Crime and Durable Goods

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Short Version

- Crime and the durability of goods are strongly connected topics.
- However, surprisingly, they have been studied separately (there has not been any links)
- There are two separate literatures
  - The production of durable goods
  - The literature on crime.
- We explore the relationship between crime and the durability of goods from a theoretical perspective.
- Interaction between both issues produce important conclusions.
- The paper provides the first theoretical examination of the externality that emerges when we take into account that greater durability of goods increases crime.

Short Version II

- $\downarrow$ durability of goods $\Rightarrow\downarrow$ incentives to steal the goods$\Rightarrow\downarrow$ crime.
- Crime produces externalities (armed robbery, killed)
- Perfect competition does **not** provide the optimal durability level.
- This happens even if the externalities caused by crime are not considered.
- Two technologies for stealing are studied:
  1. Random stealing, perfect competition overproduces durability.
  2. Selective stealing, perfect competition produces goods of zero durability.
- Monopoly market structure underproduces durability.
- Policy implication: the durability of goods, and the market structure for those goods, can be an effective instrument to reduce crime.
- Making the durability of a good contingent upon that good being stolen increases welfare. (IMEI number in cells)

Motivation

- Most of the crimes are property crimes (87 % of total crime in US and 70 % in UK). Acquisitive crimes are important drivers of overall crime trends.
- A large component of property crimes is of durable goods.
- These suggests a relationship between the durability of goods and crime, unexplored so far.
- Vehicles:
  - US: 690,000 thefts of motor vehicles in 2014.
  - UK: around 32,000 motor vehicle offenses in 2014.
- Smartphones:
  - In 2013 more than one-quarter of all thefts and over half of grand larcenies from a person in New York City involved a smartphone.
  - In 2013–2014 in England and Wales, there were half a million mobile phone theft victims.

Motivation II

- Specially relevant for LAC (2013)
  - Chile, durable goods represented 96% of thefts and robberies
  - Colombia, 48% of thefts were cellular phones.
  - Mexico 52% of total thefts included cellular.
- LAC has the highest regional homicide rate: 24 per 100,000 population.
- Insecurity is the main concern of the population in every survey, more than unemployment or inflation.
- 1/4 LAC citizens claim that insecurity is the problem they care most about.

Contribution to Crime Literature

- **Can goods durability affect the equilibrium crime rate?**
- Crime economics framework (Becker, 1968): **durability increases the pay off of illegal activities**.
- Lit. mainly concentrates on the **deterrence effects** of **changing the costs of committing crimes**, increases in the certainty, celerity, and severity of punishment.
- Another strand on changes in the **incentives to engage in legal activities** (crime and unemployment or crime and education).
- Few studies on how the economic **return of crime** may change crime levels.

Durable Goods Literature

- First studies on durable goods: Akerlof (1970) on adverse selection, Swan (1970, 1971) on optimal durability, and Coase (1972) on time inconsistency.
- In the 1990s, asymmetric information and adverse selection were included in models of durable goods, and the literature initially advanced these models and then turned to other developments more consistent with the real world.
- However, this literature still ignores the externality that emerges if we take into account that reducing the durability of a good could reduce the incentives to steal that good.

Durability

- **Main question: Do monopolies produce the optimal level of durability?**
- Swan (1970, 1971): YES
  - Depreciation assumptions: a number of used units is a perfect substitute for a new unit.
- Waldman (1996): NO
  - Relaxes the depreciation assumption: with imperfect substitutability, a monopolist under-produces D.
  - The price of a used unit on the secondhand market constrains the monopolist in terms of the price he can charge for new units.
- **No crime in durable goods literature**.

