Platform Competition with Endogenous Multihoming

Roberto Roson

NOTA DI LAVORO 20.2005

JANUARY 2005

PRCG – Privatisation Regulation Corporate Governance

Roberto Roson, *Dipartimento di Scienze Economiche, Università Ca' Foscari di Venezia*

Platform Competition with Endogenous Multihoming

Summary

A model of two-sided market (for credit cards) is introduced and discussed. In this model, agents can join none, one, or more than one platform (multihoming), depending on access prices and the choices made by agents on the opposite market side. Although emerging multihoming patterns are, clearly, one aspect of equilibrium in a two-sided market, this issue has not yet been thoroughly addressed in the literature. This paper provides a general theoretical framework, in which homing partitions are conceived as one aspect of market equilibrium, rather than being set ex-ante, through ad-hoc assumptions. The emergence of a specific equilibrium partition is a consequence of: (1) the structure of costs and benefits, (2) the degree and type of heterogeneity among agents, (3) the intensity of platform competition.

Keywords: Two-sided markets, Network externalities, Standards, Platforms, Multihoming

JEL Classification: D85, L10, L15, L89

Justus Haucap provided useful comments on an earlier draft of this work. The usual disclaimer applies.

Address for correspondence

Roberto Roson
Dipartimento di Scienze Economiche
Università Ca' Foscari di Venezia
Cannaregio S. Giobbe 873
30121 Venezia
Italy
E-mail: roson@unive.it

1 Introduction

In two-sided markets, two (or more) parties need access to a common platform, to initiate a transaction or interaction. The capability and willingness to join the platform depend on (1) the number of joining agents on the opposite side and (2) the access price applied to each party. Examples of two-sided markets are: computer operating systems, real estate agencies, scientific journals, payment systems, media, etc..

The number of agents on the opposite market side matters because more agents means more potential interactions, or a better match in searching a partner. In this sense, we can speak of bilateral network externalities.

Access prices on each side matter because agents cannot realize a full pass-through of cost margins. This is due to the existence of membership fees, independent of transaction volumes, or of specific contractual restraints (e.g., non discrimination rules in credit cards). Because of this, market equilibrium is affected by both the aggregate price level, chosen by the platform, and the price structure (Rochet and Tirole (2004)).

Two-sided markets have been the subject of a recent literature, mainly stemmed from the study of credit cards and media industries[1]. This literature has initially focused on monopolistic platforms, and on their act of balancing prices "to get both sides on board". Competition between platforms has been tackled only recently (Armstrong (2004), Rochet and Tirole (2003a), Guthrie and Wright (2003), Schiff (2003), Caillaud and Jullien (2003), Hagiu (2004), Chakravorti and Roson (2004), Manenti and Somma (2004), Gabszewicz and Wauthy (2004)).

One special difficulty of dealing with platform competition is given by the fact that agents can often join more than one platform (multihoming). For example, consumers may carry, and merchants may accept, more than one credit card for payment. Computer users may install a Windows or a Linux operating system

[1]It could be argued that other two-sided markets had been studied in the past (e.g., shopping malls). General principles of two-sided markets do not seems to have been investigated in a general and systematic way, though.

on their PCs, or both. Software developers may write applications for Windows, Linux, or both. People may have one, or more than one, SIM card, of different operators, on their mobile phones. Web pages may be written using a code that allows sophisticated graphical content to be appropriately displayed in one, or multiple, browser environments.

Multihoming involves costs and benefits. Among costs: fixed costs for learning, searching, adapting to the alternative platform; variable transaction costs (possibly different between platforms); plain membership fees. Among benefits: higher acceptance rate, better market penetration, possibility of choice of the preferred platform during a transaction.

Agents should choose between single and multihoming (or, more precisely, on how much to multihome) by comparing costs and benefits. Analyses of multihoming markets, however, are complicated by two elements. First, some of the costs and benefits are endogenously determined in a market equilibrium. For instance, competing platforms may use price instruments to attract customers. In doing so, they do not only affect market shares, but also the extent of multihoming behaviour. Second, customers choices are interdependent. Consider this trivial example: consumers choosing products of different brands. If all brands are offered in two or more shops (multihoming), each consumer need to visit only one shop to have the whole range available (singlehoming). If the shops are located quite close to each other, it may also be possible that brands are sold exclusively in one of the shops (singlehoming), and consumers would then visit more shops (multihoming). Sellers multihome if buyers singlehome, but buyers multihome if sellers singlehome.

Although emerging multihoming patterns are, clearly, one aspect of equilibrium in a two-sided market, this issue has not yet been thoroughly addressed in the literature, mainly because of the need of retaining analytical tractability. Most papers on platform competition have either pre-determined which market side single/multihomes (based on empirical evidence for specific industries), or have adopted specific assumptions (typically, homogeneity in some parameters,

symmetry) that allows one to anticipate which market side will eventually multihome[2].

The question which side multihomes (possibly both), why and how much, is not a merely theoretical issue. As an example, consider the striking differences that exist between the American and European markets for credit cards. In North America, consumers typically carry several credit cards, although one of them is prevalently used (Rysman (2004)). In Europe, most consumers adopt one credit card, or none, and most merchants accept all major credit cards, or none. Explaining these differences in terms of market competition is a challenging task. Which fundamental characteristics of the two markets may explain this outcome? Are these patterns time-persistent, as one would expect in the presence of network externalities? Is there any role played by market imperfections and barriers to competition? May a shift in policy regime produce an abrupt change in the qualitative characteristics of the market? What are the implications of market integration and increased international competition?

As a further example, consider the penetration of the Linux operating system(s) in the market for personal computers OS. This is a market dominated by the Microsoft Windows family. However, many users have recently started using Linux. Most of them have done that by partitioning the hard disk, thereby retaining both environments. The advantage of increased software availability, compatibility, and flexibility is being weighted against the implicit cost of reducing the hard disk space for Windows native programs. But, what will happen in the future? Will Linux become a serious alternative to Windows, or will it continue living side by side with the dominant standard?

In this paper, we introduce and discuss a model of duopoly competition, with endogenous multihoming, between payment card networks. The case of payment

[2]For example, if agents on one side are all similar, we know that they will end up by making the same choices. In equilibrium, they will either all singlehome on the same platform, or they will all multihome.

A more sophisticated formulation has been adopted in a recent paper by Armstrong and Wright (2004), where conditions for specific homing configurations are derived beforehand and introduced as model assumptions.

cards is taken because the model is derived from Chakravorti and Roson (2004), but most concepts can be readily extended to other two-sided markets. Whereas the latter paper pre-determines which market side singlehomes (the consumers) and which market side - potentially - multihomes (the merchants), the model introduced here allows for endogenous single/multihoming on both sides. To this end, we adopt an approach similar to Hermalin and Katz (2004). Contrary to them, we assume ex-ante which market side (the consumers) has the right to choose the payment instrument when *both* sides multihome. On the other hand, we consider two aspects that have been neglected in their model: (1) the existence of two-sided network externalities, and (2) the possible existence of fixed costs and benefits.

The paper is structured as follows. In the next section, a general theoretical framework is specified, in which the multihoming pattern stems from the equilibrium of a sequential game, in which platforms choose prices first, and agents select which platform(s) to join afterwards. Since equilibria for these games cannot, in general, be specified as closed form solutions, section three provides some illustrative numerical simulations, shedding light on the implications of various assumptions on the market equilibria and homing configurations. An ending section draws some final remarks.

2 The model structure

2.1 Assumptions and definitions

There are: a set S of consumers (shoppers), a set M of merchants, two payment networks (1 and 2). Every consumer makes one transaction (buys one good) with every merchant[3], using cash or one of the two payment instruments. For a payment instrument to be used, both sides must have adopted the corresponding "platform". When both sides have joined both platforms, the consumer decides which instrument is used.

[3]This assumption, often adopted in the literature, rules out "business stealing" motivations for adoption of credit cards by merchants.

Except for the right of selecting the network under reciprocal multihoming, the two sides are symmetric. Each agent on each side ($s \in S, m \in M$) is associated with a vector of (potential) benefits $\mathbf{b^s} = \{B_1^s, b_1^s, B_2^s, b_2^s\} \in \Re^4$ or $\mathbf{b^m} = \{B_1^m, b_1^m, B_2^m, b_2^m\} \in \Re^4$. Benefits B_i^k ($i = \{1, 2\}, k = \{s, m\}$) express the utility (possibly negative), derived by the mere ownership of a payment instrument (e.g., status), whereas b_i^k express transaction benefits, obtained every time a transaction is carried out on a specific platform.

