Competition between Mail and Electronic Substitutes in the Financial Sector
A Hotelling Approach

Helmuth Cremer (IDEI), Philippe De Donder (IDEI)

Paul Dudley (Royal Mail) & Frank Rodriguez (Oxera)

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Introduction

- Financial institutions have been large mail users, as they provide financial information via paper statements to their customers.

- Recently, their customers have been offered the choice of alternative services through the digital medium on-line.

- This has generated significant switching from transactional mail to the digital alternative.

- Important for financial viability of the Universal Service Provider to understand these changes.

- Last year, we studied the volume of transactional mail as the equilibrium of a Cournot game between banks.

- We did not provide micro-foundations for demand functions.

The model

- Two banks (A and B) offer a bundle of goods and services to consumers.

- One service offered is financial information, that can be provided with paper statements (good 2) or an electronic substitute (good 1).

- All characteristics of the banks and services are exogenous, and we concentrate on how banks price these two goods.

- Horizontal differentiation model à la Hotelling on two dimensions.

- Banks are located on the $X = [0, 1]$ axis (ex: location on main street). Bank A located at 0, bank B at 1.

- Transactional media are located on the $Z = [0, 1]$ dimension. Paper statements are located at 1, electronic substitutes at 0.

- A continuum of consumers who differ in their preferences for banks and for transactional media.

- Two dimensions are independent from each other.

- Consumers are uniformly and independently distributed over $Z \times X = [0, 1] \times [0, 1]$.

- If location on X is x, consumer has disutility of tx if patronizes bank A and of $t(1-x)$ if chooses bank B.

- If location on Z is z, consumer has disutility of rz if chooses good 1 (electronic medium) and of $r(1-z)$ if chooses good 2 (paper statements).

- Each consumer has to choose one (and only one) bank (A or B) and transactional medium (good 1 or 2).

- We denote by q_i^j the consumer price of good i ($i = 1, 2$) in bank j ($j = A, B$) and we assume that banks set their prices in order to maximize profits.

The timing of the model

- Banks first post (simultaneously) their prices q_i^j.

- Consumers then choose which bank to patronize and which form of transactional medium to use in that bank.

- To simplify the presentation, we assume that consumers first choose their bank, and then choose their preferred form of transactional medium.

Choice between paper statements and electronic substitutes

- Consumers all obtain a gross utility level of U_i^j when they consume one unit of good i in bank j.

- The net utility level V_i^j takes into account that

  – the characteristics of the banks and of the medium differ from the ideal characteristics of a consumer located at (x, z),

  – consumers have to pay q_i^j.

- We have

$$
\begin{aligned}
V_1^A &= U_1^A - q_1^A - rz - tx, \\
V_2^A &= U_2^A - q_2^A - r(1-z) - tx, \\
V_1^B &= U_1^B - q_1^B - rz - t(1-x), \\
V_2^B &= U_2^B - q_2^B - r(1-z) - t(1-x).
\end{aligned}
$$

- An individual located at (x, z) and with an account in bank j chooses paper statements (good 2) over the electronic substitute (good 1) if

$$
\begin{aligned}
& V_1^j \leq V_2^j \\
\Leftrightarrow\ & U_1^j - q_1^j - rz \leq U_2^j - q_2^j - r(1-z) \\
\Leftrightarrow\ & z \geq \tilde{z}^j(q_1^j, q_2^j) = \frac{1}{2} + \frac{(U_1^j - q_1^j) - (U_2^j - q_2^j)}{2r}.
\end{aligned}
$$

- As r increases, it becomes more difficult to convince consumers by changing price levels to consume a variant of the transactional medium different from the one closer to their most-preferred option.

- The preference for bank A *vs* B of the client plays no role.

The choice of a bank

- We denote by W^j the net utility of opening an account with bank j and we obtain

$$
\begin{aligned}
W^A &= V_1^A = U_1^A - q_1^A - rz - tx \text{ if } z \leq \tilde{z}^A(q_1^A, q_2^A), \\
W^A &= V_2^A = U_2^A - q_2^A - r(1-z) - tx \text{ if } z > \tilde{z}^A(q_1^A, q_2^A), \\
W^B &= V_1^B = U_1^B - q_1^B - rz - t(1-x) \text{ if } z \leq \tilde{z}^B(q_1^B, q_2^B), \\
W^B &= V_2^B = U_2^B - q_2^B - r(1-z) - t(1-x) \text{ if } z > \tilde{z}^B(q_1^B, q_2^B).
\end{aligned}
$$

- The decision of which bank to choose depends on both x and z.

- Assume for the moment that $\tilde{z}^A(q_1^A, q_2^A) \leq \tilde{z}^B(q_1^B, q_2^B)$.

- Depending on his preferences for transactional medium (as given by his location z), a consumer belongs to one of three groups.

