The Downside of Real Options: Evidence from Netflix’s Entry into Television

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Abstract
Uncertainty about outcomes has led managers to pursue a real options strategy in such diverse areas as project selection, technology investments, joint ventures partnerships and entrepreneurship. Although real options can enable managers to take advantage of future opportunities, using real options can also adversely affect outcomes since unlike a pure financial instrument, managers are responsible for the project underlying the real option. Not using real options effectively results in commitment, which has been shown to benefit firms by for example restricting competitors, building internal capabilities and more optimally aligning incentives. Until now, researchers have struggled to provide evidence about whether real options or commitment is optimal in specific empirical settings. To address this gap, I employ a data set of US television shows and test the how show quality is affected by the decision to produce the first episode, called the pilot, before committing to the full first season. Using the entrance of Netflix into television show production to assist with identification, I find a statistically significant decrease in overall quality when piloting is used. In addition, I provide evidence that piloting reduces the quality of the later episodes relative to shows committed to without a pilot. Interpreting each new show as a new product and a pilot as a real option on that product, these findings suggest that beyond the mitigating effect real options can have on uncertainty, managers need to consider how real options can distort the quality of the final product when evaluating whether use real options or commit.
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1. Introduction

Uncertainty underlies many of the challenges firms face (Cyert and March, 1963), ranging from changes in demand (Siggelkow, 2001) to new innovations (Nelson, 1961; Sorensen and Stuart, 2000; Henderson and Clark, 1990; Christensen, 1997). Uncertainty has therefore long been a core topic for strategy researchers (Ghemawat, 2002), resulting in a number of approaches to dealing with uncertainty, one of which involves the use of options: small investments which potentially allow the owner to take advantage of future opportunities (Bowman and Hurry, 1993). In the strategy literature, the real options approach has been recommended for project selection (Wernerfelt and Karnani, 1987), technology investments (Hurry, Miller and Bowman, 1992), joint ventures (Kogut, 1991) and well as product development (Huchzermeier and Loch, 1996). More recently, entrepreneurship researchers have recast options as experiments useful for both venture capitalists (Nanda and Rhodes-Kropf, 2016) and entrepreneurs themselves as Lean Startup’s “Minimal Viable Products” (Ries, 2011).

However, the use of real options in strategy has understudied side effects missing from its original financial context (Adner and Levinthal, 2004). These side effects derive from the close connection the firm often has with the asset underlying the real option. Consider for example the classic oil exploration example (Paddock, Siegel and Smith, 1988), where the oil company uses a lease to take an option on a plot of land. Conditional on initial testing suggesting the presence of sufficient oil, the oil company will invest further to develop land. In the strategy context, firms often invent a new product, akin to the oil company “making” the land. The incentives of the oil company’s land “inventors” to make oil-rich land could decrease if the land is tested before development and compensation is tied to development (Manso, 2011). The oil company could therefore benefit from always developing land if it incentivizes inventors to create sufficiently better land, an effort mechanism that did not exist when the oil company only explored exogenously created land.

This implies real options could run contrary to another important concept in the strategy literature: commitment (Ghemawat, P., 1991). Committing to a future course of action rather than retaining the option to change may constrain the firm in ways that are beneficial by for example preventing competitive entry (Schmalensee, 1978), fostering core capabilities (Leonard-Barton, 1992) or aligning incentives (Lerner and Wulf, 2007; Azoulay, Graff-Zivin and Manso, 2011) as in the oil example above. This begs the empirical question: do these benefits of commitment outweigh usefulness of real options for dealing with uncertainty? The majority of empirical papers studying this question have focused on whether firm level behavior aligns with theoretically optimal predictions (Hurry, Miller and Bowman, 1992; Ghemawat, 1993; McGrath and Nerkar, 2004). These papers do not address whether a specific project would have been better off under commitment or real options. Rather, they address whether firms are acting as if a tradeoff exists between the two approaches. The empirical challenge in asking what is best for a specific project has been in constructing a data set that is large enough for statistical analysis, contains projects that are comparable to each other, exhibits variation in level of commitment and allows for identification of the impact of commitment. MacCormack, Verganti and Iansiti (2001) for example provide evidence that taking real options can improve product quality but rely
on a small dataset of products as dissimilar as a web browser (Netscape 3.0) and an internet start page (My Yahoo!). Thomke (1998) restricts his sample so the projects are comparable but has variation in underlying technology rather than level of commitment.

In order to address these shortcomings, I examine the development of new television shows. The process of creating new television shows has used a real options approach long before strategy researchers advocated their use in uncertain environments. Each year in the fall, writers looking to create their own show (creators) approach US television networks with ideas. Before a new show is committed to, the networks fund the first episode, termed the pilot, akin to taking a real option on that idea. Network executives would use the pilot to solicit a quality signal, often by showing the pilot to limited test audiences (Bunn, 2002). Conditional on a positive signal, the networks would provide feedback on the pilot to creators, fund the rest of the show’s first season episodes and publicly broadcast those episodes, much like a firm taking a new a product to market after a favorable outcome for a real option.

The incumbent US television networks on average produce 300 to 400 such pilots a year, enough to construct a dataset large enough for statistical analysis. Television shows are arguably similar to each other: they are all classifiable into either comedies or dramas, run for either a half hour or a full hour and often based on similar themes of for example an anti-hero in *The Sopranos* and *Breaking Bad*. Not all shows have a pilot; a share of shows skip the pilot, providing the necessary variation in level of commitment. For identification I use an approach similar to Whinston and Collins (1992) where new entry reveals incumbent behavior. In my setting I provide evidence that the entrance of Netflix shifted some incumbent produced shows from real options to commitment due to creator bargaining power, partially addressing concerns about selection bias.

My results suggest committed shows are of higher quality than shows employing a real option, implying real options calculations that consider only real options’ mitigating effect on uncertainty can lead to its overuse by firms. In addition, I utilize the episode structure of television shows to test what mechanisms could be behind this benefit from commitment. I find the higher show quality derives primarily from higher quality episodes later in a show’s season, a pattern that consistent with mechanisms such as experience curve (Asher, 1956) or multitask incentives (Holmstrom and Milgrom, 1991) but not learning from experimental feedback (Eisenhardt and Tabrizi, 1995).

The rest of this paper proceeds as follows. Section 2 describes how both real options and commitment are used in the production of television. Section 3 uses comparative statics to derive predictions that differentiate the learning effect from the effort effect. Section 4 maps my theoretical objects of interest to the data used for this paper. Section 5 lays out my empirical strategy to test the derived predictions on the data. Section 6 provides empirical results. Section 7 discusses the paper’s results and concludes.
2. Studying Television Show Production

In order for television show production to have promise as a setting to study the tradeoff between real options and commitment, both real options and commitment must be present in television show production. In addition, there must be a way to identify any difference in show outcome as caused by the use of real options or commitment.

2.1 Real Options

Although a definition of real options as small investments which potentially allow the owner to take advantage of future opportunities is accurate, it may also be overly broad since it includes objects such as financial options which are not the primary focus of strategy researchers. Bowman and Moskowitz (2001) survey the empirical work on real options in strategy and induce an operational definition based on how the concept has been applied by strategy researchers:

A common theme in all of these decisions is that they entail the use of a two stage process: In the first stage, a small investment is made that gives the company the right to participate in the project (i.e., the company purchases the option). Some time later, when more information is known, the second stage occurs when the company faces a choice about making a larger investment in the project (i.e., the company exercises the option).

They suggest there are couple key elements to how strategy researchers have applied real options. First, there is a project being considered by a firm, ranging from investments in other firms (Kogut, 1991; Hurry, Miller and Bowman, 1992) to product development (Thomke, 1998; MacCormack, Verganti and Iansiti, 2001). Second, two distinct investment opportunities exist, an initial one that creates an option on the project and a second one that funds the project. Third, between the first and second investments, information is learned about the project which influences the decision to invest in the second stage. Empirical settings that display these characteristics will at least be consistent with how strategy researchers have operationalized real options in the past.

The production of television shows is one such setting. First, new television shows are projects under consideration for investment by firms. The incumbent television networks have historically providing the bulk of funding for new television shows by paying for the right to first broadcast the show (Blumenthal and Goodenough, 2006, p. 203). Each fall, the incumbent television networks decide which ideas for shows receive the investment necessary to produce the show. The outcome of these projects, television shows, are products in the sense of a good for sale, albeit intangible ones. Television audiences usually “pay” for watching them by consuming advertising in a bundle, but it is also common to pay for the product more directly by for example subscribing to a cable channel or purchasing a show’s DVD. Television shows are also products in the differentiated sense in contrast to commodities: although both My Little Pony and Bojack Horseman are animations about equines, a typical consumer is likely to prefer one over the other.
Second, the investment in television shows is staged. Television show production follows a yearly schedule that starts with ideas and ends with a season of show episodes. The first decision point on the part of a network is whether to take an “option” on a show idea. In return for an upfront investment, an option gives the purchasing network the right of first refusal for the script based on a show idea. After the script is created, the network can make a second investment by commissioning a pilot, a show’s first episode, based on the script. Finally, the network order the show’s first season for broadcast.