Networks apply, to both sides, a membership fee P (possibly zero or negative) and a transaction fee p. This is a simple form of non-linear pricing which, as we shall see later, allows to price discriminate among different classes of customers, according to their multihoming behaviour. Networks also incur on fixed per-member costs C and transaction costs c. In short, they select a vector of prices $\mathbf{p_i} = \{P_i^s, p_i^s, P_i^m, p_i^m\}$ on the basis of costs $\{C_i^s, c_i^s, C_i^m, c_i^m\}$.

Consumers belong to five categories. First, some consumers do not join any platform, and use only cash. Their utility is normalized to zero ($W_0 = 0$). Some other consumers carry only card 1, and use it whenever they find a merchant who have joined platform 1. Let us define their utility as (Rochet and Tirole (2004)):

$$W_1 = (B_1^s - P_1^s) + (b_1^s - p_1^s)(m_1 + m_{12}) \tag{1}$$

where m_1 stands for the number of merchants accepting, in addition to cash, only card 1, and m_{12} for the number of merchants accepting both payment instruments.

The symmetric definition of utility for consumers joining only platform 2 is:

$$W_2 = (B_2^s - P_2^s) + (b_2^s - p_2^s)(m_2 + m_{12}) \tag{2}$$

There are also a fourth and a fifth category, including those consumers who carry both cards. Here we make a distinction between those who prefer to use card 1 when a choice is possible, because a merchant has joined both platforms, and those who would rather select card 2. Utility for these groups is defined as:

$$W_{12.1} = (B_1^s - P_1^s) + (b_1^s - p_1^s)(m_1 + m_{12}) + (B_2^s - P_2^s) + (b_2^s - p_2^s)m_2 \tag{3}$$

$$W_{12.2} = (B_1^s - P_1^s) + (b_1^s - p_1^s)m_1 + (B_2^s - P_2^s) + (b_2^s - p_2^s)(m_2 + m_{12}) \quad (4)$$

Each consumer belongs to the category in which her utility is highest. Formally, let us define a partition of the set of consumers in the following way:

Definition 1 *A Utility Maximizing Partition (UMP) of the set of consumers is defined as:*

$$H^s(\mathbf{p_1}, \mathbf{p_2}, G^m) = \{\gamma_0\gamma_1, \gamma_2, \gamma_{12.1}, \gamma_{12.2}\}$$

where G^m is a partition of the set of merchants, determining m_1, m_2, m_{12}, and:

$$\gamma_i = \{s : W_i \geq W_j \quad \forall j \neq i\} \quad i, j \in \{0, 1, 2, 12.1, 12.2\}$$

Let us also define $n_i = \texttt{card}(\gamma_i)$ as the number of consumers in each subset.

On the basis of the definition above, it could be possible for a consumer to belong to more than one category, when utilities in two or more groups match. For all practical applications of the model, however, we shall assume that consumers of this type are equally split among the categories for which utility is equal[4].

We adopt a similar framework for the merchant side. The only difference is that here we have four, instead of five, categories, because merchants are assumed not to choose the payment instrument under bilateral multihoming. Again, we can normalize to zero the utility of cash-only merchants: $V_0 = 0$. For the remaining three cases, let us define utility as:

$$V_1 = (B_1^m - P_1^m) + (b_1^m - p_1^m)(n_1 + n_{12.1} + n_{12.2}) \quad (5)$$

$$V_2 = (B_2^m - P_2^m) + (b_2^m - p_2^m)(n_2 + n_{12.1} + n_{12.2}) \quad (6)$$

$$\begin{aligned} V_{12} = (B_1^m - P_1^m) + (b_1^m - p_1^m)(n_1 + n_{12.1}) + \\ +(B_2^m - P_2^m) + (b_2^m - p_2^m)(n_2 + n_{12.2}) \end{aligned} \quad (7)$$

We can define a UMP for merchants as:

[4]This implies that the intersection between any two subsets is the empty set, whereas the union of all subsets is the entire set of consumers.

Definition 2 *A Utility Maximizing Partition (UMP) of the set of merchants is defined as:*

$$H^m(\mathbf{p_1}, \mathbf{p_2}, G^s) = \{\mu_0\mu_1, \mu_2, \mu_{12}\}$$

where G^s is a partition of the set of consumers, determining $n_1, n_2, n_{12.1}, n_{12.2}$, and:

$$\mu_i = \{m : V_i \geq V_j \quad \forall j \neq i\} \quad i, j \in \{0, 1, 2, 12\}$$

Let us also define $m_i = \texttt{card}(\mu_i)$ as the number of merchants in each subset.

Notice that the partition of consumers can be identified on the basis of a partition of merchants and vice versa. Quite naturally, let us define a configuration in which partitions of the two sets are mutually consistent:

Definition 3 *A Consistent Dual Partition (CDP) is defined as:*

$$(H^s(\mathbf{p_1}, \mathbf{p_2}, H^m), H^m(\mathbf{p_1}, \mathbf{p_2}, H^s))$$

As in most coordination games, there can be multiple CDP for given prices. For example, suppose that all agents are homogeneous and platforms apply equal prices (but not too high). There are two possible configurations: in both, only one platform is used to carry out transactions[5]. This is because network externalities produce a special type of economies of scale, which may easily bring about corner solutions.

Here, however, we are considering platforms that provide differentiated services, so that if differentiation is sufficiently strong and agents are heterogeneous in terms of benefits, both platform can be active in a CDP. Furthermore, as noted also by Armstrong and Wright (2004), network externalities and differentiation create opposite effects. The higher the degree of differentiation, the more the individual decisions are based on agent-specific parameters, rather than on expectations about other agents' choices.

[5]The other one could still be joined if membership benefits are high enough.

Notice also that the existence of multiple CDP is linked to the presence of fixed costs and benefits. To see this, suppose that, for one side k of the market, both B_1^k, B_2^k, and P_1^k, P_2^k are zero. Then, utility of k-type agents would still depend on the magnitude of the opposite side network, but *their decision about joining or not a certain platform would not*. Indeed, platform i would be joined whenever $b_i^k > p_i^k$. If adoption choices on one side do not depend on the opposite side choices, multiple CDP cannot occur.

Prices are determined by profit-maximizing platforms. Profits for the two platforms are given by:

$$\Pi_1 = (P_1^s - C_1^s)(n_1 + n_{12.1} + n_{12.2}) + (P_1^m - C_1^m)(m_1 + m_{12}) + \\ + (p_1^s + p_1^m - c_1)[(n_1 + n_{12.1})(m_1 + m_{12}) + n_{12.2} m_1] \tag{8}$$

$$\Pi_2 = (P_2^s - C_2^s)(n_2 + n_{12.1} + n_{12.2}) + (P_2^m - C_2^m)(m_2 + m_{12}) + \\ + (p_2^s + p_2^m - c_2)[(n_2 + n_{12.2})(m_2 + m_{12}) + n_{12.1} m_2] \tag{9}$$

Notice that profits depend on specific partitions of consumer and merchant sets. It is natural, then, to assume that these partitions are determined by the selected prices, and are mutually consistent. More precisely, let us define a game in the following way:

Definition 4 *A Card Multihoming Game (CMG) is defined as a game in which platforms choose prices* $\mathbf{p}$ *to maximize profits, and demand for platform services is implicitly defined by a CDP associated with the same prices. In a non-cooperative CMG each platforms aims at maximizing profits, while taking the prices of other platforms as given. The equilibrium of the game is a Nash equilibrium. In a cooperative CMG, instead, prices are jointly determined, in order to maximize the sum of profits for all platforms.*

When benefits for consumers and merchants, and costs for platforms, are symmetrically distributed, we can speak of a *symmetric CMG*. A symmetric equilibrium for a symmetric CMG (cooperative or non-cooperative) is the one in which platform prices are equal.

Table 1: Platform interaction types

	μ_1	μ_{12}
γ_1	•	•
$\gamma_{12.1}$	•	•
$\gamma_{12.2}$	•	

Because of the possible existence of multiple CDP, a CMG can have multiple equilibria. In this case, the issue of equilibria selection could emerge in some practical applications. Critera for selecting among alternative equilibria are extensively discussed in the literature. For example, one requirement could be that a candidate equilibrium be robust to small deviations, or errors in expectations. Another possibility is to rule out candidate equilibria that are welfare-inferior for all the coordinating agents.