Introducing externality of crime

- In all the literature the threat of crime was absent
  - The traditional welfare function is
  - Consumer Surplus +Producer Surplus

$$W = \sum_i CS_i(q_i, D_i) + \sum_j PS_j(q_j, D_j)$$

where q is the quantity and D the quality or durability

- Perfect competition leads to the optimal level of durability
- However we can think that greater durability implies more crime

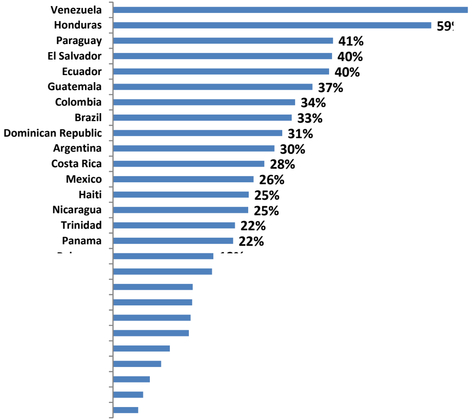
Introducing externality of crime II

- With the externality of crime:

$$W = W\left(\sum_i CS_i(q_i, D_i) + \sum_j PS_j(q_j, D_j), Crime(q, D)\right)$$

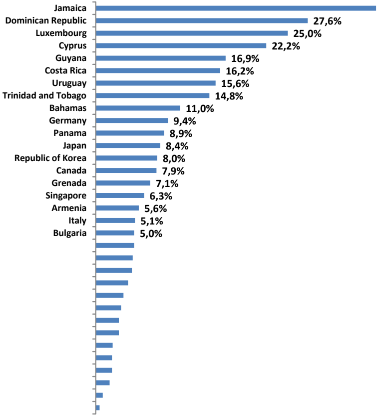
- The greater the durability of a good, the higher its selling price and the higher, in equilibrium, the amount of property crimes.
- It is clear that the cost of crime includes externalities.
- Perfect competition does not lead to the optimal level of durability even under Swan's assumptions.

- % of crime victims that suffered armed robbery



The Externalities

- % of homicides that were in robberies



The Model

- We build upon Waldman (1996) and incorporate crime.
- 2 periods world. Output lasts 2 periods.
- **Time Sequence is**

1. Period 1
    1. Production take place.
    2. Firms sell the products.
2. Period 2
    1. The goods bought in period one can be stolen.
    2. Production take place.
    3. Firms, owner of used goods and thiefs sell the goods

The Model II

Producers:

- At each period t the durability is determined D_t
- D affects both marginal costs and the Quality (D is the speed of deterioration).
- Cost: $c(D_t)$, increasing and convex.
- Quality: $Q(D_t)$ is increasing and concave in durability.
- New units of product are of quality Q^N, while in the second period units that are one period old are of quality $Q^O(D_1)$
- $\rightarrow D_2^* = 0$

The Model III

Consumers:

- Consume 1 or 0 goods in each period.
- 2 types of consumers: n_1 of type 1 and n_2 of type 2;
  - Utility if buy in legal market: $U_i = v_i Q$
  - Utility if buy in illegal market: $U_i = \alpha v_i Q$
    - where $0 \leq \alpha \leq 1$
  - type 1 consumers have lower value $v_1 < v_2$
  - Common discount factor δ, $0 < \delta < 1$.

The Model III

Thieves:

- There is a cost of stealing a mass of size m goods given that there is a mass of size h that could be stolen. the cost is $s(m, h) = \frac{m^2 k}{h}$
  - where $k \geq V_2 Q^N$
- Stealing Technologies
  1. Selective stealing, thieves choose which goods steal.
  2. Random stealing, goods are stolen randomly.

  - When the owner of a good is stolen he lost the good, he cannot consume it nor sell it.

The Model IV

Assumptions to reduce the cases

- Similarly to Waldman (1996) we look at the case where

  - $$n_1 > n_2 \qquad (1)$$

    In equilibrium the price of used goods is positive and there are incentives for steal the goods.

  - $$v_1 Q^N + \delta v_1 Q^o(D) < c(D) \qquad \forall D \qquad (2)$$

    valuation of type 1 consumers (v_1) is low enough no incentives to sell them a new good

  - $$v_2(Q^N - Q^o(\infty)) > c(0) \qquad (3)$$

    valuation of type 2 consumers is high enough that is profitable to sell them a new unit in the second period.

Used and Stolen goods Market

- We solve the model backwardly.
- Second period markets, works independently of the case.

Lemma

Whenever there is a market in the second period for used and stolen goods.