Lastly, there is uncertainty in television production that gets resolved at each stage as information about the show is learned. Ideas for shows initially are presented to the networks as treatments: a description of the show’s concept usually less than five pages long. The next stage of a show’s development, a script, typically requires an investment by the network on the order of one hundred thousand dollars and results in both the text for the first episode, running 30 to 50 pages, as well as a “bible”, a full description of all aspects of the show’s universe. The increased content gives the network more detail about the potential for the show idea. Following the script, some shows are piloted, requiring an investment of around two million dollars and resulting in the first episode of the show’s season. Beyond the network being able to now see the show idea brought to life by actors, the network is able to “test” the pilot against a live audience in a controlled environment and gain a consumer signal of the show’s quality. The networks use this additional information to inform the decision of whether to “greenlight” the show, or produce the rest of the show’s first season for broadcast.

2.2 Commitment

These aspects of an evaluated project, staging of investments and uncertainty resolution suggest real options underlie television show production; in addition, commitment is present. Ghemawat (1991) defines commitment as earlier choices that constrain later ones. He calls out three characteristics projects must have for investments in them to be considered commitments. First they must be durable in the sense of being long lasting and affecting future decisions. Second, the must be specialized in that not all future courses of action are enabled by them. Third, they must be untradeable; significant frictions must prevent a firm from offloading a committed investment.

A network that skips a stage of the television production process is committing to the project in a way consistent with Ghemawat’s definition of commitment. Durability manifests in television when for example skipping the pilot by directly greenlighting a script means one less funding slot available for the shows that are piloted. This could lead to a piloted show not getting funding even if post-pilot it appears better than the previously committed show. Shows are specialized in that a committed show that attracts a small audience will not enable the network to generate as much revenue as a show attracting a large audience. Show commitments are also not tradable between networks since the content needs and audience demographics vary even between the major national networks; a diverse comedy like ABC’s Modern Family would be an unlikely fit for CBS (Canfield, 2016).
In television, the staging of production across script, pilot and first season is akin to the use of real options. Skipping one of these stages is in contrast commitment to the show. The network’s decision of whether to pilot a script or directly create the first season is a tradeoff between real options and commitment.

2.3 Netflix

The fact that networks decide whether a script will be piloted or not implies selection bias is an identification challenge in my setting. If for example there is positive correlation between committed shows and outcomes, the networks could be picking better ex-ante shows for commitment and commitment itself could have zero or even a negative effect on outcomes. Therefore, in order to move beyond descriptive statistics I need evidence that at least some shows shifted between piloted and not piloted unrelated to the ex-ante potential outcome of the show.

To that end I focus on Netflix’s entry into television show production. Previously known as an online streaming distributor of film and television content, Netflix began funding new television production in 2011. Revealed preference on the part of show creators indicates Netflix’s later success was an unexpected shock to the rest of the industry: Netflix was initially only attracting show ideas that everyone else had passed on (Dawn, 2013). One of the reasons Netflix committed to shows by skipped the pilot was the need to prove their own commitment to television (Weisman, 2014); no one wanted to make a pilot for a new entrant that might quit the industry without making a single show. Another reason is related to the technological change Netflix represented as a streaming service. Unlike traditional broadcast networks that could only broadcast a fixed number of shows each week during prime time hours, Netflix faced no such capacity constraint. For Netflix, even a poor show was one more show that could attract viewers on their service (Weisman, 2014); piloting has little value when a show was worth developing regardless of signal. Finally, capabilities may have played a role: Netflix only had one person assigned to developing new shows (Weisman, 2014).

In 2013 two of Netflix’s shows, Orange Is the New Black and House of Cards, won both Golden Globe and Emmy awards. Afterwards, revealed preference changed, Netflix turned into a desirable place for creators to bring new show ideas (Adalian, 2013). In addition, the incumbent networks began skipping pilots for their own shows, both because Netflix’s success suggested commitment could pay off and in fear of losing shows to Netflix since show creators preferred commitment by the networks (Adalian, 2013). I term these two rationales a learning effect and a bargaining effect: learning because the incumbent networks learned about the returns to commitment and bargaining because the outside option of creators improved.

For identification to be plausible, at least one of these effects needs to be uncorrelated with outcomes. For the learning effect, the types of shows that would benefit from commitment should not in general be the better shows, perhaps somewhat implausible. For the bargaining effect, there needs to be some creators with greater bargaining power that are of the same quality as creators with lower bargaining power, perhaps more plausible. In the next section I provide
theoretical predictions that can help determine whether either of these effects is uncorrelated with outcomes.

3. Theoretical Predictions

5.1 Modelling Real Options versus Commitment

The existing strategy literature is missing a formal model of the decision to take a real option on a project versus committing to it. The foundational theory used by real options researchers studies sequential decisions to invest across multiple stages (Roberts and Weitzman, 1981; McDonald and Siegel, 1986; Majd and Pindyck, 1987) and therefore focuses on answering questions such as when it is optimal to stop investing rather than when to commit by investing for more than one stage at once. The existing empirical work testing multi-stage investments (Thomke, 1998; MacCormack, Verganti and Iansiti, 2001) does not formally model the decision and provide comparative statics.

To fill this gap, I take advantage of the experimentation approach used by Nanda and Rhodes-Kropf, (2016) in the entrepreneurial finance literature. In their paper they illustrate the use of staging investments by venture capitalists to overcome the uncertainty inherent in startups. The tradeoff faced by venture capitalists is not unique; it more generally applies to the decision managers need to make about committing to a project versus deploying real options to resolve uncertainty.

Let $V$ be the final value of a successful product for a particular market and $0$ be the value of an unsuccessful product. A product is successful with probability $\theta$. Creating a product has fixed cost $c$ associated with it, regardless of success. The decision maker can choose to use real options to make a small investment on the product with incremental cost $e$. With probability $p$, the small investment leads to positive information signal, indicating that product will be unsuccessful. By Bayesian updating, the product has probability $\frac{\theta p}{p}$ of being successful conditional on a positive signal. Let $\lambda = 1$ represent the decision to experiment on the product. The decision maker therefore maximizes:

$$\max_{\lambda \in [0,1]} \lambda (p(\frac{\theta}{p} V - c) - e) + (1 - \lambda)(\theta V - c)$$

(1)

The Appendix provides comparative statics under this model.

How might equation 1 apply to a network’s decision to pilot a particular television show idea $i$? Each idea likely varies in probability of success $\theta_i$ and information contained in the pilot signal $p_i$: a creator with a long history of successful shows like Ryan Murphy (Nussbaum, 2018) may have a higher probability of success $\theta_i$ and higher chance of positive pilot signal $p_i$. Conditional on a positive pilot signal received with probability $p_i$, the network will order a season
of episodes to broadcast. I assume the value of a successful product for a network $V$ is not going to vary by $i$: $V$ is determined more by the network’s audience size and the uncertainty lies in whether show $i$ will be a “hit” with probability $\theta_i$. Pilots cost more than an average episode to produce due to for example the shorter-term labor contracts involved (Anonymous Emmy Nominated Producer, 2017). Evaluating the pilot is another expense the networks must consider (Bunn, 2002). $e$ represents both these production and signal evaluation costs. From network’s perspective, cost $c$ is primarily a fee payed to the creator of a show for the right to broadcast the show. I also assume show specific characteristics other than the main scripted genre categories of drama and sitcoms do not affect $e$ or $c$. Networks do not consider the cost of a specific script when making pilot or series order decision for a script (Anonymous ABC Executive, 2017). Although a show on HBO will cost far more than one on ABC, variance in cost between two scripts is lower within the same network. Cost is instead involved when determining the total number of scripts to pilot or order to series; in 2006 NBC for example chose to reduce the number of scripted dramas it ordered rather than attempt to reduce the cost per drama (Barnes, 2006).

For the decision to pilot a particular television show $i$, equation 1 therefore becomes:

$$\max_{\lambda_i \in \{0,1\}} \lambda_i (p_i (\frac{\theta_i}{p_i} V - c) - e) + (1 - \lambda_i)(\theta_i V - c)$$

(2)

Under this model, the decision to pilot is decreasing in $p_i$. Intuitively, if a show has a high probability of having a good pilot, the cost of experimentation $e$ may not be worth paying.

Suppose there is a characteristic $z_i$ of the scripts that increases $p_i$, without loss of generality to the case it decreases $p_i$. Given our assumptions about $V$, $e$ and $c$ being fixed, we would expect increasing $z_i$ to cause an increase in skipping the pilot phase, an increase in commitment.

**Proposition 1:** Let $z_i$ be a show characteristic that increases (decreases) $p_i$, the probability of a positive pilot signal, and $x_i$ be a show characteristic that that has no effect. If the networks are trading off commitment versus real options, $z_i$ should also correlate with a higher (lower) probability of commitment while $x_i$ should have no correlation with commitment.