2.2 Profit maximization

Without loss of generality, consider the point of view of platform 1 in the profit maximization problem. Demand for platform 1 stems from consumers and merchants in five groups: $\gamma_1, \gamma_{12.1}, \gamma_{12.2}, \mu_1, \mu_{12}$. However, consumers in γ_1 and $\gamma_{12.1}$ affect the platform profits in the same way, so we can define a new subset $\gamma_{1+} = \gamma_1 \cup \gamma_{12.1}$, where $n_{1+} = n_1 + n_{12.1}$. As summarized in Table 1, consumers in γ_{1+} interact with merchants in μ_1 and μ_{12}, whereas consumers in $\gamma_{12.2}$ interact only with merchants in μ_1. Platform 1 selects a vector of four prices $\mathbf{p_1} = \{P_1^s, p_1^s, P_1^m, p_1^m\}$, to address the four categories of agents.

Within each category, however, there is some redundancy between membership fee and transaction fees. This is because there is no uncertainty, and members of all groups are supposed to know how many interactions will be realized in equilibrium. Since the global price, which is eventually paid, is the sum of membership fee and the product between transaction fee and total number of transactions, utility for each agent could be kept constant if the two fees are changed appropri-

ately, so as to keep the global price constant.

Nonetheless, because of the equality between agent types and price instruments[6], membership and transaction fees can be fine-tuned, so as to achieve the "right" (profit maximizing) global prices for all the four groups, as the following proposition states:

Proposition 1 *Assume that benefit distributions for merchants and consumers are such that the profit function for platform 1 is concave in prices. Then, profit is maximized when the following four conditions hold:*

$$\frac{P_1^s - C_1^s + (m_1 + m_{12})(p_1^s - (c_1 - p_1^m))}{(m_1 + m_{12})p_1^s + P_1^s} + \\ + \frac{m_1(P_1^m/(n_{1+} + n_{12.2})) + m_{12}(P_1^m/n_{1+})}{(m_1 + m_{12})p_1^s + P_1^s} = \frac{1}{\epsilon_{n1+}} \tag{10}$$

$$\frac{P_1^m - C_1^m + (n_{1+} + n_{12.2})(p_1^m - (c_1 - p_1^s))}{(n_{1+} + n_{12.2})p_1^m + P_1^m} + \\ + \frac{n_{1+}(P_1^s/(m_1 + m_{12})) + n_{12.2}(P_1^s/m_1)}{(n_{1+} + n_{12.2})p_1^m + P_1^m} = \frac{1}{\epsilon_{m1}} \tag{11}$$

$$\frac{P_1^s - C_1^s + m_1(p_1^s - (c_1 - p_1^m - (P_1^m/(n_{1+} + n_{12.2}))))}{m_1 p_1^s + P_1^s} = \frac{1}{\epsilon_{n12.2}} \tag{12}$$

$$\frac{P_1^m - C_1^m + n_{1+}(p_1^m - (c_1 - p_1^s - (P_1^s/(m_1 + m_{12}))))}{n_{1+} p_1^m + P_1^m} = \frac{1}{\epsilon_{m12}} \tag{13}$$

where:

$$\epsilon_{n1+} = -\frac{\partial n_{1+}}{\partial P_1^s}\frac{P_1^s}{n_{1+}} \quad \epsilon_{m1} = -\frac{\partial m_1}{\partial P_1^m}\frac{P_1^m}{m_1}$$

$$\epsilon_{n12.2} = -\frac{\partial n_{12.2}}{\partial P_1^s}\frac{P_1^s}{n_{12.2}} \quad \epsilon_{m12} = -\frac{\partial m_{12}}{\partial P_1^m}\frac{P_1^m}{m_{12}}$$

[6]Of course, this holds true only if the four sets $\gamma_1, \gamma_{1+}, \mu_1, \mu_{12}$ are all non-empty. If not, price redundancy would still occur.

Proof. Define the "global prices" faced by the four groups of agents as:

$$\tilde{P}_{n1+} = P_1^s + p_1^s(m_1 + m_{12}) \quad \tilde{P}_{m1} = P_1^m + p_1^m(n_{1+} + n_{12.2}) \tag{14}$$

$$\tilde{P}_{n12.2} = P_1^s + p_1^s m_1 \quad \tilde{P}_{m12} = P_1^m + p_1^m n_{1+}$$

and rewrite the profit function as:

$$\begin{aligned} \Pi_1 = (\tilde{P}_{n1+} + \tilde{P}_{m1} - c_1)n_{1+}m_1 + (\tilde{P}_{n12.2} + \tilde{P}_{m1} - c_1)n_{12.2}m_1 + \\ +(\tilde{P}_{n1+} + \tilde{P}_{m12} - c_1)n_{1+}m_{12} - C_1^s(n_{1+} + n_{12.2}) - C_1^m(m_1 + m_{12}) \end{aligned} \tag{15}$$

Take partial derivatives of Π_1 w.r.t. $n_{1+}, n_{12.2}, m_1, m_{12}$, and equalize them to zero. Introduce standard definitions of own-price elasticity, using $n_{1+}, n_{12.2}, m_1, m_{12}$ as quantities. Next, plug back global prices with membership and transaction fees. Notice that elasticity defined in terms of global price equals elasticity defined in terms of membership fee, e.g.:

$$\epsilon_{n1+} = -\frac{\partial n_{1+}}{\partial P_1^s}\frac{P_1^s}{n_{1+}} = -\frac{\partial n_{1+}}{\partial \tilde{P}_{n1+}}\frac{\tilde{P}_{n1+}}{n_{1+}} \qquad \blacksquare$$

Interpretation of first order conditions (10)-(13) is quite simple. They are special versions of the Lerner's inverse elasticity rule. This rule states that a profit maximizing entity sets prices so that the marginal mark-up (the profit share in the price of the last unit sold) equals the inverse of the own-price demand elasticity. In this case, consumers and merchants should be viewed as quantity units.

Consider the left hand sides of (10)-(13). On the denominator, we found total revenue obtained from an agent in one of the sets $\gamma_{1+}, \gamma_{12.2}, \mu_1, \mu_{12}$. This includes the fixed fee P and the transaction fee p multiplied by the number of interacting agents on the opposite market side.

On the numerator, we have per-member profits. They include three components. First, there is the margin between fixed fee and fixed costs. Second, we have transaction profits. Adding one more agent in a group allows expanding total transactions by a number equal to the size of the interacting parties. Every time

a transaction is carried out, a price p can be charged, and a transaction cost c is paid.

However, as stressed by Rochet and Tirole (2004), the relevant cost concept in a two-sided market is the *opportunity* cost, which should include (as a negative term) the transaction price that can be charged to all members of the opposite side, when a new customer is served. Here, this negative cost component does not only include the direct transaction price p, but also a share of the membership fee P, as it can be seen by defining "per-transaction global prices":

$$\frac{\tilde{P}_{n1+}}{(m_1+m_{12})} = \frac{P_1^s}{(m_1+m_{12})} + p_1^s \quad \frac{\tilde{P}_{m1}}{(n_{1+}+n_{12.2})} = \frac{P_1^m}{(n_{1+}+n_{12.2})} + p_1^m \quad (16)$$

$$\frac{\tilde{P}_{n12.2}}{m_1} = \frac{P_1^s}{m_1} + p_1^s \quad \frac{\tilde{P}_{m12}}{n_{1+}} = \frac{P_1^m}{n_{1+}} + p_1^m$$

Elasticities on the right hand side can take different values, depending also on the competing platforms' behaviour. In a Bertrand-Nash equilibrium, for example, the elasticity should be computed by changing one platform membership fee, while keeping the prices of the other platform(s) fixed. In a cooperative equilibrium, instead, elasticities should be computed on the basis of simultaneous price changes. Of course, in this latter case, elasticities would be smaller, thereby determining higher profit mark-ups in equilibrium.

Looking at the numerators of (10)-(13), one can see that profits can be raised in four different ways, corresponding to the four different price instruments available. On the other hand, all prices are interdependent. For example, suppose that, starting from an equilibrium state, one elasticity for one type of agent increases. This calls for higher profits on that type of agents, which could be achieved by raising at least one of the four prices appearing on the numerator of corresponding f.o.c. . However, once any of these prices are touched, other prices should be also adjusted, to restore equality in the other optimality conditions. Typically, this requires a compensating variation of fixed and variable fees.

Finally, notice that prices determined through (10)-(13) may well be so high that some of the sets $\gamma_{1+}, \gamma_{12.2}, \mu_1, \mu_{12}$ may be empty. For example, for sufficiently high membership fees, there could be no multihoming consumers or merchants.

3 A numerical simulation of platform competition

To get some insights about the functioning of market competition, and its implications in terms of platform adoption, we present here some results of numerical simulation experiments[7].

We consider two scenarios. In both, production costs for platforms are equal and set to $C_1^s = C_2^s = C_1^m = C_2^m = 0.5$ and $c_1 = c_2 = 0.05$. The total number of both merchants and consumers is normalized to one. As in Chakravorti and Roson (2004), we consider a Nash CMG game of price competition vs. a cooperative cartel, fixing prices for the two platforms. In addition, we focus on symmetric CDP dual partitions in the identification of the game equilibrium.