- In the **first** group, characterized by $z < \tilde{z}^A(q_1^A, q_2^A) < \tilde{z}^B(q_1^B, q_2^B)$, a consumer located at (x, z) knows that he will choose electronic statements (good 1) whatever the bank he joins. He chooses bank A if

$$
\begin{aligned}
W^A \geq W^B &\Leftrightarrow V_1^A \geq V_1^B \\
&\Leftrightarrow U_1^A - q_1^A - rz - tx \geq U_1^B - q_1^B - rz - t(1-x) \\
&\Leftrightarrow x \leq \tilde{x}_1(q_1^A, q_1^B) = \frac{1}{2} + \frac{(U_1^A - q_1^A) - (U_1^B - q_1^B)}{2t}.
\end{aligned}
$$

- The preference for paper *vs* electronic statements plays no role in the choice of banks here.

Similarly, in the **second** group, where $\tilde{z}^A(q_1^A, q_2^A) < \tilde{z}^B(q_1^B, q_2^B) < z$, the consumer located at (x, z) knows that he will choose the paper statements (good 2) whatever the bank he joins. He chooses bank A if
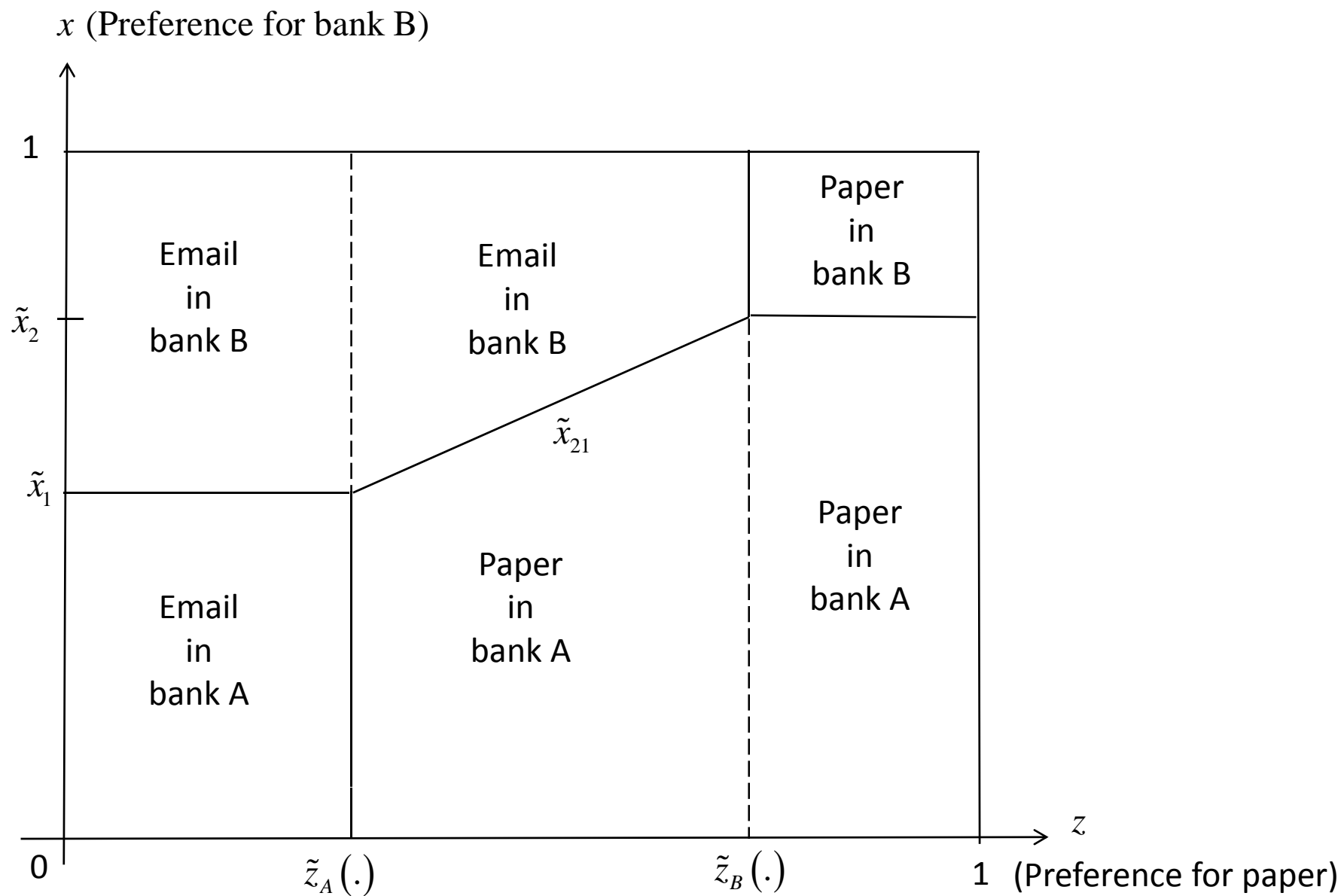
$$
\begin{aligned}
& W^A \geq W^B \Leftrightarrow V_2^A \geq V_2^B \\
\Leftrightarrow\ & U_2^A - q_2^A - r(1 - z) - tx \geq U_2^B - q_2^B - r(1 - z) - t(1 - x) \\
\Leftrightarrow\ & x \leq \tilde{x}_2(q_2^A, q_2^B) = \frac{1}{2} + \frac{(U_2^A - q_2^A) - (U_2^B - q_2^B)}{2t}.
\end{aligned}
$$

