Tax incidence on Competing Two-sided Platforms

Paul Belleflamme, Aix-Marseille University
Eric Toulemonde, University of Namur
Outline

Quick rundown

Model

Symmetric taxes

Asymmetric taxes

Concluding remarks
A quick rundown
Context

- Difficulty to tax the corporate income of global digital platforms
  - In the EU, online giants are accused of ‘dodging’ taxes by routing most of their profits to low tax rate member states.
- Attempts to use other tax instruments
  - France: ‘YouTube’ tax
  - UK: Platforms required to assist authorities to identify individuals failing to declare income from activities on a platform, but ‘digital tax relief’ for micro-entrepreneurs for the first £1,000 of their income.
- Research question: What are the impacts of such alternative taxes on the competition between digital platforms?
### Method

- **Focus on two-sided platforms**
  - Facilitate the interaction between two groups of agents
  - Interaction generates **positive cross-group external effects**
    - Agents of one group value the platform all the more that agents of the other group increase their activity on the platform.
  - Competition between two symmetric platforms
    - They set membership fees.
    - Singlehoming on both sides

- **2 exercises**
  - Tax incidence of symmetric taxes
    - Specific, ad valorem & transaction taxes
  - Effects of asymmetric taxes
    - A specific tax is levied on one platform only.
Main results

- **Impacts of symmetric taxes**
  - **Specific** taxes are entirely passed to the agents on the side on which they are levied; platforms’ profits are left unchanged.
  - **Transaction** taxes hurt agents on both sides and benefit platforms.
  - An **ad valorem** tax levied on one side hurts the agents on the other side (the taxed agents may benefit from the tax); platforms’ profits are decreased.

- **Impacts of asymmetric taxes**
  - All agents on the untaxed side benefit from the tax.
  - At least one platform benefits from the tax.
  - The taxed platform could welcome the tax because of the strategic commitment it confers.
Related literature

- Taxation in two-sided markets
  - Few papers
  - Special issue of JPET, forthcoming

- Cost pass-through
  - Multiproduct firm: Moorthy (2005), Alexandrov & Bedre-Defolie (2011)

- Taxation literature (public economics)
  - Taxes may increase profits for competing firms
    - Bertrand: Anderson, de Palma & Kreider (2001)
    - Demand must be sufficiently convex
      - In our setting, linear demands + cross-side effects
A model of price competition between taxed platforms
Setting (extension of Armstrong, 2006)

- 2 groups (a and b); mass 1, distributed on [0,1]; single-homing
- Net utilities: 3 components
  - Cross-group external benefit
    - Focus on positive cross-group effects; linear formulation
  - ‘Transportation cost’
    - Platforms are horizontally differentiated in a Hotelling fashion
  - Access fee
    - Focus on flat fee; no usage fee
**Setting (2)**

- **Net utilities**

\[
U_a(x) = R_a + \sigma_a N_b - \theta_a x - P_a \\
u_a(x) = R_a + \sigma_a n_b - \theta_a (1 - x) - p_a \\
U_b(y) = R_b + \sigma_b N_a - \theta_b y - P_b \\
u_b(y) = R_b + \sigma_b n_a - \theta_b (1 - y) - p_b
\]

- **Valuation for agents of group \(a\) of the interaction with an additional agent of group \(b\)**
  → measures the strength of the cross-group external effect exerted on agents of group \(a\)

- **Stand-alone benefits for agents of group \(a\)**
  if joining platform \(U\),

- **Access fees**

  Measures the horizontal differentiation among platforms, as perceived by agents of group \(a\)**
Pricing equilibrium

Solution

- Identify, in each group, agent indifferent between the 2 platforms:
  \[ \hat{x} \text{ such that } U_a(\hat{x}) = u_a(\hat{x}), \text{ and } \hat{y} \text{ such that } U_b(\hat{y}) = u_b(\hat{y}) \]

- Suppose both sides are fully covered
  \[ \hat{x} = N_a = 1 - n_a \text{ and } \hat{y} = N_b = 1 - n_b. \]

- Derive ‘demand functions’
  \[
  N_a = \frac{1}{2} + \frac{\theta_b}{2 \theta_a \theta_b - \sigma_a \sigma_b} \frac{p_a - P_a}{p_b - P_b} + \frac{\sigma_a}{2 \theta_a \theta_b - \sigma_a \sigma_b} \frac{p_b - P_b}{p_a - P_a}, \\
  N_b = \frac{1}{2} + \frac{\theta_a}{2 \theta_a \theta_b - \sigma_a \sigma_b} \frac{p_b - P_b}{p_a - P_a} + \frac{\sigma_b}{2 \theta_a \theta_b - \sigma_a \sigma_b} \frac{p_a - P_a}{p_b - P_b}.
  \]
Pricing equilibrium (2)