We select symmetric equilibria for two reasons. First, when facing equal platform prices, it is reasonable to assume that agents form expectations in which networks are somehow "balanced". Second, because of the way these equilibria have been numerically determined[8], they must be, at least, "locally stable" in terms of CDP partitions.

In the first case, platforms are differentiated in four dimensions: membership benefits for consumers, membership benefits for merchants, transaction benefits for consumers, transaction benefits for merchants. We assume that all four distributions for the two platforms are uniformously and *independently* distributed in the $[0, 1]$ interval. In other words, each consumer gets a draw $\mathbf{b^s} = \{B_1^s, b_1^s, B_2^s, b_2^s\}$ and each merchant gets a draw $\mathbf{b^m} = \{B_1^m, b_1^m, B_2^m, b_2^m\}$, where all components

[7] These experiments have been carried out with the Mathematica software. Original simulation files are freely available from the author.

[8] In practice, this has been obtained by numerical iterations, where UMPs for consumers and merchants have been computed in sequence, starting from an arbitrary partition in which agents were uniformously distributed among the subsets. In this case, since platform prices are equal in equilibrium (because of cost symmetry), the partitions are symmetric as well.

Table 2: Descriptive variables for collusive and competitive equilibria (Case A)

P_i^s	p_i^s	P_i^m	p_i^m	Π_i	n_0	n_i	$n_{12,i}$	m_0	m_i	m_{12}
.72	.17	.73	.13	.216	.341	.254	.076	.332	.269	.130
.70	.14	.70	.12	.213	.295	.264	.089	.283	.281	.156

are taken at random, independently, in the $[0, 1]$ segment, with equal probability for all values in the interval.

Given prices, consumers and merchants are allocated in a Dual Consistent Partition, on the basis of which platform profits can be computed. Profit maximization, under the two market structures, gives raise to the equilibria described in Table 2, where prices and sets are displayed for the two cases of cooperative cartel equilibrium (first row) and competitive Nash duopoly (second row).

Because merchants and consumers are very heterogeneous in terms of membership and transaction benefits, we can find some agents in all of the nine categories. Multihoming is more diffused among consumers[9], given the additional advantage of having the right to select the preferred platform, when multihoming occurs on both sides.

Despite the fact that consumers and merchants have identical benefit distributions, we can see that prices are not the same for the two sides. In particular, consumers are charged more per transaction: a fact that may be interpreted as a consequence of their platform selection power under reciprocal multihoming. Indeed, if prices for merchants and consumers would be the same, consumers would achieve higher utility levels, on average. The cartel and, to a lesser extent, the duopolistic platforms succeed in capturing part of this extra potential welfare.

When competition is introduced (row 2), all prices fall and welfare increases for both consumers and merchants. Chakravorti and Roson (2004) demonstrate that this result of welfare gains for both sides[10], due to platform competition, is

[9] To get the total number of multihoming consumers, $n_{12.i}$ has to be doubled.

[10] More precisely, non-negative welfare variations.

Table 3: Own-price elasticities for the four groups (Case A)

ϵ_{ni+}	ϵ_{mi}	$\epsilon_{nij.j}$	ϵ_{mij}
.722120	.692475	.993268	.851222
.725388	.699961	1.04522	.886929

a general one. Here we can see what this implies in terms of homing partitions, with less agents not joining any platform, and more agents in all other categories.

Table 3 shows the own-price elasticities for the four interacting groups of each platform (i, j), computed by inserting the values of table 2 in the first order conditions10-13.

Let us now consider a second, alternative case. We take the simplifying assumption of fixing all benefits for all agents at 0.5, except for the transaction benefits for the *consumers* associated with the *second* platform (b_2^s)[11], which continue to be uniformously distributed in $[0, 1]$. This means that: (1) all merchants are identical, so they must end up by making the same choices, and (2) consumers are heterogeneous in one dimension (platform-specific transaction benefits)[12]. Furthermore, as in the first scenario, platforms are symmetric and set equal prices in equilibrium, both in the cartel and in competition.

Under these conditions, consumers do not multihome. If there are no intrinsic benefits in joining one platform rather than another, a consumer would multihome only if there is a probability that her preferred card is not accepted by some merchants. But this would imply that merchants make different adoption choices, which is impossible here. Therefore, either the market for consumers is equally split between the two platforms, like in a symmetric Hotelling model, or only platform 2 is used by less than a half consumers[13]. This second case cannot emerge under competition, because profits of the first platform would be zero if no con-

[11] Or, alternatively, with the first platform.

[12] A similar setting has been analyzed by Armstrong and Wright (2004).

[13] That is, by those having sufficiently high transaction benefits associated with this platform.

Table 4: Descriptive variables for collusive and competitive equilibria (Case B)

P_i^s	p_i^s	P_i^m	p_i^m	Π_i	n_0	n_i	$n_{12,i}$	m_0	m_i	m_{12}
.72	.27	.66	.17	.467	0	.5	0	0	0	1
.68	.20	.66	.17	.410	0	.5	0	0	0	1

sumers join platform 1 and no transactions take place on it[14].

It turns out that, under the set of parameters considered here, it is better to serve all consumers for the cartel as well. Therefore, all consumers singlehome and half of them adopt each platform. This outcome has strong implications for the merchants. Since the number of consumers on each platform is fixed (0.5), the merchants' problems of joining the two platforms are *separable* (since utility is additive). As long as the number of consumers stays fixed, each platform is a *monopolist* on the merchant side, even under platform competition. As such, it can extract all merchants' surplus, and merchants will all multihome.

Table 4 shows the simulation results, using the same format of Table 2. We can see that homing partitions are as expected, and do not change between cartel and duopoly. Remarkably, competition has no effect on the prices faced by merchants, and platforms compete only on the consumer side. Merchant surplus is fully extracted, and merchant are almost indifferent between joining and not joining any of the two platforms.

When these results are compared with those of case A, we can see that the lower degree of heterogeneity among agents in case B is reflected in, on one hand, higher platform profits and, on the other hand, a more significant impact of the introduction of competition in the market.

Because many sets in the homing partitions are empty, some price instruments are redundant, and there is a continuum of market equilibria for the same CDP (so Table 2 shows just one of the many possible equilibria). Any price combination

[14]In principle, a platform could still be sold, because of membership benefits. Here, however, membership costs and benefits take the same value (0.5), so there are no profit margins.

satisfying the two relationships $P^m + 0.5 * p^m = 0.745 = 0.66 + 0.5 * 0.17$ and $P^s + p^s = 0.99 = 0.72 + 1 * 0.27$ (for the cartel), or $P^s + p^s = 0.88 = 0.68 + 1 * 0.20$ (for the competitive duopoly), identifies an equilibrium as well.

4 Concluding remarks

In two-sided markets with multiple platforms, agents can join none, one, or many platforms, depending on prices and adoption choices made by potential partners on the other side. This paper provides a general theoretical framework, in which homing partitions are conceived as one aspect of market equilibrium, rather than being set ex-ante, through ad-hoc assumptions.

The emergence of a specific equilibrium partition is a consequence of: (1) the structure of costs and benefits, (2) the degree and type of heterogeneity among agents, (3) the intensity of platform competition. Relatively high transaction-independent costs, or relatively low transaction-independent benefits, reduce the likelihood of multihoming. Multihoming on one side makes multihoming on the other side less likely. Agent heterogeneity makes coordination problems less severe and equilibrium partitions more stable. Platform competition create a downward pressure on prices, but its implications in terms of multihoming are ambiguous.

As mentioned in the introductory section, real markets are characterized by very diverse homing patterns, even within markets for the same good or service. The analysis conducted so far can help in understanding which factors are at the basis of these differences. Therefore, empirical research could be directed to gauging the relative importance of potential explanatory factors in specific markets. Findings on the determinants of platform adoption would have important policy implications, in several different contexts. For example, understanding why one side singlehomes, and the other side multihomes, could allow forecasting whether or not changes in policy, or technology, will alter key qualitative characteristics of a two-sided market in the future.

References

Armstrong, Mark (2004), *"Competition in Two-Sided Markets,"* Mimeo, presented at "The Economics of Two-Sided Markets" conference held at the University of Toulouse.

Armstrong, Mark and Julian Wright (2004), *"Two-Sided Markets, Competitive Bottlenecks and Exclusive Contracts"*, Mimeo, University College, London, and National University of Singapore.

Caillaud, Bernard and Bruno Jullien (2003), "Chicken & Egg: Competition among Intermediation Service Providers," *RAND Journal of Economics*, **24**, 309-328.