### 5.2 Bargaining

Beyond showing that pilots were unnecessary to create a critically acclaimed television show, there is evidence that Netflix, as an entrant committed to skipping pilots, changed the bargaining relationship between incumbent networks and content creators (Adalian, 2013). However, a shift in bargaining power away from the networks doesn’t necessarily mean networks are going to commit more often.

**Proposition 2:** Netflix’s successful entry should not affect the decision to experiment under standard cooperative bargaining models.
The appendix contains a more formal mathematical argument, but the intuition behind proposition 2 is that every bargaining agent is always best off by maximizing the total value generated by the group. Before Netflix’s entry, the networks would only be selecting piloting if the expected payoff from piloting is higher than from skipping the pilot. Because piloting generates more value and the network’s decision does not affect the fraction of value allocated to itself, the networks should always prefer piloting. Netflix’s entry just affects the share of surplus shared with show creators and the networks will always be better off with a share of the larger piloting surplus than the smaller skipping pilot surplus. To put it another way, Netflix improved the outside option of show creators, which although could have affected whether it was rational for the network to fund a script at all, could not have affected the decision to fund that script at the pilot or full series level.

Based on interviews with content creators, many prefer a show commitment from a network over a pilot offer. The commitment ensures their work will be seen by the public whereas “if you do a pilot and it doesn't get picked up, you don't have anything”, to quote Sex and the City director Allison Anders (Bunn, 2002). This preference for commitment stands in contrast to the actions of the networks, which overwhelmingly chose to pilot shows. If the preference of creators for commitment was uncompensated (England, Farkas, Kilbourne and Dou, 1988) prior to Netflix’s entry, afterwards the rate of commitment would go up. In addition, creators with stronger bargaining power would be more likely to secure a network’s commitment.

Proposition 3: If show creators were previously uncompensated for the disutility of piloting, Netflix’s entry should reduce the network’s payoff from real options relative to commitment, leading to an increase in piloting. In addition, given two shows with the same expected payoffs from real options and commitment, the show attached to a creator with higher bargaining power is more likely to skip the pilot.

There are two parts to proposition 3. First, Netflix’s entry forces the networks to compensate creators for their disutility from commitment; the networks would lose creators to Netflix without this compensation. If the uncompensated version of the real options payoff for the networks is not too much higher than the committed payoff, compensating creators can make the networks prefer commitment to real options. Second, when a show’s creator has high bargaining power, the network is already giving a large share of show rents to the creator, to the extent it is constrained from giving an even larger share once Netflix enters. In this case, the network would switch to commitment after Netflix’s entry because compensating for real options is not possible. Again, more formal arguments are provided in the appendix.

The second part of proposition 3 gives us an opening for potentially identifying the effect choosing real options over experimentation. The networks would be selecting between real options and commitment not based on the expected payoff from the show, but because of bargaining power which could have low correlation with payoffs.
5.3 Upside of Commitment

Adner and Levinthal (2004) point out that much of the strategy theory used to understand real options derives from the finance real option literature where the option holder and underlying asset holder are two distinct entities. They suggest this foundation ignores challenges to executing real options that firms face as holders of both the option and the asset, specifically the difficulty firms face in terminating projects. But project termination is not the only way the tradeoff between real options and commitment could be different in strategic contexts versus the traditional financial one. Real options could for example affect product values due to multitasking (Holmstrom and Milgrom, 1991): if the project team’s effort to increase a positive experimentation signal detracts from the effort required to increase the value of the final product, experimentation on a project could result in lower final product quality. Another mechanism could be uncompensated worker preferences (Bonhomme and Jolivet, 2009): high quality team members may avoid projects under experimentation since experimentation reduces job security.

This setting is does not provide the ideal experiment to test this tradeoff between experimentation and commitment; shows are not randomly assigned between pilot and skipping the pilot by the network. To illustrate consider a version of the network’s decision function that includes a fixed, non-stochastic term $V_c$, an upside of commitment:

$$\max_{\lambda_i \in \{0, 1\}} \lambda_i \left( \frac{\theta_i}{p_i} (V - c) - e \right) + (1 - \lambda_i) \left( \theta_i (V + V_c) - c \right)$$

Calculating the observed difference in mean outcome of an unpiloted show above a piloted show would be estimating:

$$E[\theta_i (V + V_c) - p_i c - e < \theta_i V_C - c] - E\left[\frac{\theta_i}{p_i} V | -p_i c - e > \theta_i V_C - c\right] \neq \theta_i V_c$$

which would not enable us to sign $V_c$ due to two opposing sources of bias. First, it's reasonable to expect positive correlation between $p_i$ and $\theta_i$ which would lead to “better” shows selected into the skipped pilot set, the effect of different conditional expressions above. Second, attrition of piloted shows that are not ordered to series could lead to “better” shows selected into the piloted set, the effect of replacing $\theta_i V$ with $\frac{\theta_i}{p_i} V$ for piloted shows above.

However, having controls $X_i$ for commitment could mitigate the first source of bias and enable testing of whether $V_c$ is positive.

$$E[\theta_i (V + V_c) - p_i c - e < \theta_i V_C - c, X_i] - E\left[\frac{\theta_i}{p_i} V | -p_i c - e > \theta_i V_C - c, X_i\right] = E[\theta_i (V + V_c) | X_i] - E\left[\frac{\theta_i}{p_i} V | X_i\right] = E\left[\frac{p_i - 1}{p_i} \theta_i V + \theta_i V_c | X_i\right] > 0 \Rightarrow V_c > 0$$

**Proposition 4:** Suppose there exists $X_i$ which controls for the selection of whether to experiment on show $i$. Then the difference in outcomes between committed and experimented shows controlling for $X_i$ will be positive only if there is an upside to commitment.
However, much of the debate about piloting within the television industry is about how the arc of episodes is affected by the decision to pilot. On one side, pilots can force a back and forth between a show’s creators and the network executives that could improve a show’s overall quality (Andreeva, 2014). The alternate view is, to quote Garrett Schneider of the Writer’s Guild of America, television shows are now ten hour movies. Would it ever make sense to order just the first twelve minutes of a two hour movie before funding the rest? Under this view, executing on the entire show at once ensures consistency of effort across all the episodes (Adalian, 2013). Of course, there could also be no relative difference between the first and later episodes. If for example planning improves the overall quality of all episodes (Delmar and Shane, 2003) and piloting sub-optimally curtailed piloting, then all shows might suffer equally from piloting relative to commitment.

**Proposition 5**: Under a model where networks use pilots to improve show quality, the pilot of committed shows should be better relative to later episodes. Under a model where effort influences the probability of a show passing the pilot phase, the pilot of committed shows should be worse relative to later episodes. Under a planning model where piloting a show forces the creators to spend a less than optimal amount of time on planning out the full season, all episodes would benefit similarly from commitment.

The appendix includes examples of such models.

### 4. Data and Measures

To empirically test the above propositions, I pool data from three sources: Gracenote, Film L.A., and the Internet Movie Database (IMDB). Gracenote, a subsidiary of Neilson Holdings, has a dataset provided commercially to the television industry. A record is made whenever a network makes a public announcement of investment in a show idea, by for example paying a writer to produce a script. Metadata is associated with each show such as genre and person responsible for the show’s production, it’s showrunner or primary creator. Film L.A. is a non-profit dedicated to facilitating film and television production in Los Angeles. They have a proprietary dataset which tracks the production of scripted US television starting at the pilot phase. Importantly, the dataset flags shows that skipped the pilot phase, a variable crucial to this paper’s analysis. IMDB, a subsidiary of Amazon.com, has a public dataset which includes ratings for shows that made it to a public airing on a network.

I match shows between Gracenote and Film L.A. using a combination of show title, alternative titles, network and year. As a publicly curated dataset, IMDB often has more variation in the titles associated with each show; bigram matching is used to add the IMDB data. Table 1 provides summary statistics for the combined dataset.

[Insert Table 1 about here]

The data is restricted to the incumbent networks that circa 2008 were consistently producing scripted television. This includes the prestige networks that would win Emmy or
Golden Globe awards (ABC, NBC, FOX, CBS, HBO, FX, USA, Showtime and AMC) as well as smaller networks (CW, Freeform, TNT, Lifetime, SyFy). When Netflix won its own Emmy and Golden Globe awards, it essentially successfully entered the business of high quality, scripted television production. By restricting my dataset to these 14 networks, my analysis is focused on the incumbents’ reaction to Netflix’s successful entry.

Since the Film L.A. dataset is only contains shows between 2008 and 2017, all observations of shows outside those years in the other datasets are dropped. Data for 2017 is currently only partially available. The years used are season years; for example, the 2008 season year runs from September 2008 to August 2009.

