INTELLECTUAL PROPERTY RIGHTS AND THE INTERNET

By:

Jonathan Cave
Department of Economics
University of Warwick
UK

J.A.K.Cave@warwick.ac.uk

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1. INTRODUCTION

This paper lays out a research strategy for investigating the 'law and economics' of liability for violation of intellectual property rights in the context of the internet. This draws together separate strands dealing with durable goods monopoly, the law and economics of copyright, patents and copying, agency theory approaches to liability and settlement behaviour. As modelled in this paper, the Internet serves to: reduce the costs of copies; provide network externalities; and define an agency relationship between users and service providers.

In this model (potential) customers have unit demand for a product. Customers of different types derive different utility from using legitimate or illegal copies. The model has (initially) two time periods; the firm announces its price in each time period subject to optimal consumer choice and credibility constraints. Users decide whether to consume a legitimate copy, an illicit copy or no copy during each period. If they purchase a legitimate copy, they make a one-time payment and enjoy the benefits throughout the game. If they elect to use an illicit copy, they are exposed to legal risk during each period in which they use the 'bootleg.' The firm's choice induces separating, pooling or semi-pooling equilibria. Society determines the level of expected penalties subject to firm profit maximisation.

The plan of analysis is as follows:

1. First, the six possible 'strategies' for each type are identified, and conditions for each to be a best reply are derived. It will be shown that the strategy of acquiring an illegal copy in the first period dominates the strategy of acquiring an illegal copy in the second period, which reduces the candidate equilibrium strategies to 5.

2. The possible equilibrium combinations of these strategies are identified, subject to the conditions that no copies can be made unless at least some purchases are made. We shall explore the effects of relaxing this condition to allow copies to be made in pd. 1 provided purchases (not necessarily by the same type) are made in pd. 2 (the 'marketing beta' case). The best-reply conditions will be combined to derive limits on P_1, P_2, and the F_θ's, and the profit-maximising prices and resulting return to the firm obtained for each such combination.

3. The variables exogenous to the firm decision are the W_θ's and V_θ's and the expected penalties F_θ. The qualitatively-significant relations between these parameters divide into a finite set of alternatives (e.g. whether $V_\theta < F_\theta$ - in which case type θ will never copy). For each, we will compare the 'profit-maximising equilibria' derived above to determine the firm's overall optimal strategy, and the associated consumer surplus for each type.

4. Next, we shall compute the optimal levels of property rights enforcement, F_θ, for each type as a function of: firm profits, consumer surpluses and the costs of enforcement.

5. Finally, we shall generalise the model to include:

    a) Firm choice of product lifetimes (number of periods, overlapping versions, etc.

    b) indemnification of the firm for a portion of the damages F_θ's as specific functions of e.g. prices, sales figures, etc.;

    c) the possibility of imposing joint & several or vicarious liability on the users' Internet Service Providers (SPs) on the grounds that they can more easily: observe the users' levels of precaution; block access to illicit copies; and afford to pay court-assessed damages;

    d) negotiation over damages between the firm and users (possibly including SPs who bear liability.

The basic idea underlying steps 1-4 is the ‘durable goods monopoly’ problem associated with the ‘Coase conjecture.’ In one view, the possibility of copying sharpens the conjecture, since the availability of copies is not limited by the original production level and the cost of their production is not affected by the first-period price. In another, this competition strengthens the credibility of the firm’s promise not to cut price in the future, since it may well be uneconomic for the firm to serve those who would otherwise use copies. This is drawn out further in the extension 5a, in which the firm can control the ‘endpoint’ of the process. Another important feature is the potential existence of network externalities (cf. Conner/Rumelt and Takeyama).

Extension 5b allows us to examine the impact of different rules for measuring losses due to violation of intellectual property rights, the contrast between the US and UK systems for assigning legal costs, and the impact of reliance doctrines.

Extension 5c uses a fairly straightforward ‘3-tier principal-agent’ analysis: the SP acts as a principal, writing a fee contract with the user that may depend on the results of noisy SP monitoring of user precautions. This combines with the ‘deep pocket’ argument to motivate SP liability, in ways that reflect the negligence/strict liability character of the legal rule. In particular, under a negligence standard (here the SP’s evidence is critical to the court), joint & several liability gives the SP an incentive to moderate its monitoring efforts and/or to adopt a strategy of never reporting information. In particular, it will emerge that there are only certain conditions under which it pays to impose full J&S liability on SPs and moreover that the optimal legal standard of due care and the degree to which it is implemented in equilibrium are sensitive to model parameters.

