International Diffusion and Intellectual Property Rights: An Empirical Analysis

Phillip McCalman
Department of Economics
University of California
Santa Cruz 95064 CA
mccalman@cats.ucsc.edu

October 2002

Abstract

Traditional thinking about intellectual property rights (IPR) suggests a monotonically increasing relationship between property rights and the speed of diffusion of new products and technology. Our analysis of data on the international release patterns of Hollywood movies suggests a more complex story: although moderate standards of IPR encourage the spread of movies, either weaker or stronger property rights tend to decrease the speed with which American movies are released abroad. This empirical finding is consistent with a variety of specifications, including allowing for countries' self-selection of IPR standards and externally imposed IPR. Overall, it appears that while some recognition of IPR may encourage diffusion, very strong IPR may actually retard the speed of diffusion.

JEL Classification: O34, F43

Keywords: International Trade, World Trade Organisation, Intellectual Property Rights, Diffusion

The increasing dependence by firms on copyrights, trademarks and patents to protect their goods and services in the international marketplace has elevated the protection of intellectual property to the center of international economic diplomacy. While efforts have sought to strength protections through both multilateral initiatives (WTO's TRIPS agreement) and bilateral pressures, the complexity of intellectual property rights (IPR) along with the redistributive implications of reform means that there is no clear-cut first best solution that countries can work towards.[1] Consequently, there has been much debate over how the global system of IPR should be structured.

In these debates, one potential advantage that has been highlighted is that higher IPR are likely to be associated with the faster diffusion of new goods and services (UNDP, 2001 and World Bank, 2001). This relatively intuitive insight does have a theoretical underpinning.[2] Since the adoption of an innovation is associated with a fixed cost (conversion to a new technology or the expenditures involved in the promotion and marketing of a new product) the concomitant increment in the revenue stream needs to be sufficiently large to justify its introduction. As this revenue stream is critically affected by the standards of IPR, the prediction emerges that the greater the security of intellectual property rights, the faster a new good or service is likely to diffuse. However, this is not the only mechanism that is likely to operate. In particular, a contrary view suggests that an increase in market power (such as that associated with a strengthening of IPR) may reduce the speed of diffusion due to concerns over the cannibalization of revenue from existing products and technology (see Quirmbach 1986). This implies that the speed of diffusion will ultimately be determined as the net effect of these two forces.

To date, no empirical study has tried to assess the relative influence of these factors on the international diffusion on new goods and services, resulting in a lack of empirical evidence to guide this aspect of the debate over IPR reform. It is the goal of this paper to provide evidence on this issue. In order to gain insight into the association between IPR and diffusion, this paper studies the behavior of the major Hollywood movie studios and

[1] For an indication of the redistributive implications see McCalman (2001).
[2] See Reinganum (1981) for a model which is consistent with this claim.

examines how they exploit their IPR in their global operations. This industry provides an especially attractive setting in which to study this association for a number of reasons. Most significantly, this is an industry where there are no technological barriers to the international diffusion of new goods/services (i.e. Hollywood movies). This suggests an environment where diffusion, in principle, could be instantaneous, and so provides an ideal benchmark against which to measure observed behavior. In fact, the international diffusion of movies is surprisingly slow, with the average lag in excess of 3 months.[3] Given the size of this lag, when no appreciable lag was expected, one aim of this paper is to explore why it exists, and try to determine the role, if any, of IPR in this process.

One would expect IPR to be important in the decision making process of Hollywood studios. Given the high upfront costs and the relatively low cost of duplication, the success of Hollywood relies heavily on the ability to protect its intellectual property both within the U.S. and in foreign markets. Indeed foreign markets now account for a greater share of revenue than the domestic U.S. market, a situation that has contributed to the audio-visual sector being ranked as the second largest exporter for the U.S..[4] The global success enjoyed by Hollywood also means it is often cast in the role of villain in debates over IPR standards, a dominant player seeking to further drive home its advantage by insisting that countries raise their standards of protection. This tension mirrors the pattern of IPR negotiations in general, and so provides a valuable and accessible template for exploring the implications of IPR reform.

The variation in the standards of IPR around the world offers one potential way of studying the implications of reform for the speed of diffusion. To exploit this potential, I construct a dataset that covers 60 Hollywood movies and their subsequent diffusion to 37 foreign countries. Combining this dataset with a duration model methodology reveals a non-monotonic relationship between the speed of diffusion and the standards of IPR. Increasing IPR standards from a relatively low level to an intermediate level is estimated

[3] To provide a context, the typical Hollywood movie is simultaneously released in all major cities within the US.
[4] This is a claim that is routinely made, see for instance the discussion of Peter Sutherland (Director General of the GATT at the time) in relation to the Uruguay Round negotiations (Sutherland, 1993). For an attempt to establish the validity of the claim see Acheson and Maule (1999).

to increase the speed of diffusion. However, increasing IPR standards from an intermediate level to a high level is predicted to decrease the speed of diffusion. Such a non-monotonic relationship has important implications for the size of reform a country maybe willing to undertake in relation to its IPR regime, especially since one apparent benefit of IPR reform is that it contributes to a faster diffusion of new products and technologies. These results suggest that such conjectures should not be accepted unquestioningly, and in fact may need to be heavily qualified.

However, these conclusions rely not only on the dataset used, but also critically on the assumptions employed to identify the impact of IPR standards on the speed of diffusion. In particular, the methodology utilized assumes both a parametric form of the distribution of release dates as well as an assumption of exogenous selection with respect to IPR. If either of these assumptions is incorrect, then the validity of the above conclusion is questionable. In order to examine the robustness of the results, each of these assumptions is relaxed. In place of an assumption about the parametric distribution of diffusion, semi-parametric estimation techniques are employed. The results of this exercise reveal the same non-monotonic relationship as the parametric model.

When adopting the assumption of exogenous selection, one imposes the restriction that unobserved factors do not jointly determine both the speed of diffusion and the standards of IPR. This assumption is made to address the problem that the data alone cannot reveal the counterfactual outcome. That is, the data only tell us how quickly a movie is released in a country for the standard of IPR they actually have (e.g. low), but it cannot tell us how quickly the same movie would have been released if the country had instead adopted a different set of IPR standards (e.g. medium or high). In order to examine this assumption, a non-parametric bounds methodology is employed (developed in a series of papers by Manski and his co-authors). This analysis begins with a technique that does not require any assumptions about the role of unobserved factors. However, these "no-assumption" bounds are, by construction, consistent with a wide range of possibilities.[5]

[5] The "no-assumption" bounds are based on the methodology set out in Manski (1989).

To narrow the range of outcomes, a number of alternative assumptions based on prior information about the mechanism that determines the selection of IPR are explored. One plausible assumption is that countries choose their IPR standards with the objective of minimizing lags in diffusion. Imposing this assumption substantially reduces the range of possible outcomes from IPR reforms, however it does not isolate the sign of the impact of reforms on the speed of diffusion.