Chakravorti, Sujit and Roberto Roson (2004),*"Platform Competition in Two-Sided Markets: The Case of Payment Networks,"* Federal Reserve Bank of Chicago Working Paper 2004-09, July.

Gabszewicz, Jean J. and Xavier Y. Wauthy (2004),*"Two-Sided Markets and Price Competition with Multi-homing "*, Mimeo, CORE, Louvain-la-Neuve University.

Guthrie, Graeme and Julian Wright (2003), *"Competing Payment Schemes,"* Working Paper No. 0311, Department of Economics, National University of Singapore.

Hagiu, Andrei (2004), *"Optimal Pricing and Commitment in Two-Sided Markets"*, Mimeo, presented at "The Economics of Two-Sided Markets" conference held at the University of Toulouse.

Hermalin, Benjamin E. and Michael L. Katz (2004), *"Your Network or Mine? The Economics of Routing Rules"*, Mimeo, presented at "The Economics of Two-Sided Markets" conference held at the University of Toulouse.

Manenti, Fabio M. and Ernesto Somma (2004), *"Plastic Clashes: Competition among Closed and Open Systems in the Credit Card Industry"*, Mimeo, presented at "The Economics of Two-Sided Markets" conference held at the University of Toulouse.

Rysman, Marc (2004), *"An Empirical Analysis of Payment Card Usage"*, Mimeo, presented at "The Economics of Two-Sided Markets" conference held at the University of Toulouse.

Rochet, Jean-Charles, and Jean Tirole (2003a), "Platform Competition in Two-Sided Markets" , *Journal of European Economic Association*, **1**, 990-1029.

Rochet, Jean-Charles, and Jean Tirole (2004), "Two-Sided Markets: An Overview", mimeo, IDEI University of Toulouse. A preliminary version was presented at "The Economics of Two-Sided Markets" conference, held at the University of Toulouse, January.

Schiff, Aaron (2003), "Open and Closed systems of Two-sided Networks," *Information Economics and Policy*, **15**, 425-442.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Paper Series

Our Note di Lavoro are available on the Internet at the following addresses:

http://www.feem.it/Feem/Pub/Publications/WPapers/default.html
http://www.ssrn.com/link/feem.html

NOTE DI LAVORO PUBLISHED IN 2004

IEM	1.2004	*Anil MARKANDYA, Suzette PEDROSO and Alexander GOLUB*: Empirical Analysis of National Income and So2 Emissions in Selected European Countries
ETA	2.2004	*Masahisa FUJITA and Shlomo WEBER:* Strategic Immigration Policies and Welfare in Heterogeneous Countries
PRA	3.2004	*Adolfo DI CARLUCCIO, Giovanni FERRI, Cecilia FRALE and Ottavio RICCHI:* Do Privatizations Boost Household Shareholding? Evidence from Italy
ETA	4.2004	*Victor GINSBURGH and Shlomo WEBER:* Languages Disenfranchisement in the European Union
ETA	5.2004	*Romano PIRAS:* Growth, Congestion of Public Goods, and Second-Best Optimal Policy
CCMP	6.2004	*Herman R.J. VOLLEBERGH:* Lessons from the Polder: Is Dutch CO2-Taxation Optimal
PRA	7.2004	*Sandro BRUSCO, Giuseppe LOPOMO and S. VISWANATHAN* (lxv): Merger Mechanisms
PRA	8.2004	*Wolfgang AUSSENEGG, Pegaret PICHLER and Alex STOMPER* (lxv): IPO Pricing with Bookbuilding, and a When-Issued Market
PRA	9.2004	*Pegaret PICHLER and Alex STOMPER* (lxv): Primary Market Design: Direct Mechanisms and Markets
PRA	10.2004	*Florian ENGLMAIER, Pablo GUILLEN, Loreto LLORENTE, Sander ONDERSTAL and Rupert SAUSGRUBER* (lxv): The Chopstick Auction: A Study of the Exposure Problem in Multi-Unit Auctions
PRA	11.2004	*Bjarne BRENDSTRUP and Harry J. PAARSCH* (lxv): Nonparametric Identification and Estimation of Multi-Unit, Sequential, Oral, Ascending-Price Auctions With Asymmetric Bidders
PRA	12.2004	*Ohad KADAN* (lxv): Equilibrium in the Two Player, k-Double Auction with Affiliated Private Values
PRA	13.2004	*Maarten C.W. JANSSEN* (lxv): Auctions as Coordination Devices
PRA	14.2004	*Gadi FIBICH, Arieh GAVIOUS and Aner SELA* (lxv): All-Pay Auctions with Weakly Risk-Averse Buyers
PRA	15.2004	*Orly SADE, Charles SCHNITZLEIN and Jaime F. ZENDER* (lxv): Competition and Cooperation in Divisible Good Auctions: An Experimental Examination
PRA	16.2004	*Marta STRYSZOWSKA* (lxv): Late and Multiple Bidding in Competing Second Price Internet Auctions
CCMP	17.2004	*Slim Ben YOUSSEF:* R&D in Cleaner Technology and International Trade
NRM	18.2004	*Angelo ANTOCI, Simone BORGHESI and Paolo RUSSU* (lxvi): Biodiversity and Economic Growth: Stabilization Versus Preservation of the Ecological Dynamics
SIEV	19.2004	*Anna ALBERINI, Paolo ROSATO, Alberto LONGO and Valentina ZANATTA:* Information and Willingness to Pay in a Contingent Valuation Study: The Value of S. Erasmo in the Lagoon of Venice
NRM	20.2004	*Guido CANDELA and Roberto CELLINI* (lxvii): Investment in Tourism Market: A Dynamic Model of Differentiated Oligopoly
NRM	21.2004	*Jacqueline M. HAMILTON* (lxvii): Climate and the Destination Choice of German Tourists
NRM	22.2004	*Javier Rey-MAQUIEIRA PALMER, Javier LOZANO IBÁÑEZ and Carlos Mario GÓMEZ GÓMEZ* (lxvii): Land, Environmental Externalities and Tourism Development
NRM	23.2004	*Pius ODUNGA and Henk FOLMER* (lxvii): Profiling Tourists for Balanced Utilization of Tourism-Based Resources in Kenya
NRM	24.2004	*Jean-Jacques NOWAK, Mondher SAHLI and Pasquale M. SGRO* (lxvii):Tourism, Trade and Domestic Welfare
NRM	25.2004	*Riaz SHAREEF* (lxvii): Country Risk Ratings of Small Island Tourism Economies
NRM	26.2004	*Juan Luis EUGENIO-MARTÍN, Noelia MARTÍN MORALES and Riccardo SCARPA* (lxvii): Tourism and Economic Growth in Latin American Countries: A Panel Data Approach
NRM	27.2004	*Raúl Hernández MARTÍN* (lxvii): Impact of Tourism Consumption on GDP. The Role of Imports
CSRM	28.2004	*Nicoletta FERRO:* Cross-Country Ethical Dilemmas in Business: A Descriptive Framework
NRM	29.2004	*Marian WEBER* (lxvi): Assessing the Effectiveness of Tradable Landuse Rights for Biodiversity Conservation: an Application to Canada's Boreal Mixedwood Forest
NRM	30.2004	*Trond BJORNDAL, Phoebe KOUNDOURI and Sean PASCOE* (lxvi): Output Substitution in Multi-Species Trawl Fisheries: Implications for Quota Setting
CCMP	31.2004	*Marzio GALEOTTI, Alessandra GORIA, Paolo MOMBRINI and Evi SPANTIDAKI:* Weather Impacts on Natural, Social and Economic Systems (WISE) Part I: Sectoral Analysis of Climate Impacts in Italy
CCMP	32.2004	*Marzio GALEOTTI, Alessandra GORIA ,Paolo MOMBRINI and Evi SPANTIDAKI:* Weather Impacts on Natural, Social and Economic Systems (WISE) Part II: Individual Perception of Climate Extremes in Italy
CTN	33.2004	*Wilson PEREZ:* Divide and Conquer: Noisy Communication in Networks, Power, and Wealth Distribution
KTHC	34.2004	*Gianmarco I.P. OTTAVIANO and Giovanni PERI* (lxviii): The Economic Value of Cultural Diversity: Evidence from US Cities
KTHC	35.2004	*Linda CHAIB* (lxviii): Immigration and Local Urban Participatory Democracy: A Boston-Paris Comparison

