# STRATEGIC MARKET RESEARCH AND INDUSTRY STRUCTURE IN INTEGRATED ECONOMY

Jacek CUKROWSKI,* Manfred M. FISCHER**

**Abstract:**
The paper is concerned with the impact of market research prior to integration with European Union (EU) on the structures of noncompetitive industries in integrated economy. The analysis focuses on monopolistic markets with stochastic demand. Firms are considered in dynamic multiperiod model, where intertemporal links are determined by expenditures on market research in a present period and benefits from this activity (i.e., smaller variance of the prediction error) in the future. We show that the optimal market research strategy is stationary and depends on market size. Consequently, after accession firms operating prior to integration in small markets are expected to have much less information about the total market than their competitors from the EU. This informational asymmetry may affect the structure of the industry in integrated economy. In the extreme case, the firm operating before integration in the small market can be ruled out from the integrated market.

**Keywords:** European integration, demand uncertainty, industry structures, asymmetric information, demand forecasting, barriers for entry

**JEL Classification:** F15, D80, L10

## 1. Introduction

Success of the transformation of Eastern European societies has created an entirely new situation for the European Union, where we could observe two, to some extend contradictory,[1] tendencies: to deepen the community of European countries and to expand the EU. Finland, Sweden and Austria joined the EU in 1995, however, the target solution is considered to be the admittance of the following countries: Poland, the Czech Republic, Hungary, Slovenia, Slovakia, Estonia, Lithuania, Latvia, Malta and Cyprus. It has been already decided that in 2004 all the countries

---

*) University of Finance and Management (WSFiZ), Ciepla 40, 15-472 Bialystok and Center for Social and Economic Research (CASE), Sienkiewicza 12, 00944 Warsaw, Poland (e-mail: Jacek.Cukrowski@case.com.pl).

**) Department of Economic Geography and Geoinformatics, Vienna University of Economic and Business Administration, Rossauer Lände 23/1, A-1090 Vienna, Austria.

1) Note that the more ”integrated” the present EU becomes, the more the difficult the admission of new members will be.

specified above will join the EU. Thus, in few years firms from Eastern Europe will start to enter on a larger scale into various economic relationships (market competition, joint venture, licensing, foreign direct investment, etc.) with their Western European counterparts. All of these will have significant impact on market structure of integrated economy.

In the presented paper, we intend to show that behavior of the firms in pre-integration period may affect the structure of the industry in integrated economy. In particular, we want to show that, under demand uncertainty, informational asymmetry between firms resulting from their past behavior will result in cost advantage of firms operating before integration in European market over their competitors from acceding countries.

Since in real life firms are never sure about a number of variables characterizing market environment such as factor prices, or the exact shape of demand curve (see, e.g., Nelson, 1960; Ghosal, 1996), we focus on firms operating in the market with uncertain demand. Economic research shows that uncertainty of demand can change the basic predictions of economic theory under certainty. The basic conclusions concerning the behavior of firms operating in markets with uncertain demand have been presented by Sandmo (1971), Leland (1972) and Lim (1980). In most of those papers, the firms' beliefs about demand are summarized in a subjective probability distribution, which cannot be changed by the firms' actions. The fact that the firm may be able to predict changes in demand, or at least to decrease the range of possible variations, is usually neglected in the standard studies of economic behavior under uncertainty. Nevertheless, the ability of the firm to predict demand, although not always perfect, may affect not only a number of parameters of economic equilibrium (see, e.g., Nelson, 1960), but also the structure of the industry.

In the analysis which follows we focus on two separated single commodity markets for the same product and we assume that in both markets the relationship between quantities demanded and market prices randomly varies from period to period, and that demand analysis is both costly and time consuming. In particular, we focus on markets where the total demand originates from a large (but finite) number of sources. The demand curve in each individual source changes randomly from period to period, but in any time period changes of demand are assumed to be correlated with the changes prior to this period, reflecting a certain inertness in consumer behavior. Since information gathering and data processing requires time, the sum of individual demands (i.e., the total demand) cannot be instantaneously determined. In particular, we assume that the results of the market analysis are available only after the end of the period. Thus, the firms' output-price decisions have to be made based not on the true demand but on its prediction. In each period the profit-maximizing firms set their volumes of output, since it has a high commitment value within a period of time (i.e., the output decisions are irreversible within the time unit). The price is assumed to be more flexible and can change due to real market conditions. However, firms operating in the market are still assumed to be unable to learn the true demand function during the period of time, and, consequently, have to rely only on the results of the demand analysis.[2] Since demand forecasts are based on past data, a prediction error appears, and, consequently, firm's output decisions always deviate from what is optimal.

---

2) Note that by allowing for a small price adjustment, we avoid the problem of inventories and any potential losses connected with them (see Zabel, 1970, for an analysis of the behavior of the firm in a multiperiod model with inventories).

Note that better predictions resulting in smaller variance of current demand make the firm's output decisions close to optimal, but on the other hand, they induce additional costs (more resources have to be devoted to market research in the firm). Consequently, the selection of the optimal demand forecasting strategy faces the traditional cost-benefit trade off problem.

In the present paper we intent to show that the optimal amount of resources devoted to market research is proportional to the market size (i.e., firms operating in larger market devote more resources to market analysis than firms operating in smaller one), what implies that firms operating in different markets (before integration) will have different information about the consolidated market just after integration (in particular, the firm operating in larger market will have much more information about integrated market than a firm operating in the smaller one). Resulting informational asymmetry may affect the industry structure in the integrated market.

The paper is organized as follows. Uncertainty of demand and basic principles of demand forecasting are characterized in section 2. Section 3 provides an analysis of the optimal demand forecasting strategy in the monopolistic firm operating in the single commodity market. The implication of the size of the market on the scope of market research is presented in section 4. Section 5 explores how market research strategies prior to integration may affect industry structure in the integrated market. The concluding section summarizes some of the major findings of the study.

## 2. Forecasting Market Demand

Consider a single commodity market where total demand originates from a large number of identical sources $N$ (one can think of these sources as retail outlets or consumers). Suppose that demand in each individual source $i$ ($i$ = 1,2, ..., $N$) at any period of time $t$ ($t$ is an integer number, $-\infty < t < +\infty$) is linear with an additive random term $\eta_{i,t}$ (for the sake of simplicity, assume that random variables $\eta_{i,t}$ are identically distributed with zero mean and finite variance $\sigma_{i,t}^2 = \sigma_t^2$), i.e., inverse demand in source $i$ ($i$ = 1,2, ..., $N$) at any period of time $t$ is characterized as

$$P_{i,t}(q_{i,t}, \eta_{i,t