While a model that allows for self-selection of IPR is appealing, many countries have had the selection of their IPR mediated by the U.S. under Special 301 of the Trade Act. To incorporate this type of selection mechanism, Manski and Nagin's skimming model is applied to IPR and diffusion. Estimates from this model suggest that reforms which raise IPR standards from a low level to a medium level are consistent with an increase in the speed of diffusion. However, further reforms that raise standards from medium to high are estimated to decrease the rate of diffusion. This non-monotonic relationship between IPR and diffusion is consistent with the predictions of the parametric model, even though the nature of prior information used is very different. Therefore, despite the ambiguity created by the selection problem, all of the alternative estimates presented in this paper are consistent with the inference that the association between the speed of diffusion and standards of IPR is non-monotonic.

In order to demonstrate these results Section 1 describes the data and presents results based on a survival framework. Section 2 discusses what can be learned without making any assumptions about prior information, while Section 3 explores the implications of the outcome optimization and the skimming models.

1. Estimates From A Duration Model

To date, the international literature has studied diffusion from the perspective of models of endogenous technological change. Here the notion of "spillovers" plays a central role. In this setting, efforts have been directed towards identifying circumstances that lead a country to have a greater ability to benefit from access to foreign technology. In general, this literature focuses on aggregate measures of diffusion, such as an increase in total factor productivity not accounted for by domestic R&D, and the channels that may facilitate diffusion (trade, FDI, improved communications).[6] While IPR have played a role in this literature, their effect on the speed of diffusion has not been directly investigated.[7] This omission is significant in light of the TRIPS agreement, and suggestions that higher IPR may promote faster diffusion of new goods and services (UNDP, 2001 and World Bank, 2001). By using the international release dates of Hollywood movies, the hypothesis that the speed of diffusion is positively associated with the standard of IPR can be examined.

The primary data source used in this analysis is the internet movie database (imdb) which contains information on the release dates of movies across countries.[8] The quantity of interest is the period of time between the first release of a movie within the U.S. and its first release in another country. For a given movie a number of such periods (durations) will be generated, one for each country in which the movie is released. The unit of measure of these durations is days.

The study examines the top 60 grossing American (Hollywood) movies from 1997 to 1999 within the U.S., and their subsequent release in 37 other countries. In total, this combination of movies and countries yields 2022 observations. By concentrating on the top 60 movies, the analysis focuses on the set of movies that are most likely to be successful abroad, and consequently, these are also the movies one would expect to diffuse abroad the fastest. As there are no real barriers to the international distribution of movies, this setting is one where you would expect to see very fast diffusion. In this sense, focusing on the top Hollywood movies provides an ideal benchmark since there are no obvious physical reasons why these movies are not released quickly in other countries. If there is a lag, it is likely to reflect non-technological factors.

[6] See Keller (2001) for a survey of this literature.
[7] Patents play a central role in models of endogenous growth as they represent a mechanism for which information about new technology is disclosed. In the empirical literature on international diffusion, international patenting behavior has been used to document where an innovation originated and to which countries it has diffused (Branstetter, 2001, Eaton and Kortum, 1996 and 1999).
[8] The website is located at www.imdb.com. The majority of release dates are drawn from this source. Gaps in the data were filled from newspapers from various countries.

Table 1 provides a list of the countries analyzed and some summary statistics for the key variables. A major point to emerge from this table is that even though the movies considered are the top Hollywood movies, on average their global distribution lags U.S. releases by over three months. Given the technological possibility that a movie can be released anywhere in the world soon after the U.S. release, the size of the gap between the U.S. release and foreign release is surprisingly large.

To try to understand what determines this lag, the empirical approach taken in this section utilizes a hazard rate formulation. This is the methodology typically used in single country/industry studies of diffusion (for example, see the surveys by Geroski, 2000, Karshenas and Stoneman, 1995). In constructing this hazard rate, empirical models of diffusion have frequently assumed that the duration of diffusion follows a Weibull process. This practice is also followed in this paper, with the hazard function assumed to take the following form,

$$h(t;\gamma,x,p) = pt^{p-1}\exp\{x'\gamma\} \qquad (1)$$

Here, the vector γ and the scalar p are the unknown parameters, while x is a vector of covariates.

While there is a large theoretical literature dealing with diffusion, the complexity of these models has limited their influence on the structure of empirical analysis. Consequently, the relationship between the hazard rate and the explanatory variables has been expressed as a reduced form. This practice typically seeks to include variables that are likely to affect the profitability of adopting an innovation, and consequently the speed at which it is likely to diffuse. Due to Hollywood's heavy reliance on intellectual property, central among the variables examined in this study is IPR. The measure of IPR employed is described in Ginarte and Park (1997) and has been extended to cover the standards in place in 1995.[9]

While the policy literature has emphasized the possibility of a positive relationship between IPR and diffusion, the theoretical literature is much more ambiguous about the role of market structure in determining the speed of diffusion. One strand of the literature suggests that an increase in market power leads to an increase in the ability to appropriate rents from new products or technologies, which tends to encourage faster diffusion (see Reinganum, 1981). In the case of films, where a major source of competition is likely to be from pirated versions of a movie, the release of a movie may be delayed in a country due to concerns over the extent of piracy if IPR are weak. Consequently, undertaking the fixed expenditures involved in releasing a new film in a country with weak IPR may not be warranted since they are likely to result in a poor box office, but a large market for the pirated product. Furthermore, releasing a movie quickly in a country with weak IPR may facilitate the spread of pirated copies not only within that country, but also to other countries, especially those that speak the same language.

In contrast, Quirmbach (1986) constructs a model where the pace of diffusion is reduced by increases in market power due to a concern over the cannibalization of rents from existing products and technologies. Concerns about cannibalization are likely to be most pronounced for a Hollywood studio when IPR are already at a relatively high level. In this setting, a studio may be less concerned with loss of box office revenues due to piracy, than the cannibalization of revenues that may potentially occur from competition with a studio's own product.[10] To avoid this type of cannibalization, there is an incentive to stagger the release of movies further apart. This may be especially the case in comparison to the U.S. release pattern, due to the legally sanctioned export cartel of the major Hollywood studios.[11]

[9] I would like to thank Walter Park for making this unpublished series available.
[10] Davis (2002) also considers cannibalization in the movie industry. However, his focus is on cannibalization due to an expansion of the number of cinemas within the U.S..
[11] The Motion Picture Export Association (MPEA) was formed in 1945. Under the Webb-Pomerene Export Trade Act of 1918, the MPEA was able to claim an exemption from anti-trust laws as an organization exclusively engaged in overseas trade.

Taken together these perspectives extend the hypothesis contained in the policy literature that the relationship between IPR and diffusion should be positive. In particular, the cannibalization motive is likely to be most pronounced when IPR are relatively strong, which suggests that a negative association between IPR and the speed of diffusion is most likely when IPR are relatively high. A simple way to formulate a test of these predictions is to include a quadratic term in the model. Since the motive to increase the speed of diffusion due to increases in IPR is likely to be most pronounced when IPR are low, the linear component should be positive. In contrast, slower diffusion due to concerns over cannibalization associated with increased IPR are likely to occur when IPR are already at a relatively high level, suggesting that the coefficient on the quadratic term should be negative. These two predictions form the basis of the hypotheses to be tested.

1.1 Results

The estimated coefficients, along with the asymptotic standard errors are reported in column (1) of Table 2. One advantage of the Weibull model is that despite its non-linear specification, the estimated coefficients have an interpretation that is analogous to the standard linear regression model, meaning estimated coefficients can be interpreted as partial derivatives of the hazard rate with respect to the covariate in question.