KTHC	36.2004	*Franca ECKERT COEN and Claudio ROSSI* (lxviii): Foreigners, Immigrants, Host Cities: The Policies of Multi-Ethnicity in Rome. Reading Governance in a Local Context
KTHC	37.2004	*Kristine CRANE* (lxviii): Governing Migration: Immigrant Groups' Strategies in Three Italian Cities – Rome, Naples and Bari
KTHC	38.2004	*Kiflemariam HAMDE* (lxviii): Mind in Africa, Body in Europe: The Struggle for Maintaining and Transforming Cultural Identity - A Note from the Experience of Eritrean Immigrants in Stockholm
ETA	39.2004	*Alberto CAVALIERE:* Price Competition with Information Disparities in a Vertically Differentiated Duopoly
PRA	40.2004	*Andrea BIGANO and Stef PROOST:* The Opening of the European Electricity Market and Environmental Policy: Does the Degree of Competition Matter?
CCMP	41.2004	*Micheal FINUS* (lxix): International Cooperation to Resolve International Pollution Problems
KTHC	42.2004	*Francesco CRESPI:* Notes on the Determinants of Innovation: A Multi-Perspective Analysis
CTN	43.2004	*Sergio CURRARINI and Marco MARINI:* Coalition Formation in Games without Synergies
CTN	44.2004	*Marc ESCRIHUELA-VILLAR:* Cartel Sustainability and Cartel Stability
NRM	45.2004	*Sebastian BERVOETS and Nicolas GRAVEL* (lxvi): Appraising Diversity with an Ordinal Notion of Similarity: An Axiomatic Approach
NRM	46.2004	*Signe ANTHON and Bo JELLESMARK THORSEN* (lxvi): Optimal Afforestation Contracts with Asymmetric Information on Private Environmental Benefits
NRM	47.2004	*John MBURU* (lxvi)*:* Wildlife Conservation and Management in Kenya: Towards a Co-management Approach
NRM	48.2004	*Ekin BIROL, Ágnes GYOVAI and Melinda SMALE* (lxvi)*:* Using a Choice Experiment to Value Agricultural Biodiversity on Hungarian Small Farms: Agri-Environmental Policies in a Transition al Economy
CCMP	49.2004	*Gernot KLEPPER and Sonja PETERSON:* The EU Emissions Trading Scheme. Allowance Prices, Trade Flows, Competitiveness Effects
GG	50.2004	*Scott BARRETT and Michael HOEL:* Optimal Disease Eradication
CTN	51.2004	*Dinko DIMITROV, Peter BORM, Ruud HENDRICKX and Shao CHIN SUNG:* Simple Priorities and Core Stability in Hedonic Games
SIEV	52.2004	*Francesco RICCI*: Channels of Transmission of Environmental Policy to Economic Growth: A Survey of the Theory
SIEV	53.2004	*Anna ALBERINI, Maureen CROPPER, Alan KRUPNICK and Nathalie B. SIMON:* Willingness to Pay for Mortality Risk Reductions: Does Latency Matter?
NRM	54.2004	*Ingo BRÄUER and Rainer MARGGRAF* (lxvi): Valuation of Ecosystem Services Provided by Biodiversity Conservation: An Integrated Hydrological and Economic Model to Value the Enhanced Nitrogen Retention in Renaturated Streams
NRM	55.2004	*Timo GOESCHL and Tun LIN* (lxvi): Biodiversity Conservation on Private Lands: Information Problems and Regulatory Choices
NRM	56.2004	*Tom DEDEURWAERDERE* (lxvi): Bioprospection: From the Economics of Contracts to Reflexive Governance
CCMP	57.2004	*Katrin REHDANZ and David MADDISON:* The Amenity Value of Climate to German Households
CCMP	58.2004	*Koen SMEKENS and Bob VAN DER ZWAAN:* Environmental Externalities of Geological Carbon Sequestration Effects on Energy Scenarios
NRM	59.2004	*Valentina BOSETTI, Mariaester CASSINELLI and Alessandro LANZA* (lxvii): Using Data Envelopment Analysis to Evaluate Environmentally Conscious Tourism Management
NRM	60.2004	*Timo GOESCHL and Danilo CAMARGO IGLIORI* (lxvi):Property Rights Conservation and Development: An Analysis of Extractive Reserves in the Brazilian Amazon
CCMP	61.2004	*Barbara BUCHNER and Carlo CARRARO*: Economic and Environmental Effectiveness of a Technology-based Climate Protocol
NRM	62.2004	*Elissaios PAPYRAKIS and Reyer GERLAGH*: Resource-Abundance and Economic Growth in the U.S.
NRM	63.2004	*Györgyi BELA, György PATAKI, Melinda SMALE and Mariann HAJDÚ* (lxvi): Conserving Crop Genetic Resources on Smallholder Farms in Hungary: Institutional Analysis
NRM	64.2004	*E.C.M. RUIJGROK and E.E.M. NILLESEN* (lxvi): The Socio-Economic Value of Natural Riverbanks in the Netherlands
NRM	65.2004	*E.C.M. RUIJGROK* (lxvi): Reducing Acidification: The Benefits of Increased Nature Quality. Investigating the Possibilities of the Contingent Valuation Method
ETA	66.2004	*Giannis VARDAS and Anastasios XEPAPADEAS*: Uncertainty Aversion, Robust Control and Asset Holdings
GG	67.2004	*Anastasios XEPAPADEAS and Constadina PASSA*: Participation in and Compliance with Public Voluntary Environmental Programs: An Evolutionary Approach
GG	68.2004	*Michael FINUS*: Modesty Pays: Sometimes!
NRM	69.2004	*Trond BJØRNDAL and Ana BRASÃO*: The Northern Atlantic Bluefin Tuna Fisheries: Management and Policy Implications
CTN	70.2004	*Alejandro CAPARRÓS, Abdelhakim HAMMOUDI and Tarik TAZDAÏT*: On Coalition Formation with Heterogeneous Agents
IEM	71.2004	*Massimo GIOVANNINI, Margherita GRASSO, Alessandro LANZA and Matteo MANERA*: Conditional Correlations in the Returns on Oil Companies Stock Prices and Their Determinants
IEM	72.2004	*Alessandro LANZA, Matteo MANERA and Michael MCALEER*: Modelling Dynamic Conditional Correlations in WTI Oil Forward and Futures Returns
SIEV	73.2004	*Margarita GENIUS and Elisabetta STRAZZERA*: The Copula Approach to Sample Selection Modelling: An Application to the Recreational Value of Forests