Finally, extension 5d uses the analysis of legal signalling developed by Cave, Png, Salant, Reinganum/Stokey and others to examine settlement behaviour.

The rest of this document develops illustrative analyses of steps 1-4.

2. THE COPYING MODEL

2. 1. GENERAL DETAILS

There are two types of consumer (indicated by θ = H or L). A consumer of type θ derives value W_θ [V_θ] from using a legitimate [illegal] copy of a product, and demands 0 or 1 units in each period. There are N_θ customers of type θ.

There are two time periods. In period t, the firm (we assume a single firm) charges price P_t. The firm announces the price vector [P_1, P_2] at the beginning of the game - we limit attention to subgame-perfect equilibria. The firm has constant unit cost, m of making/distributing the product.

Both sides of the market discount the future with a constant factor δ.

The cost of making copies is assumed to be 0 but each period that an illegal copy is used exposes the user of type θ to an expected fine of F_θ. The expected penalty differs by type because:

- enforcement resources may be allocated differently;
- the probability of detection, apprehension, proof, etc. varies by type;
- 'fair use' doctrines may (partially) immunise one or another type of user; and/or
- differences in user wealth may limit effective liability.

2. 2. STRATEGIES AND BEST REPLIES

Given prices Pt, the strategic choices open to a customer of type q involve a choice of Buy (B), Copy (C), or Nothing (N) in each period. Certain combinations can be dismissed on *a priori* grounds: B followed by C is dominated by B followed by N[1]; B followed by B and C followed by C are dominated due to the durability of the product. The remaining combined strategies and their expected payoffs are described in Table 1:

Table 1: Strategies and Payoffs

Period 1	Period 2	Expected Payoff
N	*N*	0
B	*N*	$(1+\delta)W_\theta - P_1$
N	*B*	$\delta(W_\theta - P_2)$
C	*N*	$(1+\delta)[V_\theta - F_\theta]$
N	*C*	$\delta[V_\theta - F_\theta]$
C	*B*	$V_\theta - F_\theta + \delta[W_\theta - P_2]$

Note that the strategy <N, C> is never a best reply: it is dominated by <N, N> or <C, N>. For convenience, let $\chi_\theta = \max\{0, V_\theta - F_\theta\}$ denote type θ's incentive to use a bootleg copy and $R_\theta = W_\theta - \chi_\theta$ be type θ's surplus from using a legitimate copy. Table 2 gives the conditions under which each candidate equilibrium strategy will by type θ's best reply.

Table 2: Best Reply Conditions

[1] Unless the utility of using a bootleg exceeds that of using a legitimate copy.

Strategy	P_1 condition	P_2 condition	F_θ condition
<*N, N*>	$P_1 \geq (1+\delta)W_\theta$	$P_2 \geq W_\theta$	$F_\theta \geq V_\theta$
<*B, N*>	$P_1 \leq (1+\delta)R_\theta$	$P_1 - \delta P_2 \leq R_\theta$	
<*N, B*>	$P_1 \geq W_\theta + \delta P_2$	$P_2 \leq W_\theta$	$F_\theta \geq V_\theta$
<*C, N*>	$P_1 \geq (1+\delta)R_\theta$	$P_2 \geq R_\theta$	$F_\theta \leq V_\theta$
<*C, B*>	$P_1 - \delta P_2 \geq R_\theta$	$P_2 \leq R_\theta$	$F_\theta \leq V_\theta$

2. 3. EQUILIBRIA

The candidate equilibria shown in Table 3. The four types that survive the firm's profit maximisation are indicated by name and bold type.

Table 3: Possible Equilibria

$\sigma_L \backslash \sigma_H$	<*N, N*>	<*B, N*>	<*N, B*>	<*C, N*>	<*C, B*>
<N, N>	X	**Elite**	2	X	a
<B, N>	3	**Pool**	5	6	**Beta**
<N, B>	8	9	10	b	c
<C, N>	X	**Piracy**	d	X	e
<C, B>	f	12	g	h	i

We now examine each in turn, identifying all relevant conditions and finding the profit-maximising prices subject to those conditions. Before doing so, notice that taken together, the conditions:

- $P_1 = (1+\delta)R_\theta$ and
- $P_1 - \delta P_2 = R_\theta$

imply:

- $P_2 = R_\theta$

Moreover, while we assume that it is economic to serve either type of customer in the absence of copying (e.g. $W_H > W_L > m$), it is not self-evident that it is economic to serve them once the incentive to copy is taken into account. We say that it is economic to serve type θ if θ's surplus from using a legitimate copy exceeds the cost of supplying one: $W_\theta - \chi_\theta > m$.