The variables included account for the expected profitability of a given movie in a given country. The movie characteristics cover things such as budget, U.S. box office, critical rating, month of release, genre, studio and whether or not a foreign licensee handled foreign distribution.[12] Of these factors, the budget, U.S. box office, and the FDI position of a studio in a particular country all have a positive and statistically significant impact on the hazard function. Interestingly, the quality measure defined by the San Francisco Chronicle's "Critical Consensus" is associated with a negative sign, though it is not statistically significant. Country characteristics such as size and growth of the market, domestic film production, and language are all estimated to have statistically significant effects on the hazard function.

[12] A list of variables and sources is contained in the appendix.

One of the most striking results to emerge from Table 2 is that the impact of IPR standards on the speed of diffusion is estimated to be non-monotonic. The null hypothesis that the linear component is negative can be rejected at the 1% level of significance. Similarly, the null hypothesis that the coefficient on the quadratic term is positive can be rejected at the 1% level of significance. The signs and significance of these results are also robust to a number of specifications. To examine the parametric specification of the hazard rate, column (2) explores the possibility that the Weibull specification may account for the results by presenting semi-parametric results from Cox's proportional model. This specification confirms the results of the baseline model.

To examine more explicitly the cannibalization motive, the quadratic term is interacted with a count of the number of films released in the U.S. market around the same time as the film under consideration.[13] This count is termed cannibalization, and reflects the idea that the U.S. market is more competitive than markets in other countries.[14] Since the concern over cannibalization is predicted to increase as the standards of IPR are increased (while controlling for the potential for cannibalization), this interaction term should be negative. The results in column (3) confirm this prediction and are consistent with the operation of a mechanism where studios do respond to higher IPR by trying to avoid the cannibalization of rents.

Given the presence of the non-monotonicity, it is of interest to assess the relative importance of the linear and quadratic components. Since the measure of IPR ranges from 0 to 5, a natural question to ask is whether the maximum occurs within this range. Solving for the maximum reveals that it occurs at an IPR level of approximately 2.8 for the baseline case in column (1). While the reason for the non-monotonic relationship is not pinned down by these estimates, the implications of the result are nonetheless important. The costs of IPR reform tend to be more immediate and obvious, such as the

---

[13] This count is based on the number of films released in the week preceding and the week following the release of the film in question.

[14] This conjecture is based on anti-trust efforts that have been undertaken in the U.S. to restrict block and blind booking, the vertical dis-integration required by the Paramount decree and the operation of the MPEA as an export cartel.

potentially detrimental implications of enhancing the market power of already dominant firms. However, the benefits of IPR reform are typically delayed or less well articulated. One suggested benefit of IPR reform is that it may contribute to a faster diffusion of new products and technologies. The results of the estimates presented in this section suggest that such conjectures should not be accepted unquestioningly, and in fact may need to be heavily qualified.

2. Non-Parametric Bounds

The results of the previous section rely not only on the dataset used, but also critically on the assumptions employed to identify the impact of IPR standards on the speed of diffusion. One particularly important assumption is that the selection of IPR are exogenous.[15] In relaxing this assumption, the next two sections present alternative results from three different assumptions about the mechanism used to select the IPR standards of a country. The first set of assumptions impose no structure on the selection mechanism, and are therefore termed "no assumption" estimates. The next two sets of estimates examine assumptions that individual countries chose their standards with an objective function in mind, and alternatively countries have their IPR mediated by external pressures.

The scope to pursue these alternative assumptions comes from the ambiguity generated by the selection problem. This identification problem results from the fact that we cannot observe what the counterfactual outcome would have been. For instance, once a country has selected low IPR, we observe the outcome for that level of IPR. We cannot observe what would have happened if this country had instead selected a different level of IPR. Therefore, in order to identify the impact of IPR on diffusion we must impose some structure on what the counterfactual would have been. However, because we are imposing structure on an unobserved outcome, the empirical validity of this prior

[15] In related international contexts where the association of the standard of IPR and intellectual property intensive transactions has been studied, this assumption or that of instrumental variable estimation has been employed (Maskus and Penubarti, 1995 and Smith, 1999 and 2001).

information is unverifiable and thus represents a potential weakness of any empirical study.

To formally address the selection problem, I begin by distinguishing among three diffusion outcome variables. In particular let d_s represent the duration or speed of diffusion of a movie to a country with IPR standards s. Since we are interested in exploring the possibility of a non-monotonic association between IPR and diffusion, I evaluate d_s when s is equal to low (l), medium (m) and high (h). Thus, each observation includes three outcome variables: d_l, d_m, d_h, with one of these outcomes realized and the other two latent.

The methodology employed in this section is to examine the distribution of d_s. One measure of the impact on the speed of diffusion of moving from a given standard of IPR (s) to another standard of IPR (s') is given by:

$$\Delta[s, s' | X] = P[d_{s'} < t | X] - P[d_s < t | X] \qquad (2)$$

That is, the impact of IPR reform can be measured as the difference in the probability that diffusion will have occurred by t under IPR standards s' as opposed to IPR standards s, for all countries with covariates X. Notice that since the probabilities in equation (2) must lie between [0, 1], the impact of IPR reform defined by equation (2) must lie between [-1, 1]. Thus without data, the width of the possible range of outcomes is bounded at two. This width provides a benchmark against which to measure the information content of the data, as well as the various identifying assumptions employed.

A fundamental point to note is that the effects defined in equation (2) cannot be identified by the data alone. The primary problem is that the outcome d_s is observed only if a country has an IPR standard of s. Thus, for a country that has low IPR standards, d_l is observed but d_m and d_h are latent variables. Similarly, for countries with high IPR standards, d_h is observed but d_l and d_m are latent. This identification problem is highlighted using the law of total probability which shows that:

$$P[d_s < t| X] = P[d_s < t \mid X, ipr = s]*P[ipr = s| X] + P[d_s < t \mid X, ipr \neq s]*P[ipr \neq s| X] \quad (3)$$

where *ipr* is the actual standard of IPR offered by a country. Since each observation contains information on d_{ipr}, *ipr*, and *X*, the dataset identifies the selection probability $P[ipr = s \mid X]$, the censoring probabilities $P[ipr \neq s \mid X]$, and the probability of duration being less than *t*, conditional on the outcome being observed $P[d_s < t| X, ipr = s]$. Thus, the data reveal every term in the right side of equation (3) except the counterfactual probabilities, $P[d_s < t \mid X, ipr \neq s]$.[16] Therefore, <u>in the absence of prior information restricting the distributions of d_s and *ipr*, observations with $ipr \neq s$ reveal nothing about the latent outcome d_s</u>. Consequently, the data cannot identify the distribution of outcomes that would be observed if it were the case that all countries adopted high standards of IPR.

2.1 Estimation With No Prior Information[17]

A selection problem occurs because the data fail to reveal $P[d_s < t \mid X, ipr \neq s]$, the counterfactual probabilities. However, the data may still reveal information about the distribution of the latent variable, d_s. Since the unidentified counterfactual probabilities $P[d_s < t \mid X, ipr \neq s]$ must lie between 0 and 1, bounds can be placed on the possible values of $P[d_s < t \mid X]$.