- In the **third** group, defined by $\tilde{z}^A(q_1^A, q_2^A) < z < \tilde{z}^B(q_1^B, q_2^B)$, a consumer chooses electronic statements in bank B and paper statements in bank A. He chooses bank A if

$$
\begin{aligned}
W^A \geq W^B &\Leftrightarrow V_2^A \geq V_1^B \\
&\Leftrightarrow U_2^A - q_2^A - r(1-z) - tx \geq U_1^B - q_1^B - r - t(1-x) \\
&\Leftrightarrow x \leq \tilde{x}_{21}(q_1^A, q_1^B, z) = \frac{1}{2} + \frac{(U_2^A - q_2^A) - (U_1^B - q_1^B) - r + 2rz}{2t}
\end{aligned}
$$

- Threshold increases with z and with r if $z > 1/2$.

- Figure 1

Figure 1: Choice of banks and of medium when $\tilde{z}_A(.) < \tilde{z}_B(.)$

x (Preference for bank B)

1

Paper
in
bank B

Email
in
bank B

Email
in
bank B

$\tilde{x}_2$

$\tilde{x}_{21}$

$\tilde{x}_1$

Paper
in
bank A

Email
in
bank A

Paper
in
bank A

0

$\tilde{z}_A(.)$

$\tilde{z}_B(.)$

1 (Preference for paper)

z

We denote by Y_i^j the total demand for good i in bank j:

$$Y_1^A(q_1^A, q_2^A, q_1^B, q_2^B) = \tilde{z}^A(q_1^A, q_2^A)\tilde{x}_1(q_1^A, q_1^B),$$

$$Y_1^B(q_1^A, q_2^A, q_1^B, q_2^B) = \tilde{z}^A(q_1^A, q_2^A)(1 - \tilde{x}_1(q_1^A, q_1^B)) + \int_{\tilde{z}^A(q_1^A, q_2^A)}^{\tilde{z}^B(q_1^B, q_2^B)} (1 - \tilde{x}_{21}(q_2^A, q_1^B))dz,$$

$$Y_2^A(q_1^A, q_2^A, q_1^B, q_2^B) = (1 - \tilde{z}^B(q_1^B, q_2^B))\tilde{x}_2(q_2^A, q_2^B) + \int_{\tilde{z}^A(q_1^A, q_2^A)}^{\tilde{z}^B(q_1^B, q_2^B)} \tilde{x}_{21}(q_2^A, q_1^B)dz,$$

$$Y_2^B(q_1^A, q_2^A, q_1^B, q_2^B) = (1 - \tilde{z}^B(q_1^B, q_2^B))(1 - \tilde{x}_2(q_2^A, q_2^B)).$$

Equilibrium transactional media prices

- The profit function of bank j is given by

$$\Pi^j = (q_1^j - c_1^j)Y_1^j(q_1^A, q_2^A, q_1^B, q_2^B) + (q_2^j - c_2^j)Y_2^j(q_1^A, q_2^A, q_1^B, q_2^B).$$

- Each bank maximizes its profit by choosing its prices q_1^j and q_2^j while taking the prices of the other bank as given (Nash equilibrium).

- We assume banks are totally symmetrical in costs $(c_i^A = c_i^B = c_i)$ and in the two transactional products that they offer $(U_i^A = U_i^B = U_i)$.

- We look for a symmetrical equilibrium, where the prices posted by the banks are the same $(q_i^A = q_i^B, i = 1, 2)$ so that the marginal consumer indifferent between banks is located at $x = 1/2$.

Proposition

There is a unique symmetrical profit-maximizing equilibrium, which is such that

$$q_i^A = q_i^B = q_i^* = c_i + t.$$

- Marginal cost plus mark-up increasing in t, the intensity of competition between banks.

- The intensity of preferences for one type of transactional medium rather than another, r, plays no role.

- Assume that
$$c_2 = c_1 + k + p,$$
where p is mail price paid by banks and k is mail preparation cost.

- Paper statements should be more expensive than electronic media (since their marginal cost is higher), with lower volumes.

- The difference in the prices of the two transactional media should exactly reflect the difference in costs.

- Complete pass through of any mail price increase into the final price paid by consumers for mail statements.

- These observations remain true whatever the intensity of competition between banks.

Conclusion

- Hotelling model with two banks and two transactional media.

- Mark-up over marginal cost, inversely proportional to intensity of competition between banks.

- Complete pass-through of increases in input prices (such as mail price for paper statements) into prices paid by final consumers.

- Strong assumptions: symmetry in consumers preferences (both for banks and for transactional media) and in banks marginal costs, plus linear transportation costs.