2. 3. 2. 'Elite' - First period sales to High type only

The firm maximises $[P_1 - m]N_H$ subject to:

- $P_1 \leq (1+\delta)R_H$
- $P_1 \geq (1+\delta)W_L$
- $P_1 - \delta P_2 \leq R_H$
- $P_2 \geq W_L$
- $F_L \geq V_L$

Combining these, we obtain:

Optimal Prices: $P_1 = (1+\delta)[W_H - \chi_H]$; $P_2 \geq W_H - \chi_H$.

Outside Constraints: $W_L \leq W_H - \chi_H$; $F_L \geq W_L$.

Profit: $[(1+\delta)[W_H - \chi_H] - m]N_H$.

2. 3. 3. Equilibrium 2 - Second period sales to high type only

The firm maximises $\delta[P_2 - m]N_H$ subject to:

- $P_1 \geq (1+\delta)W_L$
- $P_2 \geq W_L$
- $F_L \geq V_L$
- $P_1 - \delta P_2 \geq W_H$
- $P_2 \leq W_H$
- $F_H \geq V_H$

Combining these, we obtain:

Optimal Prices: $P_1 \geq (1+\delta)W_H$; $P_2 = W_H$

Outside Constraints: $F_L > V_L$; $F_H > V_H$

Profit: $\delta[W_H - m]N_H$.

2. 3. 4. Equilibrium 3 - First period sales to Low type only

Here the P_1 - conditions (see Table 2) are inconsistent.

2. 3. 5. 'Pool' - First-period sales to both types

The firm maximises $(P_1 - m)(N_H + N_L)$ subject to

- $P_1 \leq (1+\delta)R_H$
- $P_1 \leq (1+\delta)R_L$
- $P_1 - \delta P_2 \geq R_H$
- $P_1 - \delta P_2 \geq R_L$

Combining these and optimising profit, we note that there are two cases depending on which type has the lowest value of $W_\theta - \chi_\theta$:

Optimal Prices: $P_1 = (1+\delta)\min\{R_H, R_L\}$; $P_2 \geq \min\{R_H, R_L\}$.

Outside Constraints: none

Profit: $[(1+\delta)\min\{R_H, R_L\} - m](N_H + N_L)$

2. 3. 6. Equilibrium 5 - Sales to Low [High] in first [second] period

The firm maximises $(P_1 - m)N_L + \delta(P_2 - m)N_H$ subject to:

- $P_1 \leq (1+\delta)R_L$
- $P_1 - \delta P_2 \geq W_H$
- $P_1 - \delta P_2 \leq R_L$
- $P_2 \leq W_H$
- $F_H \leq V_H$

The second and third of these conditions are inconsistent.

2. 3. 7. Equilibrium 6 - Sales to low and copying by High in first period

The firm maximises $(P_1 - m)N_L$ subject to:

- $P_1 \leq (1+\delta)R_L$
- $P_1 - \delta P_2 \leq R_L$
- $P_1 \geq (1+\delta)R_H$
- $P_2 \geq R_H$
- $F_H \leq V_H$

This equilibrium is characterised by:

Optimal Prices: $P_1 = (1+\delta)(W_L - \chi_L)$; $P_2 \geq W_L - \chi_L$

Outside Constraints: $W_L - \chi_L \geq W_H - \chi_H$; $F_H \leq V_H$

Profit: $[(1+\delta)R_L - m]N_L$

2. 3. 8. 'Beta' - Low type buys in first period; High type copies [buys] in first [second] period

The firm maximises $(P_1 - m)N_L + \delta(P_2 - m)N_H$ subject to:

- $P_1 \leq (1+\delta)R_L$
- $P_1 - \delta P_2 \leq R_L$
- $P_2 \leq R_H$
- $P_1 - \delta P_2 \geq R_H$
- $F_H \leq V_H$

This equilibrium is characterised by:

Optimal Prices: $P_1 = R_L + \delta R_H$; $P_2 = R_H$

Outside Constraints: $R_L \geq R_H$; $F_H \leq V_H$

Profit: $[R_L + \delta R_H - m]N_L + \delta(R_H - m)N_H$

2. 3. 9. Equilibrium 8 - Sales to Low in period 2

The firm maximises P_2 subject to

- $P_1 - \delta P_2 \geq W_L$
- $P_2 \leq W_L$
- $F_L \geq V_L$
- $P_1 \geq (1+\delta)W_H$
- $P_2 \geq W_H$
- $F_H \geq V_H$

These conditions are inconsistent.