Show length is provided by Film L.A. and helps distinguish between the shows most affected by Netflix’s entry. Half hour scripted shows primarily consist of situational comedies (sitcoms) like Modern Family, a very different product from Netflix’s House of Cards or Orange is the New Black. Although Netflix started making full hour shows in 2012, half hour shows were not made by Netflix until 2015.

The funnel from script to pilot to series is represented by the Script rows in Table 1. I restrict my data to show ideas that were developed in some way, either with a piloted or ordered straight to series. In the period prior to Netflix’s success, 52% of piloted shows were eventually ordered to series. Afterwards, the order rate for pilots dropped to 44%. In addition, prior to Netflix’s success, only 3% of such shows skipped the pilot phase, or to use the industry term, went straight to series. This jumped to 14% after 2013. For more details about the stages that scripts pass through, see the Appendix.

IMDB provides show ratings at both the show level and episode level for all broadcast shows. My primary outcome variable is an average of episode ratings for the show’s first season. Figure 2 provides a histogram of this first season IMDB rating. Since the distribution of ratings is skewed due to the mean being much closer to the upper cutoff of 10 than the lower cutoff of 1, heteroskedastic errors are used in all this paper’s regressions.

Table 2 shows correlation between IMDB ratings and two other measures of show performance: the renewal decision made by the networks and winning a major Emmy or Golden Globe award. IMDB ratings have a much stronger relationship with renewal than awards, suggesting it may be a better measure of a show’s financial rather than critical success.

The Gracenote dataset starts in 1980 and can be used to construct variables indicating the prior history of a show’s associated personnel. To classify the reputation of the creators of a show, I focus on each’s shows set of executives, termed Executive Producers. Executive Producers are credited as the most important personal on a show and includes the showrunner. If any of a show’s Executive Producers had a previous show that won a major Golden Globe or Emmy award, the show is marked with Exec Producer with Award.
Finally, Independent Funding indicates the show is not associated with any of the major studios that typically fund television: ABC, NBC, FOX, CBS, Sony or Time Warner. These 6 studios act as gatekeepers for television production; less than 20% of shows make it on the air without one of them backing a show. I consider getting an independent source of funding as correlated with bypassing these studios and the usual network decision making process about which shows to fund. An example of such a show would be Anger Management, a sitcom funded by the independent studio Lionsgate Television as a vehicle for Charlie Sheen to return to television after he was kicked off Two and a Half Men for substance abuse (Andreeva, 2011; Dillon, 2012).

5. Empirical Framework

5.1 Divining Network Behaviour

The first three propositions are about understanding the decision making process used by the networks. The first proposition asks whether characteristics correlated with a positive pilot signal are the only ones that correlate, in the same direction, with skipping the pilot, that’s suggestive of the networks trading off real options versus commitment for each show. The second proposition is perhaps simpler: did Netflix’s successful entry change the share of committed shows? If not, then standard cooperative bargaining could be taking place. The third asks two separate questions. Are there characteristics that do not correlate with pilot signal and yet do correlate with skipping the pilot? And if so, are those characteristics in turn uncorrelated with measures of show quality?

Trading Off Real Options versus Commitment

There are three corresponding sets of regressions necessary to test these propositions. First, regressing show observables against both the probability of a positive pilot signal and the probability of skipping the pilot will test both propositions 1 and 3.

My data does not include a direct measure of the pilot signal viewed by the network. Instead, I have information about whether a piloted show was ordered to series which I interpret as a binary measure of pilot signal: a piloted show must have had a sufficiently positive pilot signal to be ordered to series. I use a linear probability model to estimate the correlation between a show’s observables and whether was ordered to series. I provide estimates for two periods, one before Netflix’s success and one afterwards. I restrict my observations in both periods to piloted scripts. Prior to Netflix’s entry, almost all shows were piloted so perhaps the regression under the first period is a better measure of an unconditional correlation between show characteristics and a series order after pilot.

\[
PilotToSeries_{int} = \alpha + \delta_t + \beta X_t + \epsilon_{int} \tag{3}\]
In equation 3, \( i \) is a new show that was piloted. \( n \) is one of the incumbent networks that regularly produced scripted television shows over my time period of study. \( t \) is the season year the new shows came up for consideration. \( \text{PilotToSeries}_{int} \) is an indicator for whether the piloted script was ordered to series. \( X_i \) is a set of indicator observables for each show. \( \delta_t \) is a dummy for the year of the script’s production and \( a_n \) is a dummy for the network making the decision. The purpose of equation 2 is to find \( X_i \) other than genre that significantly affect the prediction of \( \text{PilotToSeries}_{int} \).

Next, I estimate the correlation between show observables and skipping the pilot phase.

\[
\text{SkippedPilot}_{int} = \alpha_n + \delta_t + \beta X_i + \varepsilon_{int} \tag{4}
\]

In equation 4 I include both piloted shows and shows ordered without a pilot. \( \text{SkippedPilot}_{int} \) indicates whether the show skipped the pilot phase.

The decision to order a piloted script or order a script straight to series may be correlated with other observations the same year for the same network. For example, networks typically have a target number of new shows they want to bring to market in a given year based on the strength of their existing show lineup. If one pilot is ordered to series, it may negatively impact another pilot’s chances of being ordered. Therefore both equations 3 and 4 are clustered at the network cross year level.

**Cooperative Bargaining**

Equations 3 and 4 test proposition 1; if the set of coefficients that are correlate with a successful pilot phase are the same that predict skipping the pilot, then the networks could be primarily trading off real options versus commitment in their decision making. Testing proposition 2 requires us to contrast the pre-Netflix regime with the post-Netflix regime. Each network \( n \) in year \( t \) has its own rate of skipping pilots. Proposition 2 makes a causal claim that the rate of piloting shifted as a result of Netflix’s success:

\[
\beta \equiv E[\text{SkippedPilot}_{nt}|\text{NetflixSuccessful} = 1] - E[\text{SkippedPilot}_{nt}|\text{NetflixSuccessful} = 0] > 0
\]

I of course do not observe a rate of skipping pilots for a given \( n \) and \( t \) both treated and untreated by Netflix’s success. One option to identify \( \beta \) is to solve for:

\[
E[\text{SkippedPilot}_{nt}|t > 2013] - E[\text{SkippedPilot}_{nt}|t \leq 2014]
\]

However, this leaves open the possibility of time trends in piloting or other non-Netflix time shocks to the decision to pilot. To overcome this, I take advantage of a natural division in length, \( l \), of a show. Each network has some full hour scripts, \( l = 1 \), and some half hour scripts, \( l = 0 \). Since full hour shows (dramas) tend to be a materially different product from half hour shows (situational comedies) and Netflix initially only made full hour shows, I consider full hour shows as treated with half hour shows as controls. This leads to the difference-in-difference equation:
\[
(E[\text{SkippedPilot}_{nt}|t > 2013, l = 1] - E[\text{SkippedPilot}_{nt}|t \leq 2014, l = 1])
- (E[\text{SkippedPilot}_{nt}|t > 2013, l = 0] - E[\text{SkippedPilot}_{nt}|t \leq 2014, l = 0])
\]

I therefore use a difference-in-difference linear probability model on repeated cross-sectional data to estimate $\beta$. Since in my data I observe the pilot decision per script rather than by network-year directly, I use the Regression CEF Theorem (Angrist and Pischke, 2008) and the definition that for script $i$ considered by network $n$ in year $t$:

\[
\text{SkippedPilot}_{nt} \equiv E[\text{SkippedPilot}_{i}|n, t]
\]
to motivate my empirical test of Proposition 2.

\[
\text{SkippedPilot}_{init} = \alpha_{nl} + \delta_{Post2013} + \gamma X_i + \beta \text{FullHour}_t \times \text{Post2013}_t + \epsilon_{init}
\]  
(5)

In equation 5, $i$ is a show idea that made it past the script phase; it was either piloted or ordered straight to series. $n$ is one of the incumbent networks that regularly produced scripted television shows over my time period of study. $t$ is the season year the new shows came up for consideration. $l$ is the length of show, either half hour or one hour. $\text{SkippedPilot}_{init}$ is an indicator for whether the script was ordered to series without a pilot. $\alpha_{nl}$ represents two fixed effects per network, one for full hour shows and another for half hour shows. $X_i$ has script specific characteristics such as the background of the script’s creator. $\text{FullHour}_t \times \text{Post2013}_t$ is an indicator that is positive for new full hour shows after 2013 while $\text{Post2013}_t$ is an indicator for new shows after 2013. Equation 1 does not include a $\text{FullHour}_t$ fixed effect since it is absorbed by the $\alpha_{nl}$ term.

The coefficient of interest is $\beta$. I expect its value to be positive if Proposition 2 is true; Netflix’s success did increase the rate at which shows skipped the pilot phase on incumbent networks.