- **Method (cont’d)**
  - Platform Uppercase chooses its fees to maximize

\[
\Pi = (1 - \tau_a^v) (P_a - \tau_a^s) N_a - C_a N_a + (1 - \tau_b^v) (P_b - \tau_b^s) N_b - C_b N_b
\]

- Same for platform lowercase

\[
\pi = (1 - \tau_a^v) (p_a - \bar{c}_a) n_a + (1 - \tau_b^v) (p_b - \bar{c}_b) n_b.
\]

- Rate of *ad valorem* (percentage) taxation
- Level of specific (unit) tax
- ‘Effective’ cost

\[\tilde{C}_k \equiv C_k / (1 - \tau_k^v) + \tau_k^s\]
Pricing equilibrium (3)

- Method (cont’d)
  - Condition for a unique & stable equilibrium with 2 active platforms
    \[ \theta_a \theta_b > \frac{1}{4} (\sigma_a + \sigma_b)^2. \]
  - General model can’t be solved.

- Simplifications to address 2 separate issues

  - Symmetric platforms and taxes
    - All taxes can be considered
  - Focus on specific taxes
    - Asymmetric taxes can be considered
Impacts of symmetric taxes
Equilibrium

- Symmetry assumption
  - Platforms face the same marginal costs: \( C_k = c_k (k = a, b) \)

- Equilibrium prices

\[
\begin{align*}
P^*_a &= p^*_a = \left[ \tilde{C}_a + \theta_a \right] \\
&= \frac{1 - \tau_b^y}{1 - \tau_a^y} \sigma_b \\
&= \frac{C_a}{1 - \tau_a^y} + \tau_a^s + \theta_a - \frac{1 - \tau_b^y}{1 - \tau_a^y} \sigma_b,
\end{align*}
\]

\[
\begin{align*}
P^*_b &= p^*_b = \left[ \tilde{C}_b + \theta_b \right] \\
&= \frac{1 - \tau_a^y}{1 - \tau_b^y} \sigma_a \\
&= \frac{C_b}{1 - \tau_b^y} + \tau_b^s + \theta_b - \frac{1 - \tau_a^y}{1 - \tau_b^y} \sigma_a.
\end{align*}
\]

Hotelling formula

Price adjustment due to cross-group external effects

→ more profitable to lower price on side \( a \) if agents of type \( a \) exert a strong effect on agents of type \( b \), and if the ad valorem tax rate is lower on side \( b \) than on side \( a \)
**Equilibrium** (2)

- **Platforms’ profits**

\[ \Pi^* = \pi^* = \frac{1}{2} \left[ (1 - \tau_a^v) (\theta_a - \sigma_a) + (1 - \tau_b^v) (\theta_b - \sigma_b) \right]. \]

  - Note: decreases with strength of cross-group external effects

- **Equilibrium surplus for agents of type k**

\[ V_k = R_k + \frac{1}{2} \sigma_k - P_k^* - \frac{1}{4} \theta_k. \]

  - Symmetry → equal split of agents → each agent interacts with a measure \( \frac{1}{2} \) of agents of the other group
  - Last term: total transportation costs
Tax incidence

- Comparison after/before taxes
  - ‘Before’ → Equilibrium without tax (superscript 0)
  - ‘After’ → Equilibrium with taxes (superscript T)

\[
\Pi^T - \Pi^0 = -\frac{1}{2} \left[ \tau_a^v (\theta_a - \sigma_a) + \tau_b^v (\theta_b - \sigma_b) \right]
\]

\[
V^T_a - V^0_a = p^0_a - p^T_a = -\tau_a^s - \frac{\tau_a^v}{1 - \tau_a^v} C_a + \frac{\tau_a^v - \tau_b^v}{1 - \tau_a^v} \sigma_b,
\]

\[
V^T_b - V^0_b = p^0_b - p^T_b = -\tau_b^s - \frac{\tau_b^v}{1 - \tau_b^v} C_b + \frac{\tau_b^v - \tau_a^v}{1 - \tau_b^v} \sigma_a.
\]
Tax incidence (2)