1. *The price of the used goods of durability D is*

$$P_2^{OD} = v_1 Q^O(D)$$

2. *The price of the stolen goods of durability D is*

$$P_2^{SD} = \alpha v_1 Q^O(D)$$

- The intuition is clear. Since the quantity of consumers that demand both used and stolen goods is higher than the supply. The equilibrium price is the buyers' reservation price.

Stealing technologies: Selective stealing Perfect Competition

- Costs of stealing are the same prices depend, positevely, on the durability.
- Goods chosen to be stolen are those with greater durability.
- Given $F(D)$, when there is selective stealing the thieves' problem is deciding the cutoff point of durability.
- Thus, they solve the following problem.

$$Max_D \int_D^\infty \alpha v_1 Q^o(s) f(s) ds - \frac{\left(\int_D^\infty f(s) dsh\right)^2 k}{h}$$

- Solving the problem we have:

$$-\alpha v_1 Q^o(D^{*SS}) + 2(1 - F(D^{*SS}) hk = 0 \tag{4}$$

Stealing technologies: Selective stealing Perfect Competition II

Lemma

The goods that have a quality higher than D^{*SS} are stolen and the ones with quality smaller there are not. The ones that has a quality equal to D^{*SS} some are stolen and some are not. Where D^{*SS} is defined implicetly by (4).

- Want to produce durability less than D^{*SS}
- Unraveling result.

Stealing technologies: Selective stealing Perfect Competition II

Proposition

Under perfect competition and selective stealing only goods with durability $D = 0$ are produced. There is no crime and the price is $P^N_{1PC} = c(0)$ and $P^N_{2PC} = c(0)$. Consumers type 1 never consume anything.

Stealing technologies: Random stealing

- Given $F(D)$, goods stolen are randomly "chosen". Thus, the thieves' decision involves the quantity of goods not the cutoff point of durability.
- To find the optimal quantity they maximize the following problem

$$Max_m \left(m \int_0^\infty \alpha v_1 Q^o(s) f(s) ds - \frac{(m)^2 k}{h} \right)$$

- The solution is

$$m^* = \frac{h \int_0^\infty \alpha v_1 Q^o(s) f(s) ds}{2k}$$

- Note that given the assumption about k this value is always smaller than h

Stealing technologies: Random stealing, Perfect Competition

- Perfect competition. Which goods stolen independently on durability.
- Firms maximize profits, taking probability given. Produce durability that maximizes consumers utility. Competition drives profits to 0.
- Durability level comes from maximizing the utility of the consumer, taking the probability of stealing as given.
- Thus, firms solve the following problem.

$$Max_{D_1} = v_2 Q^N + \delta \left[\left(1 - \frac{\int_0^\infty \alpha v_1 Q^o(s) f(s) ds}{2k} \right) v_1 Q^0(D_1) \right] - c(D_1) \tag{5}$$

Stealing technologies: Random stealing, Perfect Competition II

Proposition

Under perfect competition and random stealing the durability D_{PC} is given, implicetly, by the following equation

$$\delta\left[\left(1-\frac{\alpha v_1 Q^o(D_{PC})}{2k}\right)v_1 Q^{0'}(D_{PC})\right]-c'(D_{PC})=0 \qquad (6)$$

- All the firms will set the durability that maximizes (5). Then, all will produce the same durability that is D_{PC} so

$$\frac{\int_0^\infty \alpha v_1 Q^o(s) f(s) ds}{2k}=\frac{\alpha v_1 Q^o(D_{PC})}{2k}$$

Stealing technologies: Random stealing, Perfect Competition III

- Note that (6) always has a unique solution since
  1. $\delta\left[\left(1-\frac{\alpha v_1 Q^o(0)}{2k}\right) v_1 Q^{0'}(0)\right] - c'(0) > 0,$
  2. $\delta\left[\left(1-\frac{\alpha v_1 Q^o(D_1)}{2k}\right) v_1 Q^{0''}(D_1) - \frac{\alpha v_1 Q^{0'}(D_1)}{2k}\right] - c''(D_1) < 0 \ \forall D_1$ and
  3. $\delta\left[\left(1-\frac{\alpha v_1 Q^o(\infty)}{2k}\right) v_1 Q^{0'}(\infty)\right] - c'(\infty) < 0.$