To illustrate that the pre-trend requirements for a difference-in-difference estimator hold, I also estimate equation 1 where the treatment effect is measured per year.

\[
\text{SkippedPilot}_{init} = \alpha_{nl} + \delta_t + \gamma X_i + \beta \text{FullHour} \times \text{Year}_t + \epsilon_{init}
\]  
(6)

I cluster the estimation of equation 5 and 6 at the network cross script length level, which is consistent with the existing difference-in-difference best practice of clustering at the level of control and treated groups invariant of time (Bertrand, Duflo and Mullainathan, 2004).

Uncompensated bargaining

Equations 3 and 4 test part of proposition 3: they will uncover any covariates that correlate with commitment that are uncorrelated with a positive pilot signal. If these covariates are reasonable proxies for the creator’s bargaining power, they can assist with identification as long as they are otherwise uncorrelated with show outcomes. To complete the evaluation of proposition 3, I use a fixed effect model that run separately in the pre-Netflix and post-Netflix regimes:
In equation 6, \( \text{FirstSeasonRating}_{int} \) is the average IMDB rating of a show’s first season episodes. In equation 7, \( \text{Renewed}_{int} \) is a binary indicator of whether the broadcasted show was renewed. These two outcomes are both highly positively correlated and indicative that the show was in some way successful; I view \( \text{FirstSeasonRating}_{int} \) as a finer measure of success than \( \text{Renewed}_{int} \). \( Z_i \) in both equations represents the set of covariates that correlate with commitment but not the pilot signal from equations 3 and 4 while \( X_i \) is the remainder of the covariates. If \( \beta \) is insignificant in both equations 6 and 7, this supports that \( Z_i \) shifted bargaining power without affecting the underlying quality of the television show.

5.2 Trade-off between Real Options and Commitment

For proposition 4, I use a fixed effect model that controls for commitment predictors to seek evidence the decision to experimentation can affect the underlying value of the product.

\[
\text{FirstSeasonRating}_{int} = \alpha_n + \delta_t + \beta \text{SkippedPilot}_i + \gamma X_i + \varepsilon_{int}
\]  

(8)

In equation 8, \( \text{FirstSeasonRating}_{int} \) is the average IMDB rating of a show’s first season episodes. \( X_i \) are the variables that predicted a show skipping the pilot in table 3. Again, \( \beta \) is the variable of interest that indicates the improvement in show quality from skipping the pilot.

The tension between real options and commitment comes down to the level of uncertainty; I hypothesize when the environment is uncertain, real options provides the benefit of weeding out bad investments and when the environment is certain, commitment shines by improving product outcomes. To test this relationship, I divide my dataset by whether a show has an executive with a prior award and run equation 8 separately on each subset. The set of shows that lack executives with a track record of success corresponds to the case where uncertainty is high; here we should expect commitment to be hurtful as shows that would not usually pass the pilot phase receive funding. In contrast, for the set of shows that have award winning executives there is less uncertainty about the show’s underlying quality so there is little to gain from piloting.

It is possible for any of estimates using equation 8 to suffer from selection bias; perhaps the networks are picking “better” shows for commitment so any positive value of \( \beta \) simply reflects better shows rather than a true upside to commitment. To address this, I use a triple difference estimator that aggregates shows at the network level:
\[
\text{AverageRating}_{nit} = \gamma_{\text{FullHour}} + \delta_{\text{Post2013}} + \lambda_{\text{ShareCommitted}} + \theta_{\text{FullHour}} \\
\times \text{Post2013} + \rho_{\text{FullHour}} \times \text{SharedCommitted} + \kappa_{\text{Post2013}} \\
\times \text{SharedCommitted} + \beta_{\text{FullHour}} \times \text{Post2013} \times \text{SharedCommitted} \\
+ \epsilon_{nit}
\]

Aggregation at the network level side-steps the selection issue; if a network is selecting the better shows for commitment and commitment has no inherent value, the network’s portfolio of shows would show no improvement in rating. A diff and diff version of equation 9 might compare the average rating of each network’s yearly portfolio of new shows before and after Netflix’s entry with the share of committed shows as an intensity of treatment variable. However this leaves open the possibility of network selection: are the networks that decided to commit more often to shows the same ones that were improving over this period anyway? The triple difference controls for this by looking within the network at both hour long shows and half hours shows. If a network improvement over time impacts both types of shows equally, then network selection is addressed by the triple difference estimator. Equation 5 provides evidence that the shock affected hour long shows more relative to full hour shows, so the estimate of  \( \beta \) in equation 9 provides a measure of how much marginal rating improvement occurred from the increase in committed full hour shows relative to half hour shows.

Then to test Proposition 5, I break out episodes by their number:

\[
\text{EpisodeRating}_{eint} = \alpha_{n} + \delta_{i} + \lambda_{e} \text{EpisodeNumber}_{e} + \beta_{e} \text{EpisodeNumber}_{e} \\
\times \text{SkippedPilot}_{i} + \gamma X_{i} + \epsilon_{eint}
\]

In equation 10, \( i \) still represents a show but now \( e \) represents one of the show’s episodes, specifically an episode that was part of a show’s first commitment; the follow on order if a show was piloted or the initial order if show was not piloted. \( \text{EpisodeNumber}_{i} \) is the order number of an episode’s broadcast. \( \lambda_{e} \) picks up a trend for how the quality of a piloted show evolves over its episodes while \( \beta_{e} \), the coefficient of interest, is how the quality of shows that skipped pilots evolve differently than piloted shows.

6. **Empirical Results**

[Insert Table 3 about here]

Table 3 both tests whether the incumbent networks used a real options decision model and whether bargaining may have played a role. Between 2008 and 2013, column 1 identifies two strong indicators that a show would pass the pilot stage, the length of the show and an award-winning producer. Both raise the baseline 33% pass rate of pilots to close to 45%. These two indicators are at most a weak predictor of commitment in column 2, suggesting at least in this
period a real options decision model was not being used. Independent funding, perhaps reflecting increased bargaining power, does correlate with commitment. In contrast between 2014 and 2017, after Netflix’s entry, the show length does matter to the commitment decision, increasing the rate of commitment by 13%. Independent funding again shows a correlation with commitment, perhaps more significant here relative to column 2 because of the higher frequency of straight to series observations. A simple real options versus commitment tradeoff could not fully explain the observed correlations; the networks could have been influenced by changes in bargaining power.

[Insert Table 4 about here]

Column 1 of table 4 suggests that the rate of scripts being ordered straight to series increased by 10%. Prior to Netflix’s success, about 3% of scripts skipped the pilot phase so this is a large shift in the way television is produced. Columns 2 and 3 show this relationship is robust to various fixed effect approaches. Figure 3 plots the yearly treatment effect corresponding to column 1 of table 4.

[Insert Figure 3 about here]

This change in rate of commitment would be consistent with a change in bargaining under uncompensated differentials, as would the Table 3’s positive relationship between independent funding and commitment and lack of relationship between independent funding and piloting success. Prior to Netflix’s entry, the industry’s equilibrium had all the incumbent networks pilot shows and not compensate the creators of shows for this lack of commitment. After Netflix’s entry, some show creators were able to use Netflix’s commitment as an outside option to negotiate commitment on incumbent networks. Since the networks were picking commitment based on bargaining power which could at times be orthogonal to inherent show quality, an estimate of the difference in quality between committed and piloted shows could represent something beyond selection bias.

[Insert Table 5 about here]

Table 5 supports this argument by showing not all of the predictors of commitment correlate with show quality outcomes. Although show length is highly correlated to both IMDB quality ratings, award winning executives and independent funding are not. The relationship between show length and quality most likely stems from the relationship between length and genre: hour long shows tend to be more involved dramas like *Game of Thrones* or *The Sopranos* which on average get higher ratings than half hour sit-coms.

[Insert Table 6 about here]

Table 6 provides OLS estimates of the relationship between commitment and show quality. Column 1 in Table 6 shows no strong relationship between commitment and show quality in the overall dataset when controlling for show length, executive awards and independent funding. However, when we focus on the subset of shows with award winning executives in column 3, we do get a positive relationship between commitment and show quality. The magnitude of the change is about half a standard deviation in show rating, not enough to make a mediocre show great but
meaningful nonetheless. The fact that this effect occurs in within the pool of executives suggests something other than selection bias is driving the result; the shows with award winning executives are exactly the ones likely to be selected into the commitment group. Column 2 suggests a possible answer: known good shows benefit from commitment while shows of unknown quality benefit from real options. The shows without award winning executives do worse under commitment; perhaps the pilot provides useful information about whether those shows are worth further investment.

[Insert Table 7 about here]

Column 3 of Table 7 supports the OLS results in Table 6 by showing the portfolio of a network’s shows with award winning producers improved from commitment. The network selecting better shows for commitment by itself could not affect the quality of its overall portfolio. The point estimate is consistent with Table 6’s results; from Table 4 about 11% of a network’s portfolio of hour long award winning executive shows were shifted to commitment. Table 6 presents the effect if all shows were moved to commitment; 11% of 2.1 rating points is in the same order of magnitude of Table 4’s 0.3 estimate. Although selection bias is likely to be present, the bulk of Table 4’s estimate could be from the benefits of commitment.