- Impact of a **specific tax** (say on side $a$)

\[
\Pi^T - \Pi^0 = -\frac{1}{2} \left[ \tau_a^y (\theta_a - \sigma_a) + \tau_b^y (\theta_b - \sigma_b) \right]
\]

\[
V_a^T - V_a^0 = p_a^0 - p_a^T = -\tau_a^s - \frac{\tau_a^y}{1 - \tau_a^v} C_a + \frac{\tau_a^y - \tau_b^y}{1 - \tau_a^v} \sigma_b.
\]

\[
V_b^T - V_b^0 = p_b^0 - p_b^T = -\tau_b^s - \frac{\tau_b^y}{1 - \tau_b^v} C_b + \frac{\tau_b^y - \tau_a^y}{1 - \tau_b^v} \sigma_a.
\]

\(\Rightarrow\) a specific tax on side $k$ is entirely borne by agents on side $k$.

Nothing to do with two-sidedness
(due to inelastic demand in Hotelling model with covered market)
Tax incidence (2)

- Impact of an ad valorem tax (say on side $a$)

\[
\begin{align*}
\Pi^T - \Pi^0 &= -\frac{1}{2} \left[ \tau_a^v (\theta_a - \sigma_a) + \tau_b^v (\theta_b - \sigma_b) \right] \\
V_a^T - V_a^0 &= p_a^0 - p_a^T = -\tau_a^s - \frac{\tau_a^v}{1 - \tau_a^v} C_a + \frac{\tau_a^v - \tau_b^v}{1 - \tau_a^v} \sigma_b, \\
V_b^T - V_b^0 &= p_b^0 - p_b^T = -\tau_b^s - \frac{\tau_b^v}{1 - \tau_b^v} C_b + \frac{\tau_b^v - \tau_a^v}{1 - \tau_b^v} \sigma_a.
\end{align*}
\]

- Benchmark: no cross-group effects ($\sigma_a = \sigma_b = 0$) → platforms and agents of type $a$ share the burden of the tax (red)

- With positive cross-group effects ($\sigma_a, \sigma_b > 0$) → 2 impacts (orange)
  - tax burden on side $a$ agents ↓
  - tax burden on side $b$ agents ↑
Tax incidence (3)

- Impact of a transaction tax
  - No explicit modeling of transactions here
  - But, $\sigma_k = \text{value that an agent of group } k \text{ obtains from interacting with any agent of the other group.}$
  - $\rightarrow$ transaction tax reduces the strength of the external effects
    $$\sigma_k \text{ is replaced with } (1 - \tau_k \cdot ) \sigma_k$$
  - Set all other taxes to zero:
    $$\Pi^T - \Pi^0 = \frac{1}{2} \left( \sigma_a \tau_a^t + \sigma_b \tau_b^t \right), \quad V_a^T - V_a^0 = -\frac{1}{2} \sigma_a \tau_a^t - \sigma_b \tau_b^t, \quad V_b^T - V_b^0 = -\frac{1}{2} \sigma_b \tau_b^t - \sigma_a \tau_a^t.$$
Tax incidence (4)

Summary

- Impacts of symmetric taxes on symmetric platforms

<table>
<thead>
<tr>
<th></th>
<th>$\tau^s_a$</th>
<th>$\tau^s_b$</th>
<th>$\tau^v_a$</th>
<th>$\tau^v_b$</th>
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<th>$\tau^t_b$</th>
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<td>$V^T_a - V^0_a$</td>
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<td>$V^T_b - V^0_b$</td>
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- Note: if the goal is to tax away some of the platforms’ profits, the only appropriate instrument is ad valorem taxes.
Impacts of asymmetric taxes
Pricing equilibrium

- Asymmetric taxes make the model more complex
  - Asymmetric taxes $\rightarrow$ asymmetric effective costs
  - Model not tractable if different costs and ad valorem taxes
  - Assumption: no ad valorem taxes

- Equilibrium prices

$$D \equiv 9\theta_a\theta_b - (2\sigma_a + \sigma_b)(\sigma_a + 2\sigma_b)$$

$$p_a^* = [\tilde{c}_a + \theta_a] - \sigma_b - \frac{1}{3}\gamma_a - \frac{\sigma_a - \sigma_b}{3D} [3\theta_a\gamma_b + (2\sigma_a + \sigma_b)\gamma_a],$$

$$p_a^* = [\tilde{c}_a + \theta_a] - \sigma_b + \frac{1}{3}\gamma_a + \frac{\sigma_a - \sigma_b}{3D} [3\theta_a\gamma_b + (2\sigma_a + \sigma_b)\gamma_a].$$