A sharp upper bound is found by setting $P[d_s < t \mid X, ipr \neq s] = 1$ in equation (3), while the lower bound sets these unobserved probabilities equal to 0. Writing these bounds out gives:

"No assumption" upper bound on $P[d_s < t| X]$

$$P[d_s < t \mid X, ipr = s]*P[ipr = s| X] + P[ipr \neq s| X] \quad (4)$$

---

[16] Section 1 implicitly assumes that, conditional on covariates X, IPR are assigned randomly among countries. In this case the counterfactual is identified and implies $P[d_s < t \mid X] = P[d_s < t \mid X, ipr = s]$. In addition, note that Section 1 also specifies the distribution of d_s to be Weibull.
[17] The techniques employed in this section are based on Manski (1989).

"No assumption" lower bound on $P[d_s < t| X]$

$$P[d_s < t \mid X, ipr = s]*P[ipr = s| X] \quad (5)$$

The bounds on these individual distributions can then be used to construct bounds on the impact of IPR reform, that is, bounds can be placed on equation (2). These bounds are given by:

"No assumption" upper bound on $\Delta[s, s'| X]$

$$P[d_{s'} < t \mid X, ipr = s']*P[ipr = s'| X] + P[ipr \neq s'| X] - P[d_s < t \mid X, ipr = s]*P[ipr = s| X] \quad (6)$$

"No assumption" lower bound on $\Delta[s, s'| X]$

$$P[d_{s'} < t \mid X, ipr = s']*P[ipr = s'| X] - P[d_s < t \mid X, ipr = s]*P[ipr = s| X] - P[ipr \neq s| X] \quad (7)$$

In addition to making no assumptions about the joint distribution of d_s and IPR, the utilization of this bounding technique has important implications for the way in which the covariates X are used. From this section of the paper forward, covariates are merely used to define subpopulations of interest. This differs from the standard framework (as adopted in Section 1), where researchers attempt to correctly choose a set of control variables such that the exogenous selection assumption applies. This method leaves much room for debate about whether or not an important explanatory variable has been omitted and the extent of the resulting bias. The techniques employed in this and the next two sections do not assume that IPR standards are exogenous conditional on any given set of covariates. Therefore, the impact on the speed of diffusion of IPR reform among countries with covariates X is well defined regardless of how the subpopulations are specified. Using this framework, there is no correct set of control variables.

With this in mind, I focus on the impact of reforms on countries with different per capita incomes. The choice of these subpopulations is motivated by the World Trade

Organization's TRIPS agreement which differentiates between countries depending on the stage of development.[18] To capture the distinctions made within the TRIPS agreement, countries are divided into high and low income. For each of these subpopulations, the remainder of this paper is devoted to examining the implications of a number of alternative assumptions for identifying the impact of IPR reforms on the speed of diffusion.

Tables 3 and 4 present the impact of reforms under various assumptions regarding prior information for low and high-income countries respectively. Rows one and five of each table demonstrate the inferences that can be made without utilizing any assumptions about prior information and therefore are the results associated with equations (6) and (7). These bounds are sharp, no other inference can be drawn without imposing some restriction on the joint distribution of d_s and *ipr*. As can be seen, these bounds are typically very wide, nevertheless they serve two useful purposes. First, since they are based on mild assumptions, they provide a limit on the range of outcomes that are possible. Second, they serve as a sobering reminder that the data alone cannot provide all the answers, and that precise answers must rely on assumptions about prior information.

Figures 1 and 2 provide an alternative perspective on these bounds. The bounds have been presented in such a way as to consider the impact of marginal changes in IPR standards. This allows us to more clearly investigate the possibility of either non-monotonic effects of IPR reform, as suggested by the Weibull model, or to isolate some decreasing returns to IPR reform. Either characteristic would be consistent with a government being reluctant to move to a set of high IPR standards from an initial position of low or medium standards. The main point of this section is summarized in the first two bars of Figure 1, which relate to IPR reform for a low-income country.[19] As can be seen from the fact that the two bars occupy significant space in both the positive and negative ranges, the data alone cannot isolate the impact of reforms. Therefore, the confidence that one has in claims about the impact of IPR reform really depend on the

[18] See Maskus (2000) for an overview and analysis of the TRIPs agreement and IPR reform more generally.
[19] Figure 2 presents similar information for high-income countries.

credibility of the assumptions made in order to identify the impact of reforms (i.e. how credible are the assumptions about the unobserved counterfactual outcomes).

3 Narrowing The Bounds

The last section shows that in order to derive useful inferences about the impact of IPR reforms on the speed of diffusion it is necessary to utilize prior information. However, the reliability of the point estimates displayed in Section 1 must be questioned due to the strong assumptions about prior information that were invoked. In this section I present estimates that rely on alternative, less restrictive assumptions.[20] After describing each assumption, non-parametric estimates of the effects defined by equation (2) are presented.

3.1 Outcome Optimization[21]

When countries have a choice over the standards of IPR it is natural to assume that they choose these standards with some objective function in mind. In the current context, it is assumed that countries only care about the speed of diffusion and therefore select the standard of IPR that generates the fastest rates of diffusion. While this represents a narrow objective function, it does allow the identifying power of optimizing behavior to be explored directly, offering an alternative to the assumption that IPR are randomly assigned to countries. The identifying power of this assumption comes from the restrictions it implies for the joint distribution of d_s and *ipr*, since now it must be the case that any change in the standard of IPR of a country will result in a slower rate of diffusion. Using this prior information, the bounds on the possible impact of IPR reform can be narrowed substantially.

Formally the outcome optimization assumption requires that if $ipr = s'$, then $d_{s'} < d_s$ for all t and for all $s \neq s'$. This implies that $P[d_s < t \mid X, ipr = s'] < P[d_{s'} < t \mid X, ipr = s']$.

---

[20] Other approaches to narrowing the "no assumption" bounds are considered by Pepper (2000) and Manski and Pepper (2000).
[21] The analysis of this section is based on Manski (1995).

This allows the upper bound of $P[d_s < t \mid X]$ to be tightened compared to that given by equation (4). The new tighter upper bound is given by:

Outcome optimization upper bound on $P[d_s < t| X]$

$$P[d_s < t \mid X, ipr = s]*P[ipr = s| X] + P[d_{s'} < t \mid X, ipr = s']* P[ipr = s'| X] + P[d(_{s''}) < t \mid X, ipr = s'']* P[ipr = s''| X] \qquad (8)$$

A comparison with equation (4) reveals that the "no assumption" upper bound counterfactual probabilities, that took on values of unity, have been replaced by values that represent smaller upper bounds by the optimizing assumption (i.e. $P[d_{s'} < t \mid X, ipr = s']$ replaces 1, and $P[d(_{s''}) < t \mid X, ipr = s'']$ also replaces 1 in determining the upper bound on $P[d_s < t| X]$). Since the outcome optimization assumption has no implications for the lower bound, it remains the same as under the "no assumption" case given in equation (5). Even so, the bounds on equation (2) can be tightened to:

Outcome optimization upper bound on $\Delta[s, s'| X]$

$$P[d_{s'} < t \mid X, ipr = s']*P[ipr=s'] + P[d_{s''} < t \mid ipr = s'']*P[ipr=s''] \qquad (9)$$

Outcome optimization lower bound on $\Delta[s, s'| X]$

$$- P[d_s < t \mid ipr = s]*P[ipr = s] - P[d_{s''} < t \mid ipr = s'']*P[ipr=s''] \qquad (10)$$

Note that since the upper bound is always positive and the lower bound is always negative, the assumption of outcome optimization cannot identify the sign of the impact of IPR reform on the speed of diffusion. Nevertheless, further insight into the potential impact of IPR reform can be gained due to the narrowing of the bounds. The results implied by equations (9) and (10) are given in the second and sixth rows of Tables 3 and 4.