[Insert Figure 4 about here]

Finally figure 4 plots the improvement of each episode of a commitment show’s initial run relative to the first, pilot episode. The later episodes seem to be of higher quality than the first episode, suggesting the mechanism behind the upside of commitment may involve optimizing the effort put into the first episode relative to the rest of the season.

7. Conclusion

This paper provides evidence for three main points. First real options improves outcomes when there is uncertainty about the value of the underlying project; it effectively avoids investment in poor projects. Second, when there is certainty about project value, the benefits of commitment outweigh any potential gains from the pruning function of real options. Third, incentives that distort effort towards passing the option phase could be at the core of the tension between real options and commitment.

These results can apply broadly to a number of different areas within strategy. Take venture capital investment as one example, where the contrast between real options and commitment manifests as the amount of funding provided to a startup. A venture capitalist should take a real option on startup created by an unproven group of recent college grads by funding the startup for a short period of time; there is too much uncertainty about final outcomes. However, an experienced serial entrepreneur with a new company idea might warrant a larger upfront investment from venture capitalist that funds the startup for a longer period of time. Not only is it more efficient from a real options standpoint to avoid the extra costs associated with reviewing the startup’s progress after a short period and renewing funding, it also could incentivize the
entrepreneur to focus on the startup’s long term success rather than the requirements to meet its next short term funding goals.

If this is true, why didn’t the incumbent television networks make more use of commitment before Netflix’s success? Short-term incentives (Baker, 1992) could explain this sub-optimal use of real options by incumbent networks. The networks bias their evaluation of a broadcasted show’s success towards the outcome of the show’s first episode. Since the early days of television, advertisers have pre-paid for slots on new television programing, the pre-payment being used to fund the development of those new shows. In return, the networks guarantee to deliver a certain number of viewers to those advertisers. When a new show falls short, the networks must provide advertisers with “make goods”; free advertising on their network until the gap is closed (Vogel, 2015). A new show that underperforms therefore eats away at a network’s revenue by forcing the network to give away advertising it would otherwise charge for, leading the network to kill shows early that miss targets (Angwin and Vranica, 2006). The networks may lack the ability to change relational contracts with advertisers to improve television shows (Gibbons and Henderson, 2012).

8. Appendix

5.3 Television Production Primer

The production function of a television show can be broken into five stages.

Pilot

Based on the success of shows in the current season, the network has some idea of how many slot will be open for new shows the following season. For each slot, the network picks 2 to 3 scripts from its pool of optioned scripts to pilot. Pilot involves funding the production company to make the first episode of the series. Pilot is the first stage of decision making where the needs of a vertically integrated studio and network are jointly optimized by an executive in charge of both.

Treatment

Ideas for shows can come from a variety of places; a writer might come up with a plot idea for a new show or a network executive might wonder how a book would translate into a television series. The first tangible step after someone has an idea is the drafting of a log-line or synopsis (treatment) of the idea that captures the main setting and how the story might evolve over the course of a series. Since production companies and studios are deficit financed (they take a loss when a show is originally broadcast on TV hoping to recoup during syndication), there is an interest in selecting ideas that have the potential to generate the approximately 100 episodes necessary to warrant a syndication deal. High level talent has first look deals with production
companies or studios. This means ideas (or if at later stage scripts) must be rejected by the production company or studio before it can go on the open market.

*Script*

Treatments are pitched to network executives. Agents act as brokers that match ideas to networks and gate keep access to network executives. Networks are looking for ideas that are a good match for their audience. Although there are some demographic target differences between ABC, NBC, and CBS, in general similar content would appeal to all the broadcast networks. On the other hand an idea that is suitable to Lifetime probably isn't going to be interesting to Syfy. Any treatment that is judged to have the potential be successful on the network is funded for pilot script as well as a “bible”, a full description of all aspects of the show’s universe. Scripts typically cost on the order of $100k and may have a penalty attached to them if the network opts not to shoot or air a pilot. Penalties are generally attained by producers or writers with a proven track record to incentivize the network to follow through on production rather than have the script die after purchase. Scripts (or pilots) that are abandoned by the network can be pitched to other networks after the network’s option period has expired.

It's possible in a vertically integrated firm that the seller of the script and the network are part of the same firm. Decision making here is usually made separately by each side. The studio selling the script to the network made its own decision on what treatments to pitch. The network independently decides what of the studio’s treatments to finance into scripts. The studio within a vertically integrated firm has the advantage of potentially having insider information about what kinds of scripts are desired by the network. The vertically integrated network can be thought of as having the right of first refusal on treatments by the “sister” studio.

*First Season*

The network now decides which pilots to green light for production. On the extensive margin, some existing shows that executives hoped to cut could say on the air if there is enough uncertainty about whether a piloted show could do better. A non-vertically integrated network would simply rank the pilots by a quality measure and select the shows with the highest potential. A vertically integrated firm would green light pilots that clearly had strong potential regardless of the backing studio. However for pilots with less consensus on success the firm would bias towards the sister studio if having to choose between a pilots owned inside or outside the firm.

Scheduling is an important aspect of a new show's success. Networks believe placing a new show after an existing hit creates a readymade audience for the new show that greatly boosts the chances of the new show's success. A similar but muted effect occurs when a new show is placed before an existing show.
Usually the costs of shows in the network's consideration set are close enough that the relative cost of a show is immaterial to the green lighting decision. If costs are a concern, the network is more likely to reduce the number of pilots green lit rather than alter the mix of pilots green lit. Reducing the number of scripted pilots may lead the network to pick up more lower cost reality TV shows for their upcoming season.

Subsequent Season

If show has high viewership ratings there's a high likelihood of renewal. There has been cases when for example CBS had a very strong lineup so a new show was cut even though the show's ratings would have been more than enough to be renewed at another network. Contract negotiations can also cause renewal to fail; the original actor's contract is limited to 7 years by California law so talent can turn a highly profitable show like Friends into a low performer if their bargaining position is too strong. Talent can also choose to end the show after a number of years as in Seinfeld.

It's also possible for a vertically integrated firm to nudge owned shows on the margin towards renewal with the intent of recouping costs during syndication. The downside is losing a slot for a new show that might have done better on the network.

5.4 Mathematical proofs

First Order Stochastic Dominance with Binary Outcomes

First order stochastic dominance of distribution $F$ over $G$ holds if and only if for any weakly increasing function $u$:

$$\int u(x) dF \geq \int u(x) dG$$

Take the case binary where there are two outcomes, $x'$ and $x$ such that $x' > x$. Let $p_F$ be the probability of the $x'$ outcome under $F$ and $p_G$ is the probability of the $x'$ outcome under $G$. Will show the FOSD holds if and only if $p_F \geq p_G$

For the if case, we can rewrite the expected utility relationship as:

$$p_F u(x') + (1 - p_F)u(x) \geq p_G u(x') + (1 - p_G)u(x)$$

This simplifies to:

$$(p_F - p_G)(u(x') - u(x)) \geq 0$$

Since the function $u$ is weakly increasing, $u(x') - u(x)$ must be weakly positive. In order for the FOSD condition to hold we must have $p_F \geq p_G$ outside of the corner case where $u$ is monotone. Because FOSD requires the relationship to hold for any function $u$, the corner case does not affect the proof. Therefore for binary outcomes, $F$ dominates $G$ in the first order sense when $p_F \geq p_G$. 


Next for the only if case, suppose the FOSD relationship does not hold; there exists a weakly increasing function $u^*$ such that

$$\int u^*(x)dF < \int u^*(x)dG$$

This implies

$$(p_F - p_G)(u^*(x') - u^*(x)) < 0$$

Since $u^*$ is weakly increasing, $u^*(x') - u^*(x)$ can either be zero or positive. When $u^*$ is zero, we get the contradiction $0 < 0$. If it is positive, we algebraically must have $p_F < p_G$. Therefore whenever the FOSD relationship fails to hold, we must have $p_F < p_G$, completing the bidirectional proof.

**Experimentation versus Commitment**

Showing that experimentation is strictly increasing in $c$, $-e$, and $-p$ as well as unaffected by $\theta$ and $V$ in the optimization problem:

$$\max_{\lambda \in \{0,1\}} \lambda (p(\theta V - c) - e) + (1 - \lambda)(\theta V - c)$$

For $c$, the set of values for $\lambda \in \{0,1\}$ and $c \in \mathbb{R}^+$ is trivially a lattice and poset. The set of values for $\lambda$ are independent of and therefore weakly increasing in $c$. The network’s objective function $f$ has increasing differences in $(\lambda, C)$ since for $c' > c$

$$(1 - p)c' > (1 - p)c$$

$$p \left(\frac{\theta}{p} V - c'\right) - e - \theta V + c' > p \left(\frac{\theta}{p} V - c\right) - e - \theta V + c$$

$$f(\lambda = 1, c') - f(\lambda = 0, c') > f(\lambda = 1, c) - f(\lambda = 0, c)$$

Therefore, by the Monotone Maxim Theorem $\lambda$ is increasing in $c$.