- Hotelling formula
- Price adjustment due to cross-group effects
- Effect of vertical differentiation (VD): $\gamma_k = C_k - c_k$
- Interplay between VD and cross-group effects
Pricing equilibrium (2)

- Equilibrium participations

\[ N_a^* = \frac{1}{2} - \frac{1}{2D} (3\theta_b \gamma_a + (\sigma_a + 2\sigma_b)\gamma_b), \quad n_a^* = 1 - N_a^* , \]

\[ N_b^* = \frac{1}{2} - \frac{1}{2D} (3\theta_a \gamma_b + (2\sigma_a + \sigma_b)\gamma_a), \quad n_b^* = 1 - N_b^* . \]

- Depend on the *difference* between the effective costs
- Symmetric taxes leave cost difference unchanged
  - \( \rightarrow \) Impact on prices only (no impact on participation)
- **Asymmetric** taxes modify cost difference
  - \( \rightarrow \) Impact on prices *and on participation*
- Exercise: specific tax on side \( a (\tau_a) \) for platform \( U \) only

\[ \gamma_a = \tau_a, \text{ and } \gamma_b = 0 \]
Tax incidence on prices

- **Price changes**

\[
P^T_a - P^0_a = \frac{2}{3} \tau_a - (\sigma_a - \sigma_b) \frac{2\sigma_a + \sigma_b}{3D} \tau_a, \quad P^T_b - P^0_b = (\sigma_a - \sigma_b) \frac{\theta_b}{D} \tau_a,
\]

\[
p^T_a - p^0_a = \frac{1}{3} \tau_a + (\sigma_a - \sigma_b) \frac{2\sigma_a + \sigma_b}{3D} \tau_a, \quad p^T_b - p^0_b = - (\sigma_a - \sigma_b) \frac{\theta_b}{D} \tau_a.
\]

- Benchmark: no cross-group effects \((\sigma_a = \sigma_b = 0)\)
  - Only side \(a\) is affected.
  - Platform \(U\) increases its price on side \(a\) by \(2/3\) of \(\tau_a\)
  - Platform \(l\) increases its price on side \(a\) by \(1/3\) of \(\tau_a\)

- With positive cross-group effects \((\sigma_a, \sigma_b > 0)\)
  - 3 additional channels through which a tax affects prices
    - “Contamination”, “Leverage”, “Ricochet”
    - Strategic effect on prices of a (credible) cost change by one platform
Tax incidence on prices (2)

1. Contamination & Leverage

\[ \Delta^+ \tau_a \]

\[ \Delta^+ P_a \quad \& \quad \Delta^-(P_a - \tau_a) \]

Contamination \( (\sigma_b > 0) \)

Leverage \( (\sigma_a > 0) \)

\[ \Delta^- P_b \quad \Delta^+ P_b \]
Tax incidence on prices (3)

2. Ricochet (contamination & leverage again)

If $\sigma_a > \sigma_b$, then the net effect is

- $\Delta^+ P_b$
- Contamination ($\sigma_a > 0$)
- $\Delta^- P_a$

&

- $\Delta^+ P_b$
- Leverage ($\sigma_b > 0$)
- $\Delta^- P_a$

If $\sigma_a < \sigma_b$, then $\Delta^+ P_a$
Tax incidence on prices (4)

- **Summary**
  - If equal cross-group effects \( \sigma_a = \sigma_b \)
    - Platform \( U \) passes 2/3 of the tax on side \( a \).
    - Platform \( I \) reacts by passing 1/3 of the tax on side \( a \) as well.
  - Different cross-group effects
    - (1) \( \sigma_a > \sigma_b \)
      - The taxed platform transfers part of the pass-through from side \( a \) to side \( b \).
        - It may even choose a form of “negative pass-through”.
      - The other platform raises its price further on side \( a \) but reduces its price on side \( b \).
    - (2) \( \sigma_a < \sigma_b \)
      - Opposite
      - The other platform may even decrease its price on side \( a \).
Tax incidence on participations

\[ N^T_a - N^0_a = -\frac{3\theta_b}{2D} \tau_a, \quad \text{and} \quad N^T_b - N^0_b = -\frac{2\sigma_a + \sigma_b}{2D} \tau_a. \]