CCMP	74.2004	*Rob DELLINK and Ekko van IERLAND*: Pollution Abatement in the Netherlands: A Dynamic Applied General Equilibrium Assessment
ETA	75.2004	*Rosella LEVAGGI and Michele MORETTO*: Investment in Hospital Care Technology under Different Purchasing Rules: A Real Option Approach
CTN	76.2004	*Salvador BARBERÀ and Matthew O. JACKSON* (lxx): On the Weights of Nations: Assigning Voting Weights in a Heterogeneous Union
CTN	77.2004	*Àlex ARENAS, Antonio CABRALES, Albert DÍAZ-GUILERA, Roger GUIMERÀ and Fernando VEGA-REDONDO* (lxx): Optimal Information Transmission in Organizations: Search and Congestion
CTN	78.2004	*Francis BLOCH and Armando GOMES* (lxx): Contracting with Externalities and Outside Options
CTN	79.2004	*Rabah AMIR, Effrosyni DIAMANTOUDI and Licun XUE* (lxx): Merger Performance under Uncertain Efficiency Gains
CTN	80.2004	*Francis BLOCH and Matthew O. JACKSON* (lxx): The Formation of Networks with Transfers among Players
CTN	81.2004	*Daniel DIERMEIER, Hülya ERASLAN and Antonio MERLO* (lxx): Bicameralism and Government Formation
CTN	82.2004	*Rod GARRATT, James E. PARCO, Cheng-ZHONG QIN and Amnon RAPOPORT* (lxx): Potential Maximization and Coalition Government Formation
CTN	83.2004	*Kfir ELIAZ, Debraj RAY and Ronny RAZIN* (lxx): Group Decision-Making in the Shadow of Disagreement
CTN	84.2004	*Sanjeev GOYAL, Marco van der LEIJ and José Luis MORAGA-GONZÁLEZ* (lxx): Economics: An Emerging Small World?
CTN	85.2004	*Edward CARTWRIGHT* (lxx): Learning to Play Approximate Nash Equilibria in Games with Many Players
IEM	86.2004	*Finn R. FØRSUND and Michael HOEL*: Properties of a Non-Competitive Electricity Market Dominated by Hydroelectric Power
KTHC	87.2004	*Elissaios PAPYRAKIS and Reyer GERLAGH*: Natural Resources, Investment and Long-Term Income
CCMP	88.2004	*Marzio GALEOTTI and Claudia KEMFERT*: Interactions between Climate and Trade Policies: A Survey
IEM	89.2004	*A. MARKANDYA, S. PEDROSO and D. STREIMIKIENE*: Energy Efficiency in Transition Economies: Is There Convergence Towards the EU Average?
GG	90.2004	*Rolf GOLOMBEK and Michael HOEL* : Climate Agreements and Technology Policy
PRA	91.2004	*Sergei IZMALKOV* (lxv): Multi-Unit Open Ascending Price Efficient Auction
KTHC	92.2004	*Gianmarco I.P. OTTAVIANO and Giovanni PERI*: Cities and Cultures
KTHC	93.2004	*Massimo DEL GATTO*: Agglomeration, Integration, and Territorial Authority Scale in a System of Trading Cities. Centralisation versus devolution
CCMP	94.2004	*Pierre-André JOUVET, Philippe MICHEL and Gilles ROTILLON*: Equilibrium with a Market of Permits
CCMP	95.2004	*Bob van der ZWAAN and Reyer GERLAGH*: Climate Uncertainty and the Necessity to Transform Global Energy Supply
CCMP	96.2004	*Francesco BOSELLO, Marco LAZZARIN, Roberto ROSON and Richard S.J. TOL*: Economy-Wide Estimates of the Implications of Climate Change: Sea Level Rise
CTN	97.2004	*Gustavo BERGANTIÑOS and Juan J. VIDAL-PUGA*: Defining Rules in Cost Spanning Tree Problems Through the Canonical Form
CTN	98.2004	*Siddhartha BANDYOPADHYAY and Mandar OAK*: Party Formation and Coalitional Bargaining in a Model of Proportional Representation
GG	99.2004	*Hans-Peter WEIKARD, Michael FINUS and Juan-Carlos ALTAMIRANO-CABRERA*: The Impact of Surplus Sharing on the Stability of International Climate Agreements
SIEV	100.2004	*Chiara M. TRAVISI and Peter NIJKAMP*: Willingness to Pay for Agricultural Environmental Safety: Evidence from a Survey of Milan, Italy, Residents
SIEV	101.2004	*Chiara M. TRAVISI, Raymond J. G. M. FLORAX and Peter NIJKAMP*: A Meta-Analysis of the Willingness to Pay for Reductions in Pesticide Risk Exposure
NRM	102.2004	*Valentina BOSETTI and David TOMBERLIN:* Real Options Analysis of Fishing Fleet Dynamics: A Test
CCMP	103.2004	*Alessandra GORIA e Gretel GAMBARELLI:* Economic Evaluation of Climate Change Impacts and Adaptability in Italy
PRA	104.2004	*Massimo FLORIO and Mara GRASSENI*: The Missing Shock: The Macroeconomic Impact of British Privatisation
PRA	105.2004	*John BENNETT, Saul ESTRIN, James MAW and Giovanni URGA*: Privatisation Methods and Economic Growth in Transition Economies
PRA	106.2004	*Kira BÖRNER*: The Political Economy of Privatization: Why Do Governments Want Reforms?
PRA	107.2004	*Pehr-Johan NORBÄCK and Lars PERSSON*: Privatization and Restructuring in Concentrated Markets
SIEV	108.2004	*Angela GRANZOTTO, Fabio PRANOVI, Simone LIBRALATO, Patrizia TORRICELLI and Danilo MAINARDI*: Comparison between Artisanal Fishery and Manila Clam Harvesting in the Venice Lagoon by Using Ecosystem Indicators: An Ecological Economics Perspective
CTN	109.2004	*Somdeb LAHIRI*: The Cooperative Theory of Two Sided Matching Problems: A Re-examination of Some Results
NRM	110.2004	*Giuseppe DI VITA*: Natural Resources Dynamics: Another Look
SIEV	111.2004	*Anna ALBERINI, Alistair HUNT and Anil MARKANDYA*: Willingness to Pay to Reduce Mortality Risks: Evidence from a Three-Country Contingent Valuation Study
KTHC	112.2004	*Valeria PAPPONETTI and Dino PINELLI*: Scientific Advice to Public Policy-Making
SIEV	113.2004	*Paulo A.L.D. NUNES and Laura ONOFRI*: The Economics of Warm Glow: A Note on Consumer's Behavior and Public Policy Implications
IEM	114.2004	*Patrick CAYRADE*: Investments in Gas Pipelines and Liquefied Natural Gas Infrastructure What is the Impact on the Security of Supply?
IEM	115.2004	*Valeria COSTANTINI and Francesco GRACCEVA:* Oil Security. Short- and Long-Term Policies

IEM	116.2004	*Valeria COSTANTINI and Francesco GRACCEVA:* Social Costs of Energy Disruptions
IEM	117.2004	*Christian EGENHOFER, Kyriakos GIALOGLOU, Giacomo LUCIANI, Maroeska BOOTS, Martin SCHEEPERS, Valeria COSTANTINI, Francesco GRACCEVA, Anil MARKANDYA and Giorgio VICINI*: Market-Based Options for Security of Energy Supply
IEM	118.2004	*David FISK*: Transport Energy Security. The Unseen Risk?
IEM	119.2004	*Giacomo LUCIANI*: Security of Supply for Natural Gas Markets. What is it and What is it not?
IEM	120.2004	*L.J. de VRIES and R.A. HAKVOORT*: The Question of Generation Adequacy in Liberalised Electricity Markets
KTHC	121.2004	*Alberto PETRUCCI*: Asset Accumulation, Fertility Choice and Nondegenerate Dynamics in a Small Open Economy
NRM	122.2004	*Carlo GIUPPONI, Jaroslaw MYSIAK and Anita FASSIO*: An Integrated Assessment Framework for Water Resources Management: A DSS Tool and a Pilot Study Application
NRM	123.2004	*Margaretha BREIL, Anita FASSIO, Carlo GIUPPONI and Paolo ROSATO*: Evaluation of Urban Improvement on the Islands of the Venice Lagoon: A Spatially-Distributed Hedonic-Hierarchical Approach
ETA	124.2004	*Paul MENSINK*: Instant Efficient Pollution Abatement Under Non-Linear Taxation and Asymmetric Information: The Differential Tax Revisited
NRM	125.2004	*Mauro FABIANO, Gabriella CAMARSA, Rosanna DURSI, Roberta IVALDI, Valentina MARIN and Francesca PALMISANI*: Integrated Environmental Study for Beach Management:A Methodological Approach
PRA	126.2004	*Irena GROSFELD and Iraj HASHI*: The Emergence of Large Shareholders in Mass Privatized Firms: Evidence from Poland and the Czech Republic
CCMP	127.2004	*Maria BERRITTELLA, Andrea BIGANO, Roberto ROSON and Richard S.J. TOL*: A General Equilibrium Analysis of Climate Change Impacts on Tourism
CCMP	128.2004	*Reyer GERLAGH*: A Climate-Change Policy Induced Shift from Innovations in Energy Production to Energy Savings
NRM	129.2004	*Elissaios PAPYRAKIS and Reyer GERLAGH*: Natural Resources, Innovation, and Growth
PRA	130.2004	*Bernardo BORTOLOTTI and Mara FACCIO*: Reluctant Privatization
SIEV	131.2004	*Riccardo SCARPA and Mara THIENE*: Destination Choice Models for Rock Climbing in the Northeast Alps: A Latent-Class Approach Based on Intensity of Participation
SIEV	132.2004	*Riccardo SCARPA Kenneth G. WILLIS and Melinda ACUTT*: Comparing Individual-Specific Benefit Estimates for Public Goods: Finite Versus Continuous Mixing in Logit Models
IEM	133.2004	*Santiago J. RUBIO*: On Capturing Oil Rents with a National Excise Tax Revisited
ETA	134.2004	*Ascensión ANDINA DÍAZ*: Political Competition when Media Create Candidates' Charisma
SIEV	135.2004	*Anna ALBERINI*: Robustness of VSL Values from Contingent Valuation Surveys
CCMP	136.2004	*Gernot KLEPPER and Sonja PETERSON*: Marginal Abatement Cost Curves in General Equilibrium: The Influence of World Energy Prices
ETA	137.2004	*Herbert DAWID, Christophe DEISSENBERG and Pavel ŠEVČIK*: Cheap Talk, Gullibility, and Welfare in an Environmental Taxation Game
CCMP	138.2004	*ZhongXiang ZHANG*: The World Bank's Prototype Carbon Fund and China
CCMP	139.2004	*Reyer GERLAGH and Marjan W. HOFKES*: Time Profile of Climate Change Stabilization Policy
NRM	140.2004	*Chiara D'ALPAOS and Michele MORETTO*: The Value of Flexibility in the Italian Water Service Sector: A Real Option Analysis
PRA	141.2004	*Patrick BAJARI, Stephanie HOUGHTON and Steven TADELIS* (lxxi): Bidding for Incompete Contracts
PRA	142.2004	*Susan ATHEY, Jonathan LEVIN and Enrique SEIRA* (lxxi): Comparing Open and Sealed Bid Auctions: Theory and Evidence from Timber Auctions
PRA	143.2004	*David GOLDREICH* (lxxi): Behavioral Biases of Dealers in U.S. Treasury Auctions
PRA	144.2004	*Roberto BURGUET* (lxxi): Optimal Procurement Auction for a Buyer with Downward Sloping Demand: More Simple Economics
PRA	145.2004	*Ali HORTACSU and Samita SAREEN* (lxxi): Order Flow and the Formation of Dealer Bids: An Analysis of Information and Strategic Behavior in the Government of Canada Securities Auctions
PRA	146.2004	*Victor GINSBURGH, Patrick LEGROS and Nicolas SAHUGUET* (lxxi): How to Win Twice at an Auction. On the Incidence of Commissions in Auction Markets
PRA	147.2004	*Claudio MEZZETTI, Aleksandar PEKEČ and Ilia TSETLIN* (lxxi): Sequential vs. Single-Round Uniform-Price Auctions
PRA	148.2004	*John ASKER and Estelle CANTILLON* (lxxi): Equilibrium of Scoring Auctions
PRA	149.2004	*Philip A. HAILE, Han HONG and Matthew SHUM* (lxxi): Nonparametric Tests for Common Values in First-Price Sealed-Bid Auctions
PRA	150.2004	*François DEGEORGE, François DERRIEN and Kent L. WOMACK* (lxxi): Quid Pro Quo in IPOs: Why Bookbuilding is Dominating Auctions
CCMP	151.2004	*Barbara BUCHNER and Silvia DALL'OLIO*: Russia: The Long Road to Ratification. Internal Institution and Pressure Groups in the Kyoto Protocol's Adoption Process
CCMP	152.2004	*Carlo CARRARO and Marzio GALEOTTI*: Does Endogenous Technical Change Make a Difference in Climate Policy Analysis? A Robustness Exercise with the FEEM-RICE Model
PRA	153.2004	*Alejandro M. MANELLI and Daniel R. VINCENT* (lxxi): Multidimensional Mechanism Design: Revenue Maximization and the Multiple-Good Monopoly
ETA	154.2004	*Nicola ACOCELLA, Giovanni Di BARTOLOMEO and Wilfried PAUWELS*: Is there any Scope for Corporatism in Stabilization Policies?
CTN	155.2004	*Johan EYCKMANS and Michael FINUS*: An Almost Ideal Sharing Scheme for Coalition Games with Externalities
CCMP	156.2004	*Cesare DOSI and Michele MORETTO*: Environmental Innovation, War of Attrition and Investment Grants