Social Optimum

- Social Optimun and the monopoly we restrict our analysis to the case of having homogeneity on the durability. Facilitates comparison.
- The Social Optimum Problem is

$$Max_{D_1} W = W\left(CS(D_1) + PS(D1) + \phi \ thieves \ profits(D_1), Crime(D_1)\right)$$

- Which is:

$$Max_{D_1} W \left\{ \begin{array}{c} n_2 \left\{ \begin{array}{c} v_2 Q^N - c(D_1) + \\ \delta \left\{ \begin{array}{c} \left[\left(1 - \frac{\alpha v_1 Q^o(D_1)}{2k}\right) v_1 Q^0(D_1) \right] + \\ \phi \left[\begin{array}{c} \frac{\alpha v_1 Q^o(D_1)}{2k} \alpha v_1 Q^0(D_1) - \\ \left(\frac{n_2 \alpha v_1 Q^o(D_1)}{2k}\right)^2 \frac{k}{n_2^2} \end{array} \right] \\ + v_2 Q^N - c(0) \end{array} \right\} \end{array} \right\} \\ , \frac{v_1 Q^o(D_1)}{2k} n_2 \end{array} \right\}$$

Social Optimum II

- The optimal durability is the one that makes

$$
\begin{aligned}
W_1 n_2 \left\{ \begin{array}{c} \delta \left[\begin{array}{c} 1 - \frac{\alpha v_1 Q^o(D_1)}{k} + \\ \phi \left(\frac{\alpha^2 v_1 Q^o(D_1)}{k} - \left(\frac{\alpha^2 v_1 Q^o(D_1)}{2k} \right) \right) \end{array} \right] \\ v_1 Q^{0'}(D_1) - c'(D_1) \end{array} \right\} \\
+ W_2 \frac{v_1 Q^{o'}(D_1)}{2k} n_2 &= 0
\end{aligned}
$$

- To compare to the case of perfect competition and monopoly, we assume away the externality $W_2 = 0$ and we will not consider the welfare appropriated by the thieves, i.e. $\phi = 0$.
- $W_2 = 0$, **increases the social optimum** of producing durability (cost caused by the externality is not considered), $\phi = 0$ **reduces the social optimum** (reduces benefits).

Social Optimum III

- Under these assumptions the social optimun comes from the following equation.

$$\delta \left[1 - \frac{\alpha v_1 Q^o(D_{SO})}{k} \right] v_1 Q^{0'}(D_{SO}) - c'(D_{SO}) = 0 \qquad (7)$$

- Note that $(6) \geq (7)$

Social Optimum IV

- Note that (7) always has a unique solution since
  1. $\delta\left[\left(1-\frac{\alpha v_1 Q^o(0)}{k}\right)v_1 Q^{0'}(0)\right]-c'(0)>0,$
  2. $\delta\left[\left(1-\frac{\alpha v_1 Q^o(D_1)}{k}\right)v_1 Q^{0''}(D_1)-\frac{\alpha v_1 Q^{0'}(D_1)}{k}\right]-c''(D_1)<0\ \forall D_1$ and
  3. $\delta\left[\left(1-\frac{\alpha v_1 Q^o(\infty)}{k}\right)v_1 Q^{0'}(\infty)\right]-c'(\infty)<0.$

Monopoly

- .The monopoly would maximize profits. Thus, it will solve the following problem

$$\begin{aligned} Max_{D_1} &= v_2 Q^N - c(D_1) \\ &+\delta \left\{ \begin{array}{c} \left(1 - \frac{\alpha v_1 Q^o(D_1)}{2k}\right) v_1 Q^0(D_1) \\ +v_2 \left[Q^N - Q^o(D_1)\right] + v_1 Q^o(D_1) - c(0) \end{array} \right\} \end{aligned}$$

- When $2v_1 > v_2$ the monopoly would decide a durability that is defined implicetly in the following equation

$$\delta \left[1 - \frac{\alpha v_1 Q^o(D_M)}{k} - \frac{v_2}{v_1} + 1\right] v_1 Q^{0'}(D_M) - c'(D_M) = 0 \qquad (8)$$

- In the case where $2v_1 \leq v_2$. The right hand side of equation 8 is smaller than zero, thus the solution is to set $D = 0$.