2. 3. 10. Equilibrium 9 - Sales to High [Low] in first [second] period

The firm maximises $(P_1 - m)N_H + \delta(P_2 - m)N_L$ subject to:

- $P_1 \leq (1+\delta)R_H$
- $P_1 - \delta P_2 \leq R_H$
- $P_1 - \delta P_2 \geq W_L$
- $P_2 \leq W_L$
- $F_L \geq V_L$

This results in:

Optimal prices: $P_1 = R_H + \delta W_L$; $P_2 = W_L$

Outside Constraints: $W_L \leq R_H$; $F_L \geq V_L$

Profit: $[R_H + \delta W_L - m]N_H + \delta(W_L - m)N_L$

2. 3. 11. Equilibrium 10 - Sales to both types in second period

The firm maximises $(P_2 - m)(N_H + N_L)$ subject to:

- $P_1 \geq W_L + \delta P_2$
- $P_2 \leq W_L$
- $F_L \geq V_L$
- $P_1 \geq W_H + \delta P_2$
- $P_2 \leq W_H$
- $F_H \geq V_H$

This leads to:

Optimal prices: $P_1 \geq W_H + \delta W_L$; $P_2 = W_L$

Outside Constraints: $F_H \geq V_H$; $F_L \geq V_L$

Profit: $\delta(W_L - m)(N_H + N_L)$

2. 3. 12. 'Piracy' - Sales to high, copying by Low in first period

The firm maximises $(P_1 - m)N_H$ subject to:

- $P_1 \leq (1+\delta)R_H$
- $P_1 - \delta P_2 \leq R_H$
- $P_1 \geq (1+\delta)R_L$
- $P_2 \geq R_L$
- $F_L \leq V_L$

This leads to:

Optimal prices: $P_1 = (1+\delta)R_H$; $P_2 \geq R_L$

Outside Constraints: $R_H \geq R_L$; $F_L \leq V_L$

Profit: $((1+\delta)R_H - m)N_H$

2. 3. 13. Equilibrium 12: Sales to High [Low} in first [second] period; copying by Low in first period.

The firm maximises $(P_1 - m)N_H + \delta(P_2 - m)N_L$ subject to:

- $P_1 \leq (1+\delta)R_H$
- $P_1 - \delta P_2 \leq R_H$
- $P_1 - \delta P_2 \geq R_L$
- $P_2 \leq R_L$
- $F_L \leq V_L$

This leads to:

Optimal prices: $P_1 = R_H + \delta P_L$; $P_2 = R_L$

Outside Constraints: $R_H \geq R_L$; $F_L \leq V_L$

Profit: $(R_H + \delta P_L - m)N_H + \delta(R_L - m)N_L$

2. 4. THE FIRM'S CHOICES

2. 4. 1. Candidate Equilibria

We begin by reviewing the equilibrium results of the last section. Subject to the conditions resulting from policy variables (the F_θs), the firm can choose the equilibrium offering the highest profit. Four of the equilibria survive this process: their numbers have been replaced with names in the following table.