- Participation unambiguously decreases on both sides for the taxed platform
Tax incidence on competing two-sided platforms

\[ \Pi^T - \Pi^0 = -\tau_a N^T_a - \frac{\tau_a}{2D} \left[ 3\theta_b \left( p^T_a - p^0_a \right) + \left( 2\sigma_a + \sigma_b \right) \left( p^T_b - p^0_b \right) \right] + \frac{1}{2} \left( p^T_a - p^0_a + p^T_b - p^0_b \right). \]

**DIRECT effect**
- Negative

**OWN-PRICE EFFECT**
- The platform adjusts its prices, which affects its profit
- Negative

**STRATEGIC EFFECT (SE)**
- The rival platform modifies its prices, which affects the taxed platform’s profit
- Positive if \( \sigma_a = \sigma_b (=0) \)
- Even more positive if \( \sigma_a > \sigma_b \)
- Can be negative if \( \sigma_a < \sigma_b \)

- Reinforces negative effects → ‘DOUBLE JEOPARDY’
- Can outweigh negative effects → ‘LUCKY BREAK’

Can be negative if \( \sigma_a < \sigma_b \)

Even more positive if \( \sigma_a > \sigma_b \)

Positive if \( \sigma_a = \sigma_b (=0) \)
Tax incidence on competing two-sided platforms

Tax incidence on platforms’ profits (2)

- **Summary**
  - In the absence of cross-group effects, the taxed platform is hurt.
    - The negative direct and own-price effects are larger than the positive strategic effect.
  - Cross-group effects may make the strategic effect …
    - So positive that it outweighs the negative effects
      → the taxed platform benefits from the tax (‘lucky break’)
    - Negative
      → the tax hurts the taxed platform twice (‘double jeopardy’)
  - The profits of the untaxed platform can also go both ways.
  - Total profits increase.
    → At least one platform benefits from the tax.
Tax incidence on agents

- Total user surplus on side \( a \)

\[
V_a = R_a + \sigma_a \left[ N^* a N^* b + (1 - N^* a) (1 - N^* b) \right] - \left[ N^* a p^* + (1 - N^* a) p^*_a \right] - \theta_a \left( N^* a^2 - N^* a + \frac{1}{2} \right),
\]

**Total external benefits**

- Increase with the tax

**Total spending**

- Tax has ambiguous effect

**Total transportation costs**

- Increase with the tax

**Total effect**

\[
V^T_a - V^0_a = \left( \frac{9}{2} \frac{\theta^2}{D^2} \theta_a \tau_a - 1 \right) \frac{\tau_a}{2},
\]

- Clearly negative for low values of the tax; but could be positive
Tax incidence on agents (2)

- Same analysis on side $b$

$$V^T_b - V^0_b = \theta_b \left( \frac{2\sigma_a + \sigma_b}{2D} \tau_a \right)^2,$$

The tax makes agents on side $b$ unambiguously better off.
Tax incidence on welfare

- **Amount of tax collected**
  - Participation on side $a$ linearly decreases with the tax
  - $\rightarrow$ Bell-shaped Dupuit-Laffer curve

- **Other impacts**
  - Not just monetary transfers from agents to tax authority
  - Participation more concentrated on untaxed platform
    - Both external benefits & transport costs increase

\[
W^T - W_0 = (TE^T_a - TE^0_a) + (TE^T_b - TE^0_b) - (TT^T_a - TT^0_a) - (TT^T_b - TT^0_b) : \\
= \frac{(2\alpha_a + \sigma_b)(4\alpha_a + 5\sigma_b)}{4D^2} - 9\theta_a\theta_b\theta_a^2.
\]

Positive welfare effect of larger external benefits
Negative welfare effect of larger transport costs
Tax incidence an asymmetric tax

- **Summary**
  - Asymmetric tax on Platform $L$, on side $a$

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<tr>
<th>$\Pi^T$</th>
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<th>$\Pi^T + \pi^T$</th>
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Concluding remarks
Key takeaways

- **Potential counterintuitive effects of taxes in markets with platforms**

  Because platforms set their prices to reflect cross-side external effects, a tax on one side may end up being supported by agents located on the other side.

  Asymmetric taxes may improve welfare by pushing agents on the untaxed platform, which increases the total level of interactions in the market.

- Platforms (even a taxed one) may welcome taxes
Limitations

- No effect of taxes on total demand
  - Hotelling setting with covered market

- Very crude modeling of transactions on platforms
  - Need a deeper micro-foundation of the agents' utilities

- Restricted setting
  - What if agents on one side can multihome?
    - Competitive game between platforms is modified.
  - What is negative fees are prohibited (or impractical)?
    - This may limit platforms’ ability to move the burden of a tax across sides.
Thank you