Monopoly II

- Note that for the case that we have assumed ($2v_1 > v_2$) equation (8) has a unique solution this comes form the following facts

1. $\delta\left[1-\frac{\alpha v_1 Q^o(0)}{k}-\frac{v_2}{v_1}+1\right] v_1 Q^{0'}(0)-c'(0)>0$
2. $\delta\left[1-\frac{\alpha v_1 Q^o(\infty)}{k}-\frac{v_2}{v_1}+1\right] v_1 Q^{0'}(\infty)-c'(\infty)<0$
3. Whenever $\delta\left[1-\frac{\alpha v_1 Q^o(D_1)}{k}-\frac{v_2}{v_1}+1\right] v_1 Q^{0'}(D_1)-c'(D_1)=0$,

   $\delta\left[1-\frac{\alpha v_1 Q^o(D_1)}{k}-\frac{v_2}{v_1}+1\right] v_1 Q^{0''}(D_1)-\frac{\alpha v_1^2 Q^{0'}(D_1)}{k}-c''(D_1)<0$

Results

- Comparison with Waldman's model:
- Waldman's model is a special case of ours without the externalities ($W_2 = 0$) and with $\alpha = 0$.
- The monopolist in our case produces less durability.
- The level of durability under perfect competition (in both cases) and the social optimum are also smaller
- While under Waldman's model, **perfect competition** and the **social optimum** are the **same**, in **our model they are not**: there is over-production of durability under random stealing and under-production under selective stealing.
- Optimal Scheme Set Durability continget on crime.

Results II

- With Random Stealing:
- $0 < D_M < D_{SO} < D_{PC}$ when $2v_1 > v_2$
- $0 = D_M < D_{SO} < D_{PC}$ when $2v_1 \leq v_2$
- The monopoly sets a durability level that is lower than the social optimum, (under-produces durability), but perfect competition durability level is higher than the social optimum (over-produces durability).
- If we consider the externality, it reduces the socially optimal level of durability. As a consequence, the socially optimal level of durability gets closer to the monopoly. If the externality is big enough, even the monopoly could overproduce durability.$(2v_1 > v_2)$

Results III

- With Selective Stealing:
- $0 = D_{PC} < D_M < D_{SO}$ when $2v_1 > v_2$
- $0 = D_{PC} = D_M < D_{SO}$ when $2v_1 \leq v$
- There **are durable goods** under **monopoly** (when $2v_1 > v_2$) so crime can occur, while there is no crime when there is perfect competition. The durability level in monopoly is lower than the socially optimal level. There is no durables nor crime under monopoly when $2v_1 \leq v$.
- If we consider the externality, it reduces the socially optimal level of durability. As a consequence, the socially optimal level of durability gets closer to the monopoly. If the externality is big enough, the monopoly could overproduce durability under random stealing.

Policy Implications

- The level of durability affects crime and crime affects the optimal level of durability.
- Perfect competition does not lead to the optimal level of durability because there is an externality that emerges as greater durability increases the net return of crimes. This in turn increases crime and reduces social welfare.
- A straightforward implication is that the level of durability of goods can be an effective instrument to reduce crime.

Main Findings

- We add the cost of crime to the standard framework of durable goods. Reducing the durability of goods reduces the incentive to steal those goods, thus reducing crime.
- Perfect competition does not provide the optimal durability level, even if the externalities caused by crime are not considered.
- Two technologies for stealing are studied: in the case of random stealing, perfect competition overproduces durability, while in the case of selective stealing perfect competition produces goods of zero durability.
- Effects of traditional policy recommendations to reduce crime, (increase in the celerity or severity of sanctions) are probably in the long run reduced through an increase in the durability of the goods.