Similarly, $\lambda$ is decreasing in $e$ since the network’s objective function has increasing differences in $(\lambda, -e)$ since for $e' < e$

$$p \left(\frac{\theta}{p} V - c\right) - e' - \theta V + c > p \left(\frac{\theta}{p} V - c\right) - e - \theta V + c$$

$$f(\lambda = 1, e') - f(\lambda = 0, e') > f(\lambda = 1, e) - f(\lambda = 0, e)$$

For $p$, we must have the set of possible values to be $p \in [\theta, 1]$ for the post-experiment probability of success to be bounded from above by 1. These values still constitute a poset independent of $\lambda$. We have $\lambda$ decreasing in $p$ since for $p' < p$

$$-p'c > -pc$$
\[ p'(\frac{\theta}{p}V - c) > p\left(\frac{\theta}{p}V - c\right) \]

\[ p'(\frac{\theta}{p}V - c) - e - \theta V + c > p\left(\frac{\theta}{p}V - c\right) - e - \theta V + c \]

\[ f(\lambda = 1, p') - f(\lambda = 0, p') > f(\lambda = 1, p) - f(\lambda = 0, p) \]

For \( \theta \), we must have the set of possible values to be \( \theta \in [0, p] \) for the post-experiment probability of success to be bounded from above by 1. These values still constitute a poset independent of \( \lambda \). However algebraically there is no effect on the optimal decision by varying \( \theta \), so there is no relationship between \( \theta \) and \( \lambda \).

\[
\text{argmax}_{\lambda \in \{0, 1\}} \lambda (\frac{\theta}{p}V - c - e) + (1 - \lambda)(\theta V - c)
\]

\[
\text{argmax}_{\lambda \in \{0, 1\}} \lambda (\theta V - pc - e) + (1 - \lambda)(\theta V - c)
\]

\[
\text{argmax}_{\lambda \in \{0, 1\}} \theta V + \lambda (-pc - e) + (1 - \lambda)(-c)
\]

\[
\text{argmax}_{\lambda \in \{0, 1\}} \lambda (-pc - e) + (1 - \lambda)(-c)
\]

A similar argument holds for \( V \).

**Bargaining**

First, I argue the entry of a network has no bargaining power effect on the decision to experiment under standard cooperative bargaining models. I model bargaining through Shapely value, which is appropriate for bi-lateral relationships (Fontenay and Gans, 2014). Based on interviews with show creators, writers approach the networks serially with an idea. Writers rank networks based on fit with their vision and support for their show conditional on the other shows in the network’s portfolio. The number of networks in their consideration set is usually small; perhaps two or three networks are a strong fit for a particular show in a particular season. Writers then approach each network serially. When negotiations fail with a network, writers need to tweak their idea for the next network; an aggressive cop drama originally pitched to a cable network like HBO would be moderated for a broadcast network like ABC. Bi-lateral bargaining between agents in a graph is a reasonable model for this type of linear negotiation process.

The value allocated to each player \( i \) in a collation game is a weighted sum of

\[ v(S \cup \{i\}) - v(S) \]

where \( S \) is a set of players not including \( i \) and \( v(S) \) is the highest total sum of payoffs that can be generated by \( S \) through cooperation. Because there is only one bilateral contract at a time that can exist between the writer and a network, we can write \( v(S \cup \{i\}) \) as
\[
\max\{v(S), \max_{\lambda \in \{0,1\}} (\lambda^i \hat{V}_p^i + (1 - \lambda) \hat{V}_s^i)\}
\]

Network \(i\) selects whether or not to pilot, \(\lambda^i\). The expected payoff from piloting for network \(i\) is \(\hat{V}_p^i\) and the payoff from deciding to skip the pilot is \(\hat{V}_s^i\).

An equilibrium is reached if all networks always pick the higher of \(\hat{V}_p^i\) or \(\hat{V}_s^i\). When one or both of \(\hat{V}_p^i\) and \(\hat{V}_s^i\) is above \(v(S)\), picking the larger one results in the highest payoff. If both are below \(v(S)\), network \(i\) received no value from the term so picking the larger is still weakly preferred. So regardless of the number of other networks or the payoffs available to those networks, firm \(i\) will only consider whether \(\hat{V}_p^i\) or \(\hat{V}_s^i\) is larger. If the network is picking piloting over skipping the pilot prior to entry, it suggests the network views the piloting payoff as higher. Furthermore, the network should continue picking the piloting after entry since it remains optimal to do so if the coalition value is not affected by entry.

Next, what about if bargaining in television deviates from the standard assumptions, by for example exhibiting uncompensated differentials? Let \(V_E\) be expected joint payoff from experimentation, inclusive of costs of production and \(V_C\) be the joint payoff from commitment. Let \(V_E > V_C\), so that experimentation results in a larger overall payoff. The payoff is split with \(1 - \alpha\) going to the network and \(\alpha\) going to the show creator. To model uncompensated differentials, let \(\kappa\) represent a private cost to experimentation born by the show creator that is not included in \(V_E\). Before Netflix’s entry, all the networks prefer to experiment since \(V_E > V_C\). Each creator’s outside option is the payoff from experimentation on another network, so a subgame perfect equilibrium is for the networks to always experiment by funding pilots.

Once Netflix enters and only commits, the decision calculation of the incumbent networks changes to reflect that the creator’s outside option may include a payoff \(V_C\) that crucially does not cause them to incur private cost \(\kappa\). Now when experimenting, the incumbent networks need to provide a larger share of payoff \(V_E\) to the creator when experimenting, represented by \(\Delta\).

\[
\max_{\lambda \in \{0,1\}, \Delta \in [0,1-\alpha]} \lambda (1 - \alpha - \Delta) V_E + (1 - \lambda) (1 - \alpha - \Delta) V_C
\]

\[
s.t. \lambda((\alpha + \Delta) V_E - \kappa) + (1 - \lambda)(\alpha + \Delta) V_C \geq \alpha V_C
\]

When the network chooses to commit, Netflix as an outside option is not superior from the perspective of the creator so \(\Delta\) can be 0. However, under experimentation, \(\Delta\) may need to be positive so that its rational for the creator to prefer the network over Netflix. In the case when the optimal \(\Delta^* \in [0,1-\alpha]\), this means the private cost \(\kappa\) gets factored into the decision making of the network, so the optimization problem becomes:

\[
\max_{\lambda \in \{0,1\}} \lambda (V_E - \kappa) + (1 - \lambda) V_C
\]

This does not solve the identification issue since variation in bargaining power is not affected the network’s decision. However, when \(\alpha\) is high its possible that \(\Delta^* > 1 - \alpha\), making it not possible for the network to sufficiently compensate a creator to experiment: the network would be forced
to commit instead. This would lead to shows with the same expected payoff to have different production processes due to the level of creator bargaining alone.

**Relative Improvement Across Episodes**

To start, consider a basic multitasking model with two actions that represent the level of effort placed in the first episode $a_1$ and subsequent episodes $a_2$. The payoff to the show’s creator is the sum of effort $a_1 + a_2$ minus cost function $a_1^3 + a_2^3$. A cubic cost function is used rather than the traditional quadratic in order to ensure cost grows fast enough for later modifications to have finite solutions.

$$\max_{a_1, a_2 \in \mathbb{R}^+} a_1 + a_2 - (a_1^3 + a_2^3)$$

The solution to this model is symmetric with both effort levels set at $1/\sqrt{3}$. Suppose rather than receiving payoff $a_1 + a_2$, the show creator only gets that payoff with probability $p \in (0,1)$; the network can decide not to broadcast the show.

$$\max_{a_1, a_2 \in \mathbb{R}^+} p(a_1 + a_2) - (a_1^3 + a_2^3)$$

Now the level effort drops to $\sqrt{p/3}$; the show creator puts less effort into the show if there is a chance the show will not be broadcast.

But the show creator can influence the probability of a show being broadcast. Suppose the network evaluates the entire show to determine the whether the show will air and $p = \frac{1}{2}a_1 + \frac{1}{2}a_2$.

$$\max_{a_1, a_2 \in \mathbb{R}^+} \left(\frac{1}{2}a_1 + \frac{1}{2}a_2\right)(a_1 + a_2) - (a_1^3 + a_2^3)$$

Now effort level rises to $2/3$. Reducing the creator’s payoff by only conditionally broadcasting a show will not necessarily reduce effort if the creator can influence the probability of broadcasting the show. This model cannot predict that the overall quality of a show will be higher or lower based on if a show skips the pilot.

