.2%	.	7.5%	.	0.1%	0.1%	.	100.0%
France	1.5%	0.6%	0.3%	75.0%	4.8%	0.0%	2.8%	0.3%	1.0%	2.0%	3.8%	0.4%	3.9%	3.5%	100.0%
Germany	0.3%	1.3%	0.3%	2.5%	86.0%	.	0.7%	0.1%	0.9%	0.2%	3.7%	0.8%	3.1%	.	100.0%
India	0.9%	.	0.0%	.	0.0%	93.5%	.	.	.	.	.	.	5.5%	.	100.0%
Italy	0.1%	0.2%	.	3.8%	1.5%	.	90.9%	.	0.1%	0.0%	2.0%	0.7%	0.8%	.	100.0%
Japan	.	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%	95.0%	0.3%	1.5%	0.2%	0.1%	0.2%	2.4%	100.0%
Mexico	0.8%	0.6%	.	3.0%	1.2%	.	2.8%	.	82.0%	2.9%	1.8%	0.1%	4.6%	.	100.0%
South Korea	.	0.0%	1.2%	0.3%	0.0%	.	0.0%	0.6%	0.0%	97.7%	0.0%	0.0%	0.0%	.	100.0%
Spain	1.2%	1.9%	0.0%	14.6%	4.0%	.	6.8%	0.2%	5.9%	0.5%	49.7%	0.7%	0.7%	13.7%	100.0%
Turkey	0.0%	0.0%	.	0.2%	8.0%	.	0.2%	.	.	.	.	91.3%	0.2%	.	100.0%
United Kingdom	6.1%	1.6%	2.5%	5.8%	7.4%	0.8%	3.0%	3.7%	2.2%	3.3%	4.4%	0.4%	18.6%	40.2%	100.0%
United States	4.2%	2.3%	1.2%	4.5%	4.6%	0.3%	3.5%	4.0%	3.3%	2.5%	4.2%	0.5%	8.4%	56.4%	100.0%
other	2.2%	3.3%	30.0%	16.2%	6.2%	1.5%	3.3%	5.3%	3.0%	5.2%	5.7%	0.8%	3.5%	13.7%	100.0%

Table 4: Where is Destination Consumption From, 2008?

	Destination													
Origin	Australia	Brazil	China	France	Germany	India	Italy	Japan	Mexico	South	Spain	Turkey	UK	US
Australia	4.3%	0.0%	0.3%	1.0%	1.4%	6.0%	0.0%	0.0%	0.7%	0.6%	1.9%	0.6%	0.8%	0.5%
Brazil	.	6.5%	.	0.1%	.	.	0.1%	.	0.7%	0.0%	0.1%	0.0%	0.0%	.
China	0.4%	.	32.3%	0.0%	.	.	.	2.9%	.	2.0%	.	0.1%	0.0%	.
France	1.7%	1.3%	0.5%	42.6%	3.8%	0.0%	2.8%	0.2%	1.5%	2.0%	3.9%	1.9%	2.1%	0.3%
Germany	0.1%	0.7%	0.1%	0.3%	16.8%	.	0.2%	0.0%	0.3%	0.0%	0.9%	0.8%	0.4%	.
India	0.4%	.	0.0%	.	0.0%	77.7%	.	.	.	.	.	.	1.2%	.
Italy	0.0%	0.1%	.	0.7%	0.4%	.	28.9%	.	0.0%	0.0%	0.6%	0.9%	0.1%	.
Japan	.	0.1%	0.3%	0.0%	0.1%	0.0%	0.1%	59.0%	0.6%	1.9%	0.3%	0.3%	0.1%	0.3%
Mexico	0.1%	0.1%	.	0.1%	0.1%	.	0.2%	.	9.8%	0.2%	0.2%	0.0%	0.2%	.
South Korea	.	0.0%	0.9%	0.1%	0.0%	.	0.0%	0.1%	0.0%	43.3%	0.0%	0.0%	0.0%	.
Spain	0.3%	0.8%	0.0%	1.6%	0.6%	.	1.3%	0.0%	1.6%	0.1%	9.4%	0.6%	0.1%	0.2%
Turkey	0.0%	0.0%	.	0.0%	0.9%	.	0.0%	.	.	.	.	52.3%	0.0%	.
United Kingdom	14.1%	6.8%	8.7%	6.8%	12.2%	3.4%	6.4%	3.8%	6.4%	6.9%	9.3%	3.2%	20.4%	8.0%
United States	77.6%	80.5%	34.5%	42.6%	61.5%	11.5%	58.4%	32.8%	76.5%	40.7%	70.9%	37.6%	73.6%	90.0%
other	1.1%	3.0%	22.3%	4.1%	2.2%	1.3%	1.5%	1.1%	1.9%	2.3%	2.5%	1.6%	0.8%	0.6%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 5: Demand Model Estimates

