Searching Online and Product Returns

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Product Returns

- The rise of e-commerce has come with a sharp increase in products being returned after purchase.
  - National Retail Federation estimates $428 billion of merchandise value was returned in 2020, which is around 10% of total retail sales.
  - In *online retail*, these numbers are approximately $102 billion and around 18% of online sales.
- Inefficiency concerns:
  - Shipping costs.
  - Depreciation as some returned products cannot be easily re-sold.
  - Environmental Burden (Tian and Sarkis 2022).

The Other “Hidden” Side of Product Returns

- Consumers may learn more easily after purchase whether or not they like the product.
- Certainly in online markets, consumers may inspect the product in their home environment.
- Allowing consumers to return products may lead to improved match value and lower inspection cost.

Questions

- Do product returns efficiently trade-off the social costs due to waste and the social benefits of more efficient search?
- Do firms stimulate product returns and if so are the return policies they choose socially optimal?
- Who benefits from offering product returns, consumers or firms?
- What are the features of typical product markets where we may expect products to be returned?

This Paper

Introduce product returns to the search framework in Wolinsky (1986).

- Firms set the price *and* refund for returned products and have a salvage value for returned products.
- Consumers choose whether to inspect the product first or to go ahead and buy it and possibly inspect it after, when it is easier to do so.

What We Find

1. Equilibrium with positive sales is unique.
    - Refund equilibrium exists with high salvage value & low post-purchase inspection cost.
    - Otherwise, only some or no firms incentivize returns.

2. Whenever returns are efficient, the market generates too few returns.
    - Firms do not internalize the welfare benefit of consumers returning low match value products and continuing their search.

Related Literature

- Matthews and Persico (2007) allow, in a monopoly context, consumers to learn match value at an inspection cost before purchase, but without cost after purchase.
  - In a monopoly, there are always too many returns.

- Petrikaitė (2018) introduces product returns in a model where consumers learn one component of match value before purchase and another one after purchase.
  - Inspection not optional, refunds have to be full, and salvage value is equal to production cost.

- Doval (2018) characterizes optimal consumer search rule when consumers can buy without inspection, while Chen et al. (2021) introduce this into a model with observable prices.
  - Neither consider product returns and how firms may strategically influence them.

Model

Environment

- Unit mass of risk neutral firms.
- Unit mass of consumers each with unit demand.
- Match values v distributed iid G with support $[\underline{v}, \bar{v}] \subset \mathbb{R}$.
  - G and $1 - G$ logconcave.

Firms

- At the start of the game, firms set the price p and refund τ.
- Constant marginal production cost c and salvage value $\eta \leq c$ for returned items.
  - $c - \eta$ includes the cost to repair a returned item or shipping cost.

Model: Consumer Search

Consumers engage in sequential search

- *Search cost* ε to learn the price p and refund τ.

- After that they have four options:
  1. Inspect Before: First incur *inspection cost* s to learn match value v and then decide whether to buy it.

  2. Inspect After: First buy the product, inspect it at cost $\beta \cdot s$ with $\beta \in [0, 1]$, and then decide whether to keep the good or return it for a refund τ.

  3. No Inspection: Buy the good and do not apply any effort into inspecting it to decide whether it is worth keeping or returning.

  4. Leave: Proceed to the next firm without inspecting nor buying the good.

Analysis

Refund Equilibrium

Definition

A **symmetric refund equilibrium** is a PBE with passive beliefs in which firms offer the same contract and consumers inspect goods after purchasing them.

Proposition 1

If a symmetric refund equilibrium exists then it is unique and has the following properties:

1. The price and refund are set so that consumers are indifferent between inspecting products before and after purchasing them.

2. The refund exceeds the salvage value, i.e., $\tau > \eta$.

Refund Equilibrium: $U_A = U_B$

- Returns require consumers to inspect after purchase.
- Contracts must lie on a boundary or else a firm can raise its price without reducing demand.
- $U_A = U_L$ leads to the Diamond paradox.
- Hence $U_A = U_B$ must hold in equilibrium.