Networks however do not evaluate the entire show when making the straight to series order, just the pilot. Working on the rest of the series can still help the quality of the pilot by hinting at where the rest of the series will take the first episode’s story, but effort put into the pilot itself becomes more impactful to the probability a show gets ordered to series. Let $\gamma \in [0,1]$ represent the relative importance of pilot effort to effort into the rest of the episodes in determining whether a show gets greenlit.

$$\max_{a_1, a_2 \in \mathbb{R}^+} (\gamma a_1 + (1 - \gamma) a_2)(a_1 + a_2) - (a_1^3 + a_2^3)$$

This leads to an asymmetric solution where the optimum effort $a_1^*$ is increasing in $\gamma$ while $a_2^*$ is decreasing in $\gamma$. 

26
\[ a_1^* = \frac{1}{6}(1 + 2\gamma + \sqrt{5 - 4\gamma(1 - \gamma)}), a_2^* = \frac{1}{6}(1 + 2(1 - \gamma) + \sqrt{5 - 4\gamma(1 - \gamma)}) \]

Therefore this model does predict that piloting will have a different distribution of effort across episodes than skipped pilots. Piloting implies \( \gamma > \frac{1}{2} \) which results in a shift in effort towards the pilot episode relative to a show that skipped the pilot. This shift does not happen with shows that skipped the pilot. Therefore as the season goes on, piloted shows should get worse relative to shows where the pilot was skipped.

More generally the same results occur with a decision model of

\[ \max_{a_1, a_2 \in \mathbb{R}^+} p(a_1, a_2, \gamma)v(a_1, a_2) - c(a_1, a_2) \]

whenever payoff \( v \) is weakly increasing in its arguments, cost \( c \) is increasing fast enough so the optimum \( a_1^* \) and \( a_2^* \) are finite and the probability \( p \) of reaching the payoff show increasing differences in \( a_1, \gamma \) as well as \( a_2, -\gamma \).

A model where piloting helps creators improve the quality of the show could have the opposite comparative statics. Suppose there is some characteristic about a show that is the creator’s control which determines the quality of the show. In order for a show to be viewed as high quality, the level of that characteristic should match the desires of the audience, for example a drama show might need to have some action elements but too much action could detract from the plot and hurt the show’s ratings.

Let \( \theta \) be the level of the characteristic preferred by the audience, distributed \( F_\theta \). The network knows \( \theta \) but the creator does not. Each creator has a belief \( \gamma \) about what the audience would like, distributed \( F_\gamma \). Suppose there are two outputs, the first episode and the rest of the season, and the show’s value is the sum of quadratic loss from the difference between audience taste and creator beliefs for those two outputs:

\[ E[-(\gamma - \theta)^2] + E[-(\gamma - \theta)^2] \]

Now allow the network to adjust \( \gamma \) to equal \( \theta \) by piloting with cost \( e \). The network then maximizes whether to pilot \( \lambda = 1 \) based on the trade-off between piloting cost and the expected loss from the rest of the season:

\[ \max_{\lambda \in [0, 1]} \lambda(E[-(\gamma - \theta)^2|\theta] - e) + (1 - \lambda)(E[-(\gamma - \theta)^2|\theta] + E[-(\gamma - \theta)^2|\theta]) \]

The network would decide to pilot when \( E[(\gamma - \theta)^2|\theta] > e \).

In this model as long as the distributions are non-degenerate of course the quality the episodes beyond the first will be better for piloted shows; non-piloted shows have a quality loss of \( E[(\gamma - \theta)^2|\theta] \) while piloted shows have no quality loss. More interestingly, the reverse is true for the first episode. Since piloted shows have \( E[(\gamma - \theta)^2|\theta] > e \), non-piloted shows must have \( E[(\gamma - \theta)^2|\theta] < e \); \( E[(\gamma - \theta)^2|\theta, \lambda = 1] > E[(\gamma - \theta)^2|\theta, \lambda = 0] \) so the first episode of non-piloted shows are better. Experimentation occurs on the relatively “bad” shows so the first episode of the
piloted shows are worse. Experimentation improves those “bad” shows, so the subsequent episodes of the piloted shows are better. Therefore in contrast to the effort model, as the season goes on, piloted shows should get better relative to shows where the pilot was skipped.

Finally, in a planning model, one can imagine planning time $a$ and an execution time $b$ as a shares of total time spent in development.

$$\max_{a,b\in[0,1]} a + b - a^2 - b^2 \text{ s.t. } a + b = 1$$

The optimal allocation $a^*,b^*$ of time between these two tasks results in the best possible show. Suppose piloting a show constricts the amount of time that can be spent on planning before production to $c$, since the first episode must be produced according to the network’s pilot schedule.

$$\max_{a,b\in[0,1]} a + b - a^2 - b^2 \text{ s.t. } a + b = 1, a \leq c$$

If $a^* > c$, then piloting results in the suboptimal amount of time in planning. Switching to commitment would improve the quality of the show by benefiting all episodes.

9. References


10. Figures and Tables

5.5 Figures

*Figure 1. Share of Shows Ordered that Skipped the Pilot Phase*
Figure 2. Distribution of First Season IMDB Ratings
Figure 3. Diff-in-Diff of Straight to Series with Hour Long versus Half Hour Shows
Figure 4. Episode Ratings of Committed versus Piloted Shows with Award-winning Executive Producers
## 5.6 Tables

*Table 1. Summary Statistics Before and After Netflix’s Success*

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Table 2. Correlation between Outcome Variables

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$t$ statistics in parentheses
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 3. Evidence on Real Options Decision Making

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<tr>
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<td>[0.0471]</td>
<td>[0.0210]</td>
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</table>

| Shows (N)            | 612             | 628             | 427                   | 500               |
| Deg. of Freedom      | 78              | 79              | 53                    | 54                |
| Adj. R-Squared       | 0.0452          | 0.0682          | 0.0285                | 0.123             |

Standard errors in brackets
Includes year and network fixed effects. Clustered by network X year. Data restricted to shows on incumbent networks.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$
Table 4: Diff-in-Diff of estimator of change in commitment rate after 2013

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<td>Adj. R-Squared</td>
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Standard errors in brackets
Clustered at network by show length level. Data restricted to scripted shows on incumbent networks from 2008 to 2017.
* p<0.10, ** p<0.05, *** p<0.01

Table 5: Prediction of Show Quality

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Standard errors in brackets
Includes year and network fixed effects. Clustered by network X year. Data restricted to shows on incumbent networks.
* p<0.10, ** p<0.05, *** p<0.01
Table 6: Quality Differences between Piloting and Skipping the Pilot

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<td>1st Season Rating</td>
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<td>.]</td>
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<tr>
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<td>0.442***</td>
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<td>[0.284]</td>
<td>[0.200]</td>
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</tbody>
</table>

| Shows (N)                      | 241           | 114          | 127           |
| Deg. of Freedom                | 50            | 44           | 37            |
| Adj. R-Squared                 | 0.164         | 0.183        | 0.152         |

Standard errors in brackets
Include year and network FE. Clustered by network X year. Data is restricted to shows on incumbent networks from 2014 to 2017.
* p<0.10, ** p<0.05, *** p<0.01
Table 7: Triple Difference Effect of Commitment on Network Show Portfolio

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</tr>
<tr>
<td>Hour Long X Share Committed</td>
<td>0.647</td>
<td>1.733***</td>
<td>-1.387*</td>
</tr>
<tr>
<td></td>
<td>[0.681]</td>
<td>[0.289]</td>
<td>[0.659]</td>
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<tr>
<td>Post 2013 X Share Committed</td>
<td>-1.523***</td>
<td>-0.413</td>
<td>-1.243**</td>
</tr>
<tr>
<td></td>
<td>[0.383]</td>
<td>[0.331]</td>
<td>[0.527]</td>
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<tr>
<td>Hour Long</td>
<td>0.571***</td>
<td>0.469**</td>
<td>0.802***</td>
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<td></td>
<td>[0.128]</td>
<td>[0.170]</td>
<td>[0.208]</td>
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<tr>
<td>Post 2013</td>
<td>0.0971</td>
<td>0.0427</td>
<td>0.256</td>
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<td>[0.131]</td>
<td>[0.173]</td>
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<tr>
<td>Share Committed</td>
<td>0.566</td>
<td>-0.441</td>
<td>1.195***</td>
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<tr>
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<td>[0.379]</td>
<td>[0.285]</td>
<td>[0.389]</td>
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<tr>
<td>Constant</td>
<td>7.446***</td>
<td>7.470***</td>
<td>7.230***</td>
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<tr>
<td></td>
<td>[0.113]</td>
<td>[0.142]</td>
<td>[0.194]</td>
</tr>
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</table>

N  
124 75 84

Deg. of Freedom  
18 13 13

Adj. R-Squared  
0.437 0.316 0.315

Standard errors in brackets
Clustered by network X show length. Data is restricted to 2010 to 2017 so pre and post period lengths are balanced. Incumbent networks that lack hour and half hour show observations in both the pre and post periods dropped.

* p<0.10, ** p<0.05, *** p<0.01