Figure 1 provides a clear indication of the value of the optimizing assumption, with the height of the bar from outcome optimization substantially smaller than those derived under the "no assumption" case. Therefore, for those who are willing to make the assumption of outcome optimization, the bounds can be narrowed substantially. However, the results of this assumption still permit a wide range of possibilities.

3.2 Skimming Model

While assuming that countries have choice over their standards of IPR seems a reasonable assumption to explore, it does ignore the fact that IPR have been influenced to a large degree by both multilateral and bilateral pressures. Case in point, the U.S. has sought to influence the IPR of many countries through the use of Special 301 of the Trade Act of 1974. The general motivation for Special 301 is to ensure that U.S. persons have adequate and effective protection of their intellectual property rights in foreign markets. This broad mandate has been employed extensively to encourage countries to reform their IPR regimes. In this way, Special 301 provides a mechanism for the U.S. to have an impact on the selection of IPR standards in other countries. This raises the likelihood that the U.S.T.R., in administering Special 301, tries to make IPR look as effective as possible.

The skimming model developed by Manski and Nagin (1998) offers one way to examine the effect of this type of external pressure on countries. Under this model, IPR standards are assumed to be selected in order to maximize the apparent effectiveness of IPR on diffusion. In the present context, it is assumed that there are three types of countries, those with naturally high rates of diffusion, those with moderate rates of diffusion and those with low rates of diffusion. To maximize the apparent effectiveness of IPR on diffusion, the high types are allocated high IPR, in effect they are skimmed off. The next step in the skimming process is to consider the allocation of medium standards of IPR. Since the moderate types have the best outcome of the remaining types, they are allocated medium standards of IPR. Finally, the low standards of IPR are allocated to the low types.[22]

[22] While it may seem that this process has to yield an outcome that differs from the outcome optimization model, Manski and Nagin (1998) show that it is possible for the two models to give the same prediction.

If one is prepared to accept the assumptions of the skimming model, it can be shown that the bounds on equation (2) now depend on the comparison being made.[23] Since the focus is on the merits of different marginal changes, only these bounds will be presented.

Skimming upper bound on $\Delta[low, med \mid X]$

$$P[d_m < t \mid X, ipr = med]*\{P[ipr = med \mid X] + P[ipr=low \mid X]\} + P[ipr=hi \mid X] - P[d_l < t \mid X, ipr = low]$$

Skimming lower bound on $\Delta[low, med \mid X]$

$$P[d_m < t \mid X, ipr = med]*\{P[ipr = med \mid X] + P[ipr=hi \mid X]\} - P[d_l < t \mid X, ipr = low]*P[ipr=low \mid X] - P[ipr=hi \mid X] - P[ipr = med \mid X]$$

Skimming upper bound on $\Delta[med, hi \mid X]$

$$P[d_h < t \mid X, ipr = hi] - P[d_m < t \mid X, ipr = med]*\{P[ipr = med \mid X] + P[ipr=hi \mid X]\}$$

Skimming lower bound on $\Delta[med, hi \mid X]$

$$P[d_h < t \mid X, ipr = hi]* P[ipr=hi \mid X] - P[d_m < t \mid X, ipr = med]*\{P[ipr = med \mid X] + P[ipr=low \mid X]\} - P[ipr=hi \mid X]$$

Unlike the bounds of the previous sections, the sign of the impact can potentially be determined. This follows because the upper bounds in principle can be either positive or negative. The results for the skimming model are presented in the third and seventh rows of Tables 3 and 4.

The most striking feature of these results is that the impact of a move from medium to high IPR standards is predicted to be negative for three of the four cases considered. This result is most pronounced for high-income countries with a 60-day cutoff. In this case, even the most <u>optimistic</u> prediction is that the rate of diffusion will be 4 percentage points *lower* for a reform that increases the standard of IPR protection from <u>medium to high</u>.

---

[23] The details of the derivation of these bounds is contained in appendix 2.

The results for the low-income countries are similar, with the most optimistic view estimated to decrease the rate of diffusion by 2 percentage points if standards are raised from medium to high for a 60-day cutoff.

Therefore, the skimming model shows that there may be positive marginal benefits associated with a reform that increases IPR standards from a low level to a medium level. However, the incentives to move from medium standards of IPR to high standards of IPR are not associated with a higher rate of diffusion for either high or low-income countries. Once again, Figure 1 highlights the role played by the assumptions about prior information. The results for the skimming model are summarized in the fifth and sixth bars. As is evident from the position of the two bars, a non-monotonic impact of reform is consistent with the skimming model.

5. Consistency Of The Estimates

The alternative models and estimates presented in sections 2 and 4 reflect the identifying power of various assumptions. By comparing estimates derived under the various assumptions, we can test the joint hypothesis that these assumptions are valid. If the estimates derived under these different information sets do not overlap, then at least one of the assumptions may be invalid. The results for the Weibull model are presented in the fourth and eighth rows of Tables 3 and 4. As can be seen from Tables 3 and 4, not only do the regions associated with the outcome optimization and skimming models overlap, but also the predictions of the Weibull model are contained within this common intersection (given by the bold values). This is a relatively strong test, with the smallest common intersection having a width of just 0.03. Therefore, the predictions are remarkably robust across the alternative assumptions examined.

8. Conclusion

Traditional thinking about intellectual property rights suggests a monotonically increasing relationship between IPR and the speed of diffusion of new products and technologies. Since IPR reform is likely to be associated with some negative effects, this positive effect has been emphasized in the policy literature. However, theoretical models predict a more complicated relationship between IPR and diffusion, one which is determined in part by a force that raises diffusion due to greater security associated with higher IPR, but also slows the rate of diffusion due to an increase in monopoly power from higher IPR. Our analysis of data on the international release pattern of Hollywood movies shows that although moderate standards of IPR encourage the spread of movies, either weaker or stronger property rights tend to decrease the speed with which American movies are released abroad. This empirical finding is consistent with a variety of specifications, including the random assignment of IPR, self-selection of IPR and externally imposed IPR. Overall, it appears that while some IPR recognition may encourage diffusion, very strong IPR may actually retard the speed of diffusion.