	(1) logit	(2) NL exogenous price, BLP instrument for inside share	(3) NL Hausman instruments for inside share	(4) NL all IVs, price and inside share treated as endogenous	(5) NL With price interactions (GKP)
income	0.7330	0.6298	0.6162	0.5916	0.6321
	(0.2310)**	(0.0816)**	(0.0776)**	(0.1478)**	(0.0759)**
ticket price	-0.2925	-0.1842	-0.1699	-0.1578	-0.1831
	(0.1260)*	(0.0350)**	(0.0331)**	(0.0841)	(0.030)**
sigma		0.7408	0.8386	0.7632	0.7888
		(0.0790)**	(0.1197)**	(0.0761)**	(0 .0630)**
Constant	-9.6290	-4.4399	-3.7548	-4.3483	-4.087
	(0.3643)**	(0.6357)**	(0.8815)**	(0.6268)**	(0.4983)**
Observations	16189	16189	16189	16189	-0.00146
R-squared	0.04				

Notes: Robust standard errors in parentheses. * significant at 10%; ** significant at 1%. Column 1: Logit model estimated by OLS. Column 2: Nested logit model estimated via 2SLS, instrumenting for $\log(s_j/(1-s_0))$ with the log number of movies released in the exhibition country each year. Column 3: same as 3, except instrumenting for $\log(s_j/(1-s_0))$ with average prices in other countries, and higher-order terms, rather than the log number of movies released. Column 4 uses both sets of instruments and treats both the price and the inside share as endogenous. Column 5 uses the GKP price interactions. Standard errors are clustered by market.

Table 6: Mean (Median) Elasticities of Demand

	logit	NL exogenous price, BLP instrument for inside share	NL Hausman IVs for inside share	NL all IVs, price and inside share treated as endogenous	NL With price interactions (GKP)
Elasticity	-2.25 (-2.43)	-5.42 (-5.89)	-5.42 (-5.89)	-5.08 (-5.53)	-6.62 (-7.23)
Inside Elasticity	-1.87 (-2.00)	-1.18 (-1.26)	-1.18 (-1.26)	-1.01 (-1.07)	-1.17 (-1.25)

Table 7: Quality and Investment

	(1) Quality	(2) Log Budget	(3) Quality	(4) Quality	(5) Log Budget	(6) Quality
Log Budget	0.1602		0.1710	0.1619		0.1893
	(0.0042)**		(0.0105)**	(0.0047)**		(0.0733)**
Lagged Log Studio Rev		0.1342			0.1470	
		(0.0239)**			(0.0575)*	
Lagged Log Studio Budget		0.5388			-0.2287	
		(0.0298)**			(0.0605)**	
Constant	-3.4439	5.7568	-3.6306	-3.4532	19.0372	-3.9278
	(0.0736)**	(0.4189)**	(0.1821)**	(0.0827)**	(1.1865)**	(1.2668)**
Observations	4221	4221	4221	4221	4221	4221
R-squared	0.90	0.18	0.90	0.86	0.02	
Estimation	OLS	OLS	IV	OLS	OLS	IV
Destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Studio FE	No	No	No	Yes	Yes	Yes

Standard errors in parentheses. * significant at 5%; ** significant at 1%.