	P_1	*P_2*	*Profit*	*Conditions*
Elite	$\mathbf{(1+\delta)R_H}$	$\mathbf{\geq R_H}$	$\mathbf{[(1+\delta)R_H - m]N_H}$	$\mathbf{R_L \leq R_H; F_L \geq V_L}$
2	$(1+\delta)W_H$	$P_2 = W_H$	$\delta[W_H - m]N_H$	$F_L > V_L$; $F_H > V_H$
Pool	$\mathbf{(1+\delta)R^*}$	$\mathbf{R^*}$	$\mathbf{[(1+\delta)R^* - m](N_H + N_L)}$	
6	$(1+\delta)R_L$	R_L	$[R_L + \delta R_H - m]N_L$	$R_L \geq R_H$; $F_H \leq V_H$
Beta	$\mathbf{R_L + \delta R_H}$	$\mathbf{R_H}$	$\mathbf{\delta(R_H - m)N_H + [R_L + \delta R_H - m]N_L}$	$\mathbf{R_L \geq R_H; F_H \leq V_H}$
9	$R_H + \delta W_L$	W_L	$[R_H + \delta W_L - m]N_H + \delta(W_L - m)N_L$	$R_L \leq R_H$; $F_L \geq V_L$
10	$W_H + \delta W_L$	W_L	$\delta(W_L - m)(N_H + N_L)$	$F_H \geq V_H$; $F_L \geq V_L$
Piracy	$\mathbf{(1+\delta)R_H}$	$\mathbf{W_L}$	$\mathbf{((1+\delta)R_H - m)N_H}$	$\mathbf{R_H \geq R_L; F_L \leq V_L}$
12	$R_H + \delta R_L$	R_L	$(R_H + \delta R_L - m)N_H + \delta(R_L - m)N_L$	$R_H \geq R_L$; $F_L \leq V_L$

* Note: $R^* \equiv \min\{R_H, R_L\}$

To clarify the firm's choice among these equilibria, we describe the 6 logically-possible combinations of relative values of V_θ and F_θ for each θ and the relative value of R_H and R_L. Comparing the firm's profits in each candidate equilibrium, we arrive at the profit-maximising outcomes for each case shown in the next table.

V_L *v.* F_L	V_H *v.* F_H	R_H *v.* R_L	*Equilibria*
$V_L \leq F_L$	$V_H \leq F_H$	$R_L \leq R_H$	Elite[Pool] if $(R_H\text{-}R_L)N_H >[<] [R_L\text{-}m/(1+\delta)]N_L$
$V_L \leq F_L$	$V_H > F_H$	$R_H \leq R_L$	Pool[Beta] if $[R_H\text{-}(1\text{-}\delta)m)]N_H >[<] (R_L\text{-}R_H)N_L$
$V_L \leq F_L$	$V_H > F_H$	$R_L \leq R_H$	Elite[Pool] if $(R_H\text{-}R_L)N_H >[<] [R_L\text{-}m/(1+\delta)]N_L$
$V_L > F_L$	$V_H \leq F_H$	$R_L \leq R_H$	Piracy[Pool] if $(R_H\text{-}R_L)N_H >[<] [R_L\text{-}m/(1+\delta)]N_L$
$V_L > F_L$	$V_H > F_H$	$R_H \leq R_L$	Pool[Beta] if $[R_H\text{-}(1\text{-}\delta)m)]N_H >[<] (R_L\text{-}R_H)N_L$
$V_L > F_L$	$V_H > F_H$	$R_L \leq R_H$	Piracy[Pool] if $(R_H\text{-}R_L)N_H >[<] [R_L\text{-}m/(1+\delta)]N_L$

Recall that:

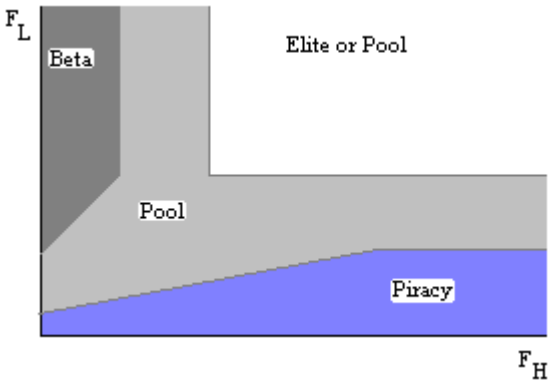
- *Elite* is a separating equilibrium in which only the high type is served during the first period, and no sales are made in the second period;
- *Pool* is a first-period pooling equilibrium;
- *Beta* is an intertemporal separating equilibrium in which the High type copies in the first period and buys in the second, while the low type buys in period 1; and
- *Piracy* is a copying equilibrium in which the High type buys and the Low type copies in period 1.

2. 5. LEVELS OF ENFORCEMENT

The following Table shows the above equilibria as functions of expected enforcement costs F_θ and the profits and surpluses associated with each equilibrium.