References

Acheson, K and C. Maule (1999), *Much ado about culture: North American Trade Disputes*, University of Michigan Press, Ann Arbor

Branstetter, L. (2001), "Is Foreign Direct Investment a Channel for Knowledge Spillovers? Evidence from Japan's FDI in the United States", NBER working paper # 8015

Davis, P. (2002), "Entry, Cannibalization and Bankruptcy in the U.S. Motion Picture Exhibition Market", MIT Sloan working paper

Eaton J. and S. Kortum (1999), "International Patenting and Technology Diffusion: Theory and Measurement", *International Economic Review*, 40: 251-278

Eaton J. and S. Kortum (1996), "Trade in Ideas: Patenting and Productivity in the OECD", *Journal of International Economics*, 40: 251-278

Ginarte, C. and W. Park (1997), "Determinants of Intellectual Property Rights: A Cross-National Study" *Research Policy*, 26: 283-301

Geroski, P. (2000), "Models of Technology Diffusion", *Research Policy*, 29: 603-625

Karshenas, P. and P. Stoneman (1995), "Technological Diffusion" in Stoneman, P. (ed.), *Handbook of the Economics of Innovation and Technological Change*, Basil Blackwell, Oxford

Keller, W. (2001), "International Technology Diffusion", *NBER working paper* #8573

Manski, C. (1989), "Anatomy of the Selection Problem", *Journal of Human Resources*, 24:343-60

Manski, C. (1995), *Identification Problems in the Social Sciences*, Harvard University Press

Manski, C. and D. Nagin (1998), "Bounding Disagreements About Treatment Effects: A Case Study of Sentencing and Recidivism", *Sociological Methodology*, 28: 99-137

Manski, C. and J. Pepper (2000), "Monotone Instrumental Variables: With An Application to the Returns to Schooling", *Econometrica*, 68: 997-1010

Maskus, K. (2000), *Intellectual Property Rights in the Global Economy*, Institute for International Economics, Washington DC

Maskus, K. and M. Penubarti (1995), "How Trade-Related are Intellectual Property Rights?", *Journal of International Economics*, 39: 227-248

McCalman, P. (2001), "Reaping What You Sow: An Empirical Analysis of International Patent Harmonization", *Journal of International Economics*, 55: 161-86

Pepper, J. (2000) "The Intergenerational Transmission of Welfare Receipt: A Nonparametric Bounds Analysis", *The Review of Economics and Statistics*, 82: 472-88

Quirmbach, H. (1986), "The Diffusion of New Technology and the Market for Information", *Rand Journal of Economics*, 17: 33-47

Reinganum, J. (1981), "Market Structure and the Diffusion of New Technology", *Bell Journal of Economics*, 12: 618-624

Screen Digest (various issues), London, England, Screen Digest Ltd

Smith, P. (1999), "Are Weak Patent Rights a Barrier to U.S. Exports?" *Journal of International Economics*, 48: 151-177

Smith, P. (2001), "How Do Foreign Patent Rights Affect U.S. Exports, Affiliate Sales, and Licenses?" *Journal of International Economics*, 55: 411-39

Sutherland, P (1993), "Uruguay Round – Peter Sutherland responds to debate on audiovisual sector", available at www.wto.org

United Nations Development Program (2001), *Human Development Report: Making New Technology Work For Human Development*, Oxford University Press, New York

World Bank (2001), *Global Economic Prospects 2002: Making Trade Work for the World's Poor*, World Bank, Washington D. C.

Table 1
Summary Measures

IPR	**Country**	**Average Duration**	**Std Dev**	**Maximum**
3.90	*Singapore*	49	40	153
3.86	*Australia*	60	44	162
2.86	*Mexico*	61	42	210
2.57	*Hong Kong*	62	44	182
3.57	*Israel*	70	48	223
3.19	*Argentina*	75	60	272
3.35	*Ireland*	80	63	381
2.45	*Iceland*	78	55	319
2.85	*Malaysia*	81	93	433
3.57	*UK*	81	65	399
4.05	*Spain*	84	57	245
2.24	*Thailand*	86	75	462
4.05	*Denmark*	86	49	175
3.86	*Germany*	89	56	216
4.24	*Sweden*	91	58	236
4.05	*France*	91	55	215
4.57	*Austria*	92	56	217
4.38	*Netherlands*	92	56	230
3.57	*South Africa*	93	58	308
3.86	*New Zealand*	93	101	517
4.19	*Finland*	94	51	203
2.98	*Portugal*	97	62	283
4.20	*South Korea*	99	110	477
3.05	*Brazil*	101	116	623
3.91	*Switzerland*	102	115	883
4.19	*Italy*	111	81	504
2.86	*Estonia*	116	61	315
3.37	*Hungary*	116	83	447
3.90	*Norway*	117	100	504
3.90	*Belgium*	124	105	495
3.94	*Japan*	137	96	491
2.65	*Greece*	142	83	315
3.07	*Chile*	149	178	734
2.90	*Poland*	153	99	476
3.19	*Czech Republic*	154	113	538
3.19	*Slovakia*	167	146	601
1.51	*India*	170	126	686
3.46	***Average***	**102**		
0.69	***Std Dev***	**31**		

Table 2
Duration Estimates

	Weibull (1)	*Cox* (2)	*Weibull* (3)
IPR	0.95***	1.12***	0.97***
IPR^2	-0.17***	-0.20***	-0.16***
*IPR^2*Cannibalization*			-0.002*
ln(GDP per capita)	0.25***	0.26***	0.25***
Growth in GDP per capita	0.09***	0.08***	0.09***
ln(Population)	0.04	0.04	0.04
ln(Domestic Film Production)	-0.12***	-0.11***	-0.12***
English speaking country	0.22***	0.23***	0.23***
ln(distance)	0.07	0.05	0.07
ln(Film Budget)	0.62***	0.64***	0.64***
Presence of a "Star"	-0.03	-0.02	-0.04
ln(U.S. Box Office)	0.27***	0.23**	0.24***
Critical Rating	-0.03	-0.02	-0.02
FDI by studio	0.18***	0.19***	0.18***
constant	-26.87***		-26.85***
Monthly Dummies	*yes*	*yes*	*yes*
Studio Dummies	*yes*	*yes*	*yes*
Genre Dummies	*yes*	*yes*	*yes*
Region Dummies	*yes*	*yes*	*yes*
p	1.71		1.71
N	2,022	2,022	2,022
Log Likelihood	-2,021.45	-12,570.87	-2,020.07

*** statistically significant at the 1% level.
** statistically significant at the 5% level.
* statistically significant at the 10% level.

Table 3

Impact of IPR reform on the Rate of Diffusion to Low Income Countries

		t = 60 bounds *lower upper*	***t = 90*** bounds *lower upper*
Process of IPR selection			
No Assumptions	Δ[*low, med*]	[-0.72, 0.65]	[-0.63, 0.73]
Outcome Optimization	Δ[*low, med*]	[**-0.14**, **0.30**]	[**-0.24**, 0.46]
Skimming	Δ[*low, med*]	[-0.58, 0.36]	[-0.42, **0.29**]
Exogenous IPR - Weibull	Δ[*low, med*]	0.04	0.04
No Assumptions	Δ[*med, hi*]	[-0.68, 0.45]	[-0.80, 0.35]
Outcome Optimization	Δ[*med, hi*]	[**-0.22**, 0.14]	[**-0.35**, 0.24]
Skimming	Δ[*med, hi*]	[-0.29, **-0.02**]	[-0.56, **-0.02**]
Exogenous IPR - Weibull	Δ[*med, hi*]	-0.04	-0.04