Table 8: Investment as Strategic Substitute or Complement (Dollar Terms)

		1% investment increase in				
		US	France	Germany	UK	China
..changes investment in						
Australia	est	-613,057	236,762	215	390,456	330,179
	se	(377,101)	(211,558)	(9,303)	(326,861)	(75,771)
China	est	-696,898*	9,004	22,672	409,908	**2,508,001**
	se	(77,297)	(39,601)	(22,171)	(250,449)	
France	est	-2,726,450*	**10,199,580**	-27,539	-1,979,127*	93,938
	se	(95,774)		(55,384)	(231,632)	(64,563)
Germany	est	-4,190,987*	-150,142	**6,903,062**	-1,018,202*	-13,806
	se	(138,752)	(180,446)		(448,216)	(39,140)
Italy	est	-867,306*	13,788	7,934	-37,272	-11,075
	se	(146,917)	(60,394)	(17,766)	(401,761)	(12,318)
Japan	est	-184,320	-15,824	-1,449	-120,354*	44,353*
	se	(135,956)	(11,478)	(7,946)	(52,822)	(15,936)
Mexico	est	-451,012	3,688	1,799	170,700	96,763
	se	(309,335)	(20,126)	(4,818)	(253,403)	(115,210)
South Korea	est	-75,369*	45,961	34,370	394,044*	11,217
	se	(35,017)	(33,938)	(21,931)	(187,624)	(8,384)
United Kingdom	est	-6,016,475*	-68,080	-2,151	**4,980,237**	3,471
	se	(231,282)	(149,108)	(41,983)		(31,375)
United States	est	**62,867,690**	-130,136	130,765*	5,307,290*	-39,229
	se		(171,629)	(59,661)	(1,100,185)	(40,801)
rest	est	-4,174,560*	-741,961*	-128,545*	-1,255,376*	-384,774*
	se	(179,791)	(68,296)	(29,790)	(196,937)	(32,088)

Note: The first column shows the response of investment in each country to an exogenous 1 percent increase in US movie investment. Subsequent columns repeat the exercise for France, Germany, the UK, and China. The own-country investment increase is shown in bold. Standard errors calculated from 50 bootstrap replications.

Table 9: Autarky, Nested Logit Estimates

	change in budget	change in CS	change in PS	total change in welfare
Australia	-54.5%	-231.0	149.0	-82.3
(s.e.)	(29.9%)	(164.0)	(81.4)	(233.0)
China	-63.9%	-285.0	330.0	44.4
	(19.9%)	(330.0)	(224.0)	(534.0)
France	-68.7%	-264.0	610.0	346.0
	(16.2%)	(302.0)	(465.0)	(711.0)
Germany	-24.2%	-200.0	1660.0	1460.0
	(20.9%)	(55.8)	(449.0)	(295.0)
Italy	-45.4%	-143.0	380.0	238.0
	(34.2%)	(188.0)	(229.0)	(396.0)
Japan	-54.7%	-157.0	1340.0	1190.0
	(12.2%)	(38.6)	(655.0)	(258.0)
Mexico	15.9%	-312.0	280.0	-32.0
	(72.1%)	(366.0)	(142.0)	(491.0)
South Korea	-52.5%	-187.0	290.0	103.0
	(25.9%)	(341.0)	(211.0)	(537.0)
United Kingdom	-89.7%	-436.0	96.9	-339.0
	(5.6%)	(333.0)	(123.0)	(444.0)
United States	-76.8%	-1460.0	-6040.0	-7500.0
	(3.9%)	(406.0)	(385.0)	(334.0)

Notes: all figures are millions of US $ except column (1) which is in percent. Standard errors appear below estimates. Standard errors are computed via bootstrapping with 50 replications as described in the text.