	Conditions	*Profit*	*High surplus*	*Low surplus*	*Welfare*
Elite	$F_L \geq V_L$; $R_L \leq R_H$; $[R_H\text{-}R_L]N_H \geq [R_L\text{-}\frac{m}{1+\delta}]N_L$	$[(1+\delta)R_H\text{-}m]N_H$	$(1+\delta)(W_H\text{-}R_H)$	0	$[(1+\delta)W_H\text{-}m]N_H$
Pool	$R_L \leq R_H$; $[R_H\text{-}R_L]N_H \leq [R_L\text{-}\frac{m}{1+\delta}]N_L$	$[(1+\delta)R_L\text{-}m]N_H$ $+ [(1+\delta)R_L\text{-}m]N_L$	$(1+\delta)(W_H\text{-}R_L)$	$(1+\delta)(W_L\text{-}R_L)$	$[(1+\delta)W_H\text{-}m]N_H$ $+ [(1+\delta)W_L\text{-}m]N_L$
	$R_L \geq R_H$; $F_H \leq V_H$; $[R_H\text{-}(1\text{-}\delta)m]N_H \geq [R_L\text{-}R_H]N_L$	$[(1+\delta)R_H\text{-}m]N_H$ $+ [(1+\delta)R_H\text{-}m]N_L$	$(1+\delta)(W_H\text{-}R_H)$	$(1+\delta)(W_L\text{-}R_H)$	
Beta	$F_H \leq V_H$; $R_H \leq R_L$; $[R_H\text{-}(1\text{-}\delta)m]N_H \leq (R_L\text{-}R_H)N_L$	$\delta[R_H\text{-}m]N_H$ $+ [R_L\text{+}\delta R_H\text{-}m]N_L$	$V_H\text{-}F_H\text{+}\delta(W_H\text{-}R_H)$	$W_L\text{-}R_L\text{+}\delta(W_L\text{-}R_H)$	$[V_H\text{-}F_H\text{+}\delta(W_H\text{-}m)]N_H$ $+ [(1+\delta)W_L\text{-}m]N_L$
Piracy	$F_L \leq V_L$; $R_L \leq R_H$; $[R_H\text{-}R_L]N_H \geq [R_L\text{-}\frac{m}{1+\delta}]N_L$	$[(1+\delta)R_H\text{-}m]N_H$	$(1+\delta)(W_H\text{-}R_H)$	$(1+\delta)(V_L\text{-}F_L)$	$[(1+\delta)W_H\text{-}m]N_H$ $+ (1+\delta)(V_L\text{-}F_L)N_L$

The following figure shows the different equilibria in policy (F_H, F_L) space.



From the unweighted social welfare function point of view, the Elite equilibrium is always worse than the Pool. Within the Piracy and Beta equilibria, social welfare is highest when the expected punishments F_θ are lowest ($F_H = 0$ for Beta and $F_L = 0$ for Piracy). The overall social optimum corresponds to:

- Pool if $m \leq \min\{\frac{W_H - V_H}{1-\delta}, (1+\delta)(W_L - V_L)\}$;
- Beta if $\min\{0, [(1+\delta)(W_L - V_L) - m]N_L\} \geq [W_H - V_H - (1-\delta)m]N_H$; and
- Piracy if $\min\{0, [W_H - V_H - (1-\delta)m]N_H\} \geq [(1+\delta)(W_L - V_L) - m]N_L$

In some sense, the optimality of the equilibria with copying is unsurprising; copying represents a cheaper means of producing the product. The firms typically prefer their 'best' Pool equilibrium (where $F_H = V_H$) to the 'best' Piracy equilibrium (where $F_L = V_L$), but may prefer a lower value of F_L and the Piracy equilibrium if the best pool is unavailable.

If firms are indemnified for a proportion λ of the expected legal penalties for copying, their profits in the four equilibria become:

- Elite: $[(1+\delta)R_H - m]N_H$;
- Pool: $[(1+\delta)R^* - m](N_H+N_L)$;
- Beta: $\delta[R_H - m]N_H + [R_L + \delta R_H - m]N_L + \lambda F_H N_H$; and
- Piracy: $[(1+\delta)R_H - m]N_H + \lambda(1+\delta)F_L N_L$

3. THE SP LIABILITY MODEL

In this section, we develop a 3-tier principal-agent model to describe the imposition of liability on service providers (SPs). The underlying motivation for liability in this model is that SPs are presumed to have better information about their users' activities and to have 'deeper pockets' for meeting legal claims.