Table 4

Impact of IPR reform on the Rate of Diffusion to High Income Countries

		t = 60 bounds *lower upper*	***t = 90*** bounds *lower upper*
Process of IPR selection			
No Assumptions	Δ[*low, med*]	[-0.92, 0.92]	[-0.92, 0.93]
Outcome Optimization	Δ[*low, med*]	[**-0.32, 0.35**]	[-0.52, 0.55]
Skimming	Δ[*low, med*]	[-0.56, 0.55]	[**-0.43, 0.29**]
Exogenous IPR - Weibull	Δ[*low, med*]	0.04	0.04
No Assumptions	Δ[*med, hi*]	[-0.63, 0.41]	[-0.47, 0.58]
Outcome Optimization	Δ[*med, hi*]	[**-0.07**, 0.32]	[**-0.09**, 0.52]
Skimming	Δ[*med, hi*]	[-0.59, **-0.04**]	[-0.42, **0.05**]
Exogenous IPR - Weibull	Δ[*med, hi*]	-0.04	-0.03

Appendix 1: Data and sources

<u>List of movies</u>

A Bug's Life, Air Force One, American Beauty, American Pie, Analyze This, Antz, Armageddon, As Good as It Gets, Batman and Robin, Big Daddy, Con Air, Contact, Deep Impact, Double Jeopardy, Dr. Dolittle, Enemy of the State, Face/Off, Flubber, George of the Jungle, Godzilla, Good Will Hunting, Hercules, Inspector Gadget, Lethal Weapon 4, Liar Liar, Men in Black, Mulan, My Best Friend's Wedding, Notting Hill, Patch Adams, Runaway Bride, Rush Hour, Saving Private Ryan, Scream 2, Shakespeare in Love, Sleepy Hollow, Stepmom, Stuart Little, Tarzan, The Blair Witch Project, The General's Daughter, The Green Mile, The Lost World: Jurassic Park, The Mask of Zorro, The Matrix, The Mummy, The Phantom Menace, The Prince of Egypt, The Rugrats Movie, The Sixth Sense, The Spy Who Shagged Me, The Truman Show, The Waterboy, The World is Not Enough, There's Something About Mary, Titanic, Tomorrow Never Dies, Toy Story 2, Wild Wild West, You've Got Mail

duration: days between theatrical release in U.S. and theatrical release in specified country
source: derived from www.imdb.com, various newspapers

IPR: Ginarte and Park index for 1995. Source: Walter Park (unpublished)
Low IPR: less than 2.5, Medium IPR: between 2.5 and 3.10, High IPR: greater than 3.10

GDP per capita, growth rates, population,. Source: World Development Indicators

Domestic Film Production. Source: Screen Digest (1999)

Film Budget, U.S. box office. Source: www.imdb.com

Presence of a “star”, dummy. Source:
ris.ss.uci.edu/econ/personnel/devany/web/papers/starlist.html

Critical rating, San Francisco Chronicle’s Critical Consensus
source: wwww.sfgate.com/eguide/movies/criticalconsensus/

FDI by studio. Source: Screen Digest (1998)

Genre. Source: Blockbuster Video

Appendix 2

The Skimming Model

In this application, it is assumed that there are three types, A, B and C. The A types are assumed to naturally receive new products very quickly. The B types are assumed to receive new products at a more moderate pace. Finally, the C types receive things very slowly.

Very simply, the skimming model is an assumption about prior information. The easiest way to think about it is to focus on what is being restricted.

For instance, in relation to high IPR:

$$P_a[d_h < t|\ X] \geq \pi_1 > P_b[d_h < t|\ X] \geq \pi_1' > P_c[d_h < t|\ X]$$

In relation to medium IPR

$$P_a[d_m < t|\ X] \geq \pi_2 > P_b[d_m < t|\ X] \geq \pi_2' > P_c[d_m < t|\ X]$$

In relation to low IPR

$$P_a[d_l < t|\ X] \geq \pi_3 > P_b[d_l < t|\ X] \geq \pi_3' > P_c[d_l < t|\ X]$$

If a decision maker or social planner wanted to make IPR look the best it could, it would make A types choose high IPR. Once this top group had been singled out it, the decision maker's problem is to try to make IPR look as good as possible in the remaining groups. So, it would assign type B's to medium IPR and type C's to low IPR.

Note that there is no restriction on the relative values of the π's (except between π and π') so an outcome in relation to the marginal impact of IPR reform is not being assumed.

What bounds are implied by these assumptions?

The upper bound on $P[d_h < t|\ X]$ is now $P[d_h < t|\ X, ipr{=}hi]$

The lower bound on $P[d_l < t|\ X]$ is now $P[d_l < t|\ X, ipr{=}low]$

What about $P[d_m < t|\ X]$? Under the skimming model it must be the case that:

$$P[d_m < t|\ X, ipr{=}med] = P_b[d_m < t|\ X] \geq \pi_2' > P_c[d_m < t|\ X] = P[d_m < t|\ X, ipr{=}low]$$

So the upper bound can be tightened by replacing the no information assumption that $P[d_m < t| X, ipr=low]$ is at most 1 with the counterfactual that $P[d_m < t| X, ipr=low]$ is at most $P[d_m < t| X, ipr=med]$.

Similarly, the lower bound can be tightened.

$P[d_m < t| X, ipr=hi]$

$$= P_a[d_m < t| X] \geq \pi_2 > P_b[d_m < t| X] = P[d_m < t| X, ipr=med]$$

So the lower bound can be tightened by replacing the no information assumption that $P[d_m < t| X, ipr=hi]$ is at least 0 with the counterfactual that $P[d_m < t| X, ipr=low]$ is at least $P[d_m < t| X, ipr=med]$.

These bounds now can be used to derive upper and lower bounds on the impact of IPR reform:

Skimming upper bound on $\Delta[low, med \mid X]$

$$P[d_m < t \mid X, ipr = med]*\{P[ipr = med| X] + P[ipr=low| X]\} + P[ipr=hi| X] - P[d_l < t \mid X, ipr = low]$$

Skimming lower bound on $\Delta[low, med \mid X]$

$$P[d_m < t \mid X, ipr = med]*\{P[ipr = med| X] + P[ipr=hi| X]\} - P[d_l < t \mid X, ipr = low]*P[ipr=low| X] - P[ipr=hi| X] - P[ipr = med| X]$$