Table 10: Eliminate European Subsidies, Nested Logit Estimates

	change in budget	change in CS	change in PS	total change in welfare
Australia	66.0%	-1.9	4.3	2.4
(s.e.)	(66.9%)	(2.1)	(6.8)	(5.2)
China	2.3%	1.7	0.9	2.6
	(10.6%)	(8.3)	(3.7)	(5.7)
France	-74.7%	-58.3	-252.0	-310.0
	(3.2%)	(20.3)	(6.5)	(16.2)
Germany	-69.5%	-19.0	-120.0	-139.0
	(6.3%)	(6.6)	(5.2)	(5.0)
Italy	-47.4%	-15.7	-41.8	-57.5
	(11.6%)	(5.2)	(4.8)	(4.2)
Japan	0.2%	-1.5	24.2	22.7
	(0.6%)	(1.6)	(11.9)	(10.7)
Mexico	49.4%	2.0	1.7	3.7
	(62.2%)	(9.7)	(6.0)	(7.2)
South Korea	1.2%	-2.9	5.9	3.0
	(12.0%)	(7.3)	(2.8)	(5.3)
United Kingdom	-19.8%	-9.3	-22.3	-31.6
	(7.3%)	(3.7)	(4.6)	(4.9)
United States	-1.9%	-32.5	790.0	758.0
	(0.8%)	(14.7)	(160.0)	(150.0)

Notes: all figures are millions of US $ except column (1) which is in percent. Standard errors appear below estimates. Standard errors are computed via bootstrapping with 50 replications as described in the text.