▸ refund

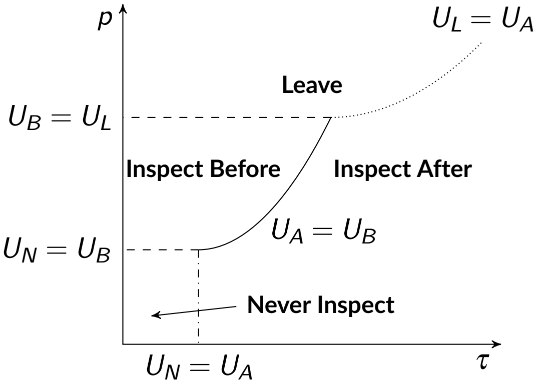
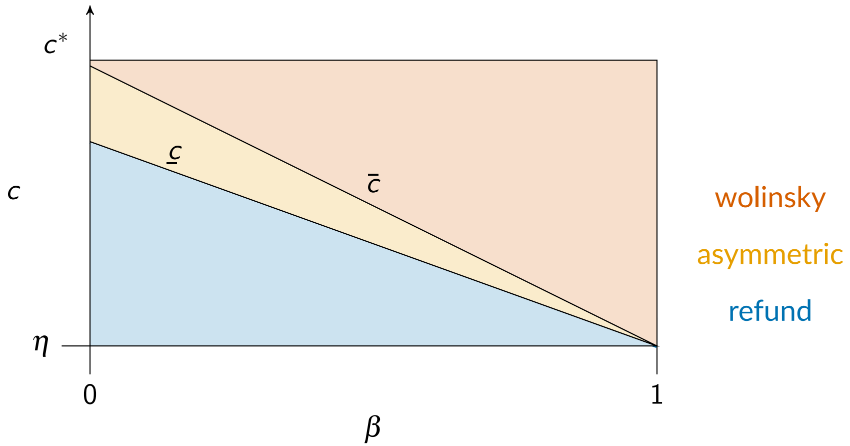


Figure: Inspection choices for a given price p and return policy τ.

Equilibrium Structure of Contracts



▸ theorem

Efficiency

- What is the socially efficient contract when consumers place returns?
- Consider the effect of starting from a refund equilibrium and **gradually increasing the refund** offered by all firms.
    1. For items that are not returned, there is no effect on welfare.
    2. For items that would have been returned beforehand, the increase in the refund is a transfer from firm to consumer, with a net zero effect on welfare.
    3. Consumers become more likely to make a return.
        - Each firm issues out more refunds, but also receives more customers.
        - This increases welfare if and only if the profit on items bought and returned is positive, i.e. $p - c - \tau + \eta > 0$.

Efficiency

Theorem

The social optimum is achieved by having all firms offer the same contract $(\hat{p}, \hat{\tau})$ with $\hat{p} - \hat{\tau} = c - \eta$ where $\hat{p}$ exceeds c but is not too large.

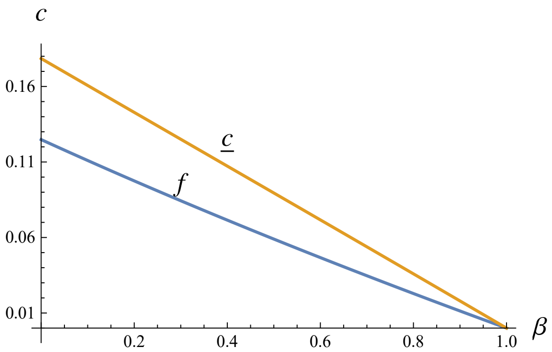
- If we interpret $c - \eta$ as transportation cost, then it is socially efficient to have consumers pay for it.

- At the social optimum, there is a strictly decreasing function $f(\beta)$ such that:

  1. If $c < f(\beta)$, consumers inspect a good after purchasing it,
  2. If $c > f(\beta)$, consumers inspect a good before purchasing it, and
  3. If $c = f(\beta)$, consumers either inspect a good before or after purchasing it.

Efficiency: Example

- Recall: Refund equilibrium exists below $\underline{c}$.
- Below $\min\{f, \underline{c}\}$, both a social planner and the market stimulate returns.
- Costs between $f < c < \underline{c}$, the market stimulates returns, but the social planner would not, i.e. there are too many returns.



Uniform distribution, $(s, \varepsilon, \eta) = (0.07, 0.001, 0)$.

Market Inefficiency

Theorem

At a point where the market is in a refund equilibrium and stimulating returns is strictly more efficient than not doing so, welfare increases by reducing $p - \tau$ to equal $c - \eta$, thereby yielding more returns.

Intuition

1. When returns are efficient, the social optimum $p - \tau = c - \eta$ leads consumers to strictly prefer inspection after purchase.
2. Thus, the equilibrium involves $p - \tau > c - \eta$ since consumers are made indifferent with inspecting after purchase.

Environmental Impact

- Considerable pollution and waste produced by items being bought and returned.
  - Fifteen million tons of CO_2 are emitted annually during the returns process.
  - Five billion pounds of returned products end up in landfills each year.