Skimming upper bound on $\Delta[med, hi \mid X]$

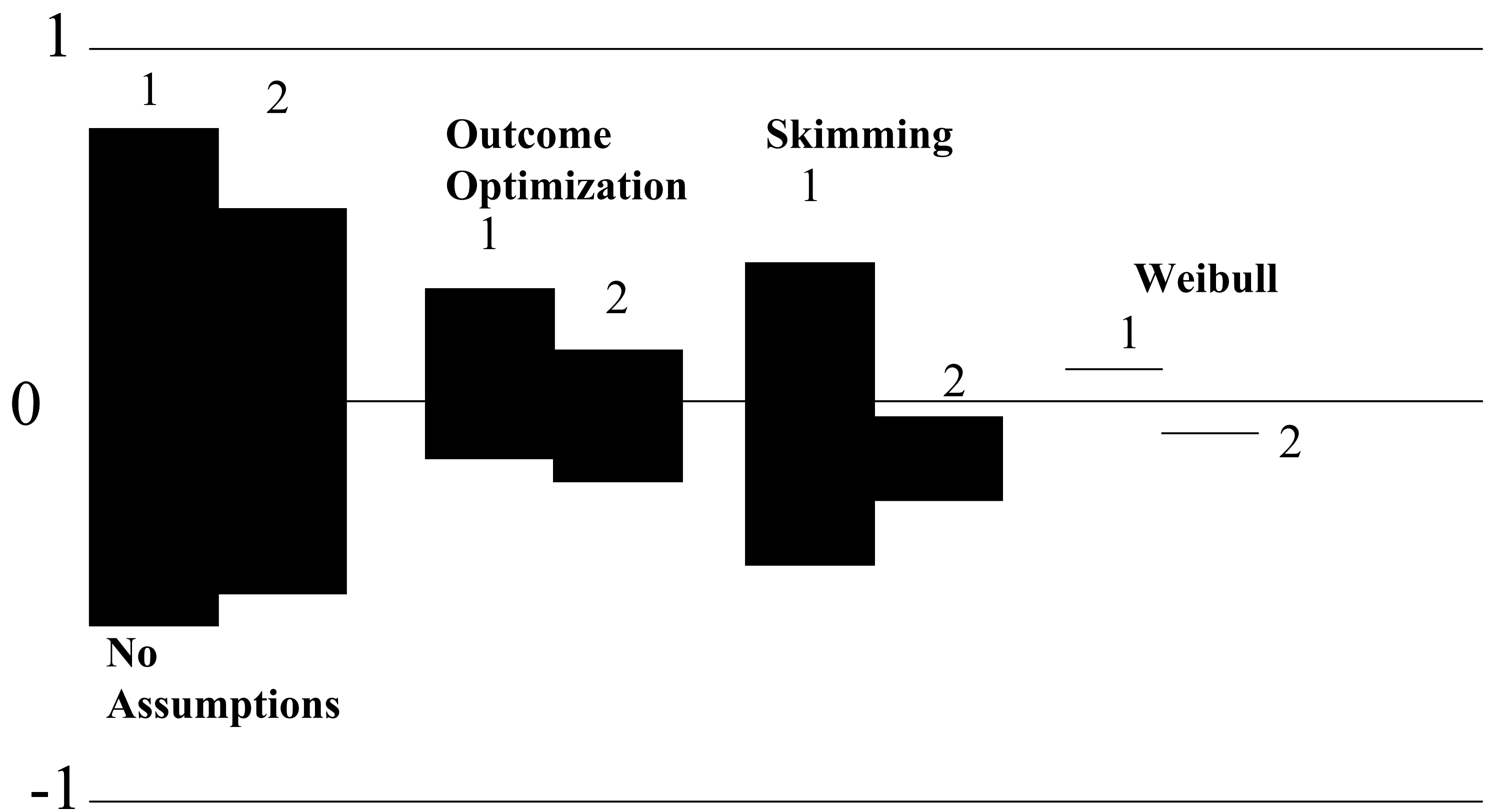
$$P[d_h < t \mid X, ipr = hi] - P[d_m < t \mid X, ipr = med]*\{P[ipr = med| X] + P[ipr=hi| X]\}$$

Skimming lower bound on $\Delta[med, hi \mid X]$

$$P[d_h < t \mid X, ipr = hi]* P[ipr=hi| X] - P[d_m < t \mid X, ipr = med]*\{P[ipr = med| X] + P[ipr=low| X]\} - P[ipr=hi| X]$$

Figure 1

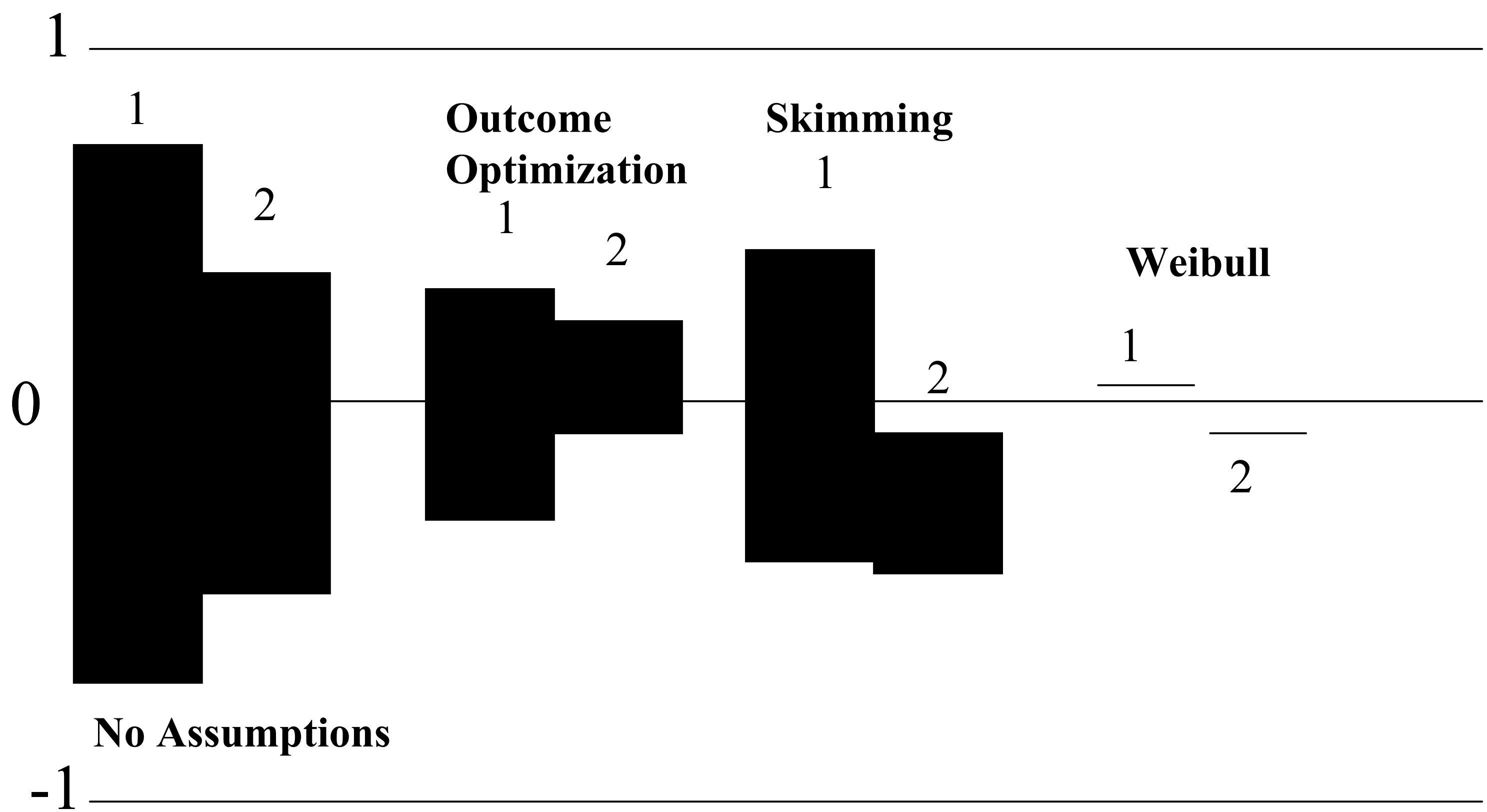
Impact of Reform
Low Income Countries



1 = Δ[low, med, d < 60]
2 = Δ[med, hi, d < 60]

Figure 2

Impact of Reform
High Income Countries



1 = Δ[low, med, d < 60]
2 = Δ[med, hi, d < 60]