Figure 1: US Box Office and DVD Revenues

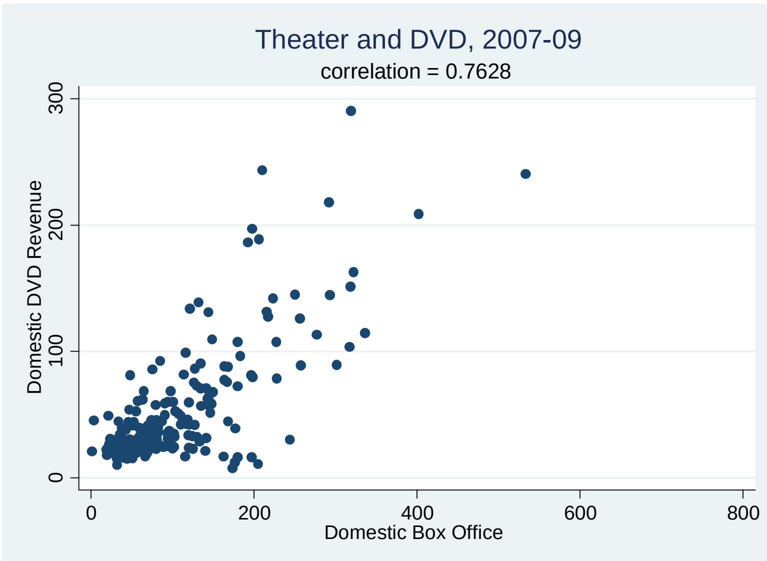


Figure 2

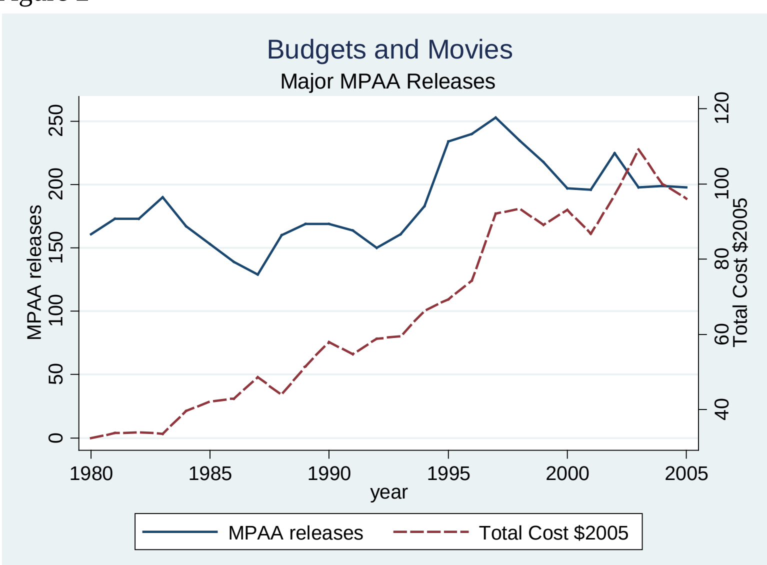
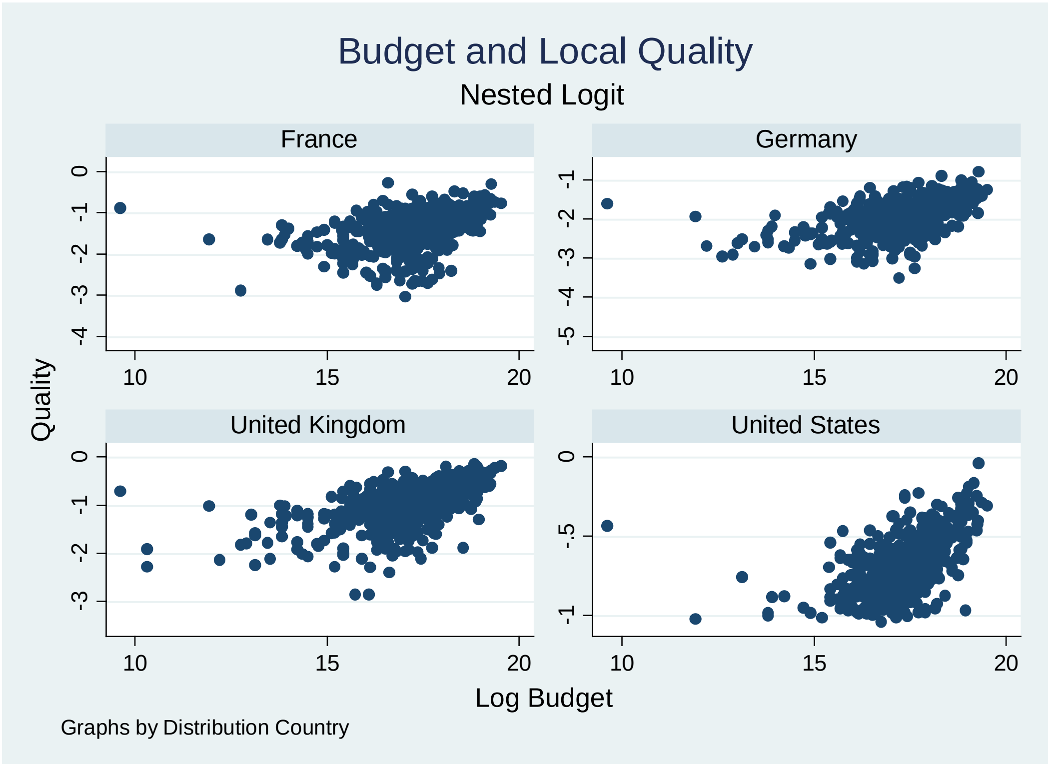


Figure 3


Budget and Local Quality
Nested Logit
France
Germany
United Kingdom
United States
Quality
Log Budget
Graphs by Distribution Country
0
-1
-2
-3
-4
-5
-.5
10
15
20

Appendix

To derive the expression $\frac{\partial}{\partial B_2}\left(\frac{\partial \Pi_1}{\partial B_1}\right)$ we start with the latter term in parentheses. In our worldwide movie market setting the marginal change in profitability for player 1 that comes from an extra dollar of investment is given by

$$\frac{\partial \Pi_1}{\partial B_1} = \sum_{c=1}^{C} M_c P_c \sum_{k \in J_{c1}} \sum_{j \in J_{c1}} \frac{\partial s_{ck}}{\partial \delta_{cj}} \frac{\partial \delta_{cj}}{\partial B_1} - 1 \quad (0.0)$$

with J_{c1} denoting the set of movies sold by player 1 in market c. Letting the marginal return to quality for good j in market c from additional investment by player $1 - \frac{\partial \delta_{cj}}{\partial B_1} -$ be given by γ_{c1} we can re-express as[24]

$$\frac{\partial \Pi_1}{\partial B_1} = \sum_{c=1}^{C} M_c P_c \gamma_{c1} \sum_{k \in J_{c1}} \sum_{j \in J_{c1}} \frac{\partial s_{ck}}{\partial \delta_{cj}} - 1 \quad (0.0)$$