CCMP	157.2004	*Valentina BOSETTI, Marzio GALEOTTI and Alessandro LANZA*: How Consistent are Alternative Short-Term Climate Policies with Long-Term Goals?
ETA	158.2004	*Y. Hossein FARZIN and Ken-Ichi AKAO*: Non-pecuniary Value of Employment and Individual Labor Supply
ETA	159.2004	*William BROCK and Anastasios XEPAPADEAS*: Spatial Analysis: Development of Descriptive and Normative Methods with Applications to Economic-Ecological Modelling
KTHC	160.2004	*Alberto PETRUCCI*: On the Incidence of a Tax on PureRent with Infinite Horizons
IEM	161.2004	*Xavier LABANDEIRA, José M. LABEAGA and Miguel RODRÍGUEZ*: Microsimulating the Effects of Household Energy Price Changes in Spain

NOTE DI LAVORO PUBLISHED IN 2005

CCMP	1.2005	*Stéphane HALLEGATTE*: Accounting for Extreme Events in the Economic Assessment of Climate Change
CCMP	2.2005	*Qiang WU and Paulo Augusto NUNES*: Application of Technological Control Measures on Vehicle Pollution: A Cost-Benefit Analysis in China
CCMP	3.2005	*Andrea BIGANO, Jacqueline M. HAMILTON, Maren LAU, Richard S.J. TOL and Yuan ZHOU*: A Global Database of Domestic and International Tourist Numbers at National and Subnational Level
CCMP	4.2005	*Andrea BIGANO, Jacqueline M. HAMILTON and Richard S.J. TOL*: The Impact of Climate on Holiday Destination Choice
ETA	5.2005	*Hubert KEMPF*: Is Inequality Harmful for the Environment in a Growing Economy?
CCMP	6.2005	*Valentina BOSETTI, Carlo CARRARO and Marzio GALEOTTI*: The Dynamics of Carbon and Energy Intensity in a Model of Endogenous Technical Change
IEM	7.2005	*David CALEF and Robert GOBLE*: The Allure of Technology: How France and California Promoted Electric Vehicles to Reduce Urban Air Pollution
ETA	8.2005	*Lorenzo PELLEGRINI and Reyer GERLAGH*: An Empirical Contribution to the Debate on Corruption Democracy and Environmental Policy
CCMP	9.2005	*Angelo ANTOCI*: Environmental Resources Depletion and Interplay Between Negative and Positive Externalities in a Growth Model
CTN	10.2005	*Frédéric DEROIAN*: Cost-Reducing Alliances and Local Spillovers
NRM	11.2005	*Francesco SINDICO*: The GMO Dispute before the WTO: Legal Implications for the Trade and Environment Debate
KTHC	12.2005	*Carla MASSIDDA*: Estimating the New Keynesian Phillips Curve for Italian Manufacturing Sectors
KTHC	13.2005	*Michele MORETTO and Gianpaolo ROSSINI*: Start-up Entry Strategies: Employer vs. Nonemployer firms
PRCG	14.2005	*Clara GRAZIANO and Annalisa LUPORINI*: Ownership Concentration, Monitoring and Optimal Board Structure
CSRM	15.2005	*Parashar KULKARNI*: Use of Ecolabels in Promoting Exports from Developing Countries to Developed Countries: Lessons from the Indian LeatherFootwear Industry
KTHC	16.2005	*Adriana DI LIBERTO, Roberto MURA and Francesco PIGLIARU*: How to Measure the Unobservable: A Panel Technique for the Analysis of TFP Convergence
KTHC	17.2005	*Alireza NAGHAVI*: Asymmetric Labor Markets, Southern Wages, and the Location of Firms
KTHC	18.2005	*Alireza NAGHAVI*: Strategic Intellectual Property Rights Policy and North-South Technology Transfer
KTHC	19.2005	*Mombert HOPPE*: Technology Transfer Through Trade
PRCG	20.2005	*Roberto ROSON*: Platform Competition with Endogenous Multihoming

(lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003
(lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL) , Venice, August 28-29, 2003
(lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003
(lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003
(lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003
(lxx) This paper was presented at the 9th Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004
(lxxi) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by Fondazione Eni Enrico Mattei and Consip and sponsored by the EU, Rome, September 23-25, 2004

2004 SERIES	
CCMP	*Climate Change Modelling and Policy* (Editor: Marzio Galeotti)
GG	*Global Governance* (Editor: Carlo Carraro*)*
SIEV	*Sustainability Indicators and Environmental Valuation* (Editor: Anna Alberini)
NRM	*Natural Resources Management* (Editor: Carlo Giupponi)
KTHC	*Knowledge, Technology, Human Capital* (Editor: Gianmarco Ottaviano)
IEM	*International Energy Markets* (Editor: Anil Markandya)
CSRM	*Corporate Social Responsibility and Sustainable Management* (Editor: Sabina Ratti)
PRA	*Privatisation, Regulation, Antitrust* (Editor: Bernardo Bortolotti)
ETA	*Economic Theory and Applications* (Editor: Carlo Carraro)
CTN	*Coalition Theory Network*

2005 SERIES	
CCMP	*Climate Change Modelling and Policy* (Editor: Marzio Galeotti)
SIEV	*Sustainability Indicators and Environmental Valuation* (Editor: Anna Alberini)
NRM	*Natural Resources Management* (Editor: Carlo Giupponi)
KTHC	*Knowledge, Technology, Human Capital* (Editor: Gianmarco Ottaviano)
IEM	*International Energy Markets* (Editor: Anil Markandya)
CSRM	*Corporate Social Responsibility and Sustainable Management* (Editor: Sabina Ratti)
PRCG	*Privatisation Regulation Corporate Governance* (Editor: Bernardo Bortolotti)
ETA	*Economic Theory and Applications* (Editor: Carlo Carraro)
CTN	*Coalition Theory Network*