- We can accommodate this by introducing an environmental cost e_s for items sold and e_r for items returned.
  - Define the *social* salvage value $\eta^e = \eta - e_s - e_r$.

- When the externalities are not too large, the efficient contract is now

$$\hat{p} - \hat{\tau} = c - \eta^e.$$

- When stimulating returns is efficient and the market does so, the equilibrium is closer to efficient when accounting for externalities.

Regulating Refunds

- Realistically, regulators might only be able to choose how generous a return policy must be.

- Thus, suppose the social planner can only choose the minimum fraction of the price a firm must offer back as a refund.
  - Specifically, the planner picks $\theta \in [0, 1]$ requiring firms to offer a contract in the region $\{(p, \tau) \in \mathbb{R}^2_+ : \tau \geq \theta \cdot p\}$.

- Refer to a *constrained equilibrium* as an equilibrium of the game subject to firms selecting contracts in the permitted region.

- Consider the interesting case where the unique equilibrium in the market is a refund equilibrium and the social planner can improve welfare by stimulating more returns.

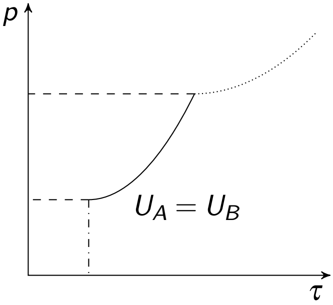
Regulating Refunds

Harmful Regulation

If θ is only slightly above the equilibrium level, there is a constrained equilibrium generating higher profit and lower consumer surplus, while keeping welfare unchanged.

Helpful Regulation

When the social benefit of returns strongly outweigh the costs ($c - \eta$ is small and $\beta < 1$), regulation can achieve the social optimum



Conclusion

- The rise of e-commerce has brought a surge in returns
  - We suggest it is important to understand product returns in a market context in connection to the relative ease of inspecting products post-purchase
- Methodologically, we extend the seminal Wolinsky (1986) paper to have firms choose price and a refund, while allowing consumers to inspect before, after or not at all.
- The market equilibrium is always unique and can be of three different categories
- If returns are provided by the market, then the return policy is never efficient
- Imposing a minimum threshold on the refund policy may lead to lower consumer surplus

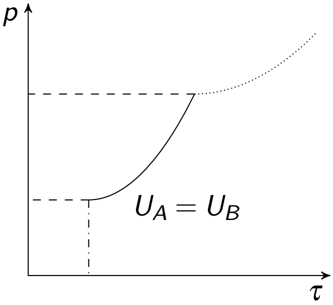
Why a Refund $\tau > \eta$?

- Let $p(\tau)$ equate $U_A = U_B$

$$\frac{d\pi_A}{d\tau} \propto \frac{G(a+\tau)}{G(a+p)} - G(a+\tau) - (\tau-\eta)g(a+\tau)$$

  - Change in consumer expenditures, fixing the frequency of returns

  - Change in frequency of returns



- Utility declines in τ: $\frac{d}{d\tau}U_A = \frac{d}{d\tau}U_B < 0$

- Envelope Theorem $\frac{d}{d\tau}U_A$ equals minus the change in consumer expenditures

$$\frac{d\pi_A}{d\tau} \propto -\frac{dU_A}{d\tau} - (\tau-\eta)g(a+\tau)$$

go back

Equilibrium Analysis

Assumption. $\pi_A(p(\tau), \tau, a)$ is quasiconcave in τ when $\eta < \tau < \bar{\tau}$ and $0 \leq a$.

- $p(\tau)$ solves $U_A(p(\tau), \tau, a) = U_B(p(\tau), a)$.
- $\bar{\tau}$ solves $U_A(p(\tau), \tau, a) = a$.

Numerical analysis finds this to hold when match values are uniformly distributed.

Focus on parameters in which markets are active.

Structure of Equilibria

Theorem

PBE with passive beliefs can be characterized by two continuous function $\underline{c}(\beta)$ and $\bar{c}(\beta)$ and a constant $c^* > \eta$ whereby $\eta < \underline{c} < \bar{c}$ for all $0 \leq \beta < 1$. For each point with $\beta < 1$ and $c \leq \max\{\bar{c}, c^*\}$ there is a unique equilibrium with trade:

1. For $\eta \leq c \leq \underline{c}$, all firms offer a refund contract.
2. For $\underline{c} < c < \bar{c}$, a fraction of firms offer a refund contract.
3. For $\bar{c} \leq c \leq c^*$, no firm offers a refund contract.

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