Taking the derivative with respect to player 2's budget we have

$$\frac{\partial}{\partial B_2}\left(\frac{\partial \Pi_1}{\partial B_1}\right) = \sum_{c=1}^{C} M_c P_c \gamma_{c1} \gamma_{c2} \sum_{l \in J_{c2}} \sum_{k \in J_{c1}} \sum_{j \in J_{c1}} \frac{\partial}{\partial \delta_{cl}}\left(\frac{\partial s_{ck}}{\partial \delta_{cj}}\right), \quad (0.0)$$

where γ_{c2} denotes change in quality to player 2's goods that arises with a small increase in player 2's budget.

There are two types of terms in this equation that are both weighted by $\left(M_c P_c \gamma_{c1} \gamma_{c2}\right)$.

The own-product terms $\frac{\partial}{\partial \delta_{cl}}\left(\frac{\partial s_{cj}}{\partial \delta_{cj}}\right)$ are given as

$$\frac{\partial}{\partial \delta_{cl}}\left(\frac{\partial s_{cj}}{\partial \delta_{cj}}\right) = A_1(\sigma) * s_{cj} s_{cl} \left(2 s_{cj} - 1\right) + A_2(\sigma) * s_{cj}^2 s_{cl} \quad (0.0)$$

and the cross-product terms $\frac{\partial}{\partial \delta_{cl}}\left(\frac{\partial s_{ck}}{\partial \delta_{cj}}\right)$ are

[24] Note that γ in the appendix contrasts with the γ in the text, which is the derivative of δ with respect to the log budget.

$$\frac{\partial}{\partial \delta_{cl}}\left(\frac{\partial s_{ck}}{\partial \delta_{cj}}\right)=\left(2A_3(\sigma)+A_4(\sigma)\right)*s_{cj}s_{ck}s_{cl} \tag{0.0}$$

On the interval $\sigma \in [0,1)$ we have $A_i(\sigma)\geq 0\ \forall i$ and $A_i(\sigma)$ increasing in σ for any fixed set of $\delta_c=\left(\delta_{c1},\dots,\delta_{cJ_c}\right)$.[25] The cross terms are always weakly positive and thus always work towards strategic complements. The latter term associated with $A_2(\sigma)$ in the own-product term also is always positive. The lead own-product term for any good j is positive (negative) if the market share is greater than (less than) 0.5. The overall derivative is then a weighted sum of all of these terms.

In the logit model $A_1(\sigma)=A_3(\sigma)=1$ and $A_2(\sigma)=A_4(\sigma)=0$ so the own-product terms are given as

$$\frac{\partial}{\partial \delta_{cl}}\left(\frac{\partial s_{cj}}{\partial \delta_{cj}}\right)=s_{cj}s_{cl}\left(2s_{cj}-1\right) \tag{0.0}$$

and the cross-product terms are

$$\frac{\partial}{\partial \delta_{cl}}\left(\frac{\partial s_{ck}}{\partial \delta_{cj}}\right)=2s_{cj}s_{ck}s_{cl} \tag{0.0}$$

which means when $\sigma \in (0,1)$ the logit model omits terms that work to increase $\frac{\partial}{\partial B_2}\left(\frac{\partial \Pi_1}{\partial B_1}\right)$.

---

[25] $A_1(\sigma)=\frac{1}{1-\sigma}^2\left(\sigma D_c^{(\sigma-1)}+1\right)$, $A_2(\sigma)=\frac{\sigma}{1-\sigma}\left(D_c^{(\sigma-2)}\left(D_c^{\sigma}+D_c\right)\right)$, $A_3(\sigma)=2*\frac{1}{1-\sigma}^2\left(\sigma D_c^{(\sigma-1)}+1\right)$, and $A_4(\sigma)=\frac{\sigma}{1-\sigma}D_c^{(\sigma-2)}\left(D_c^{\sigma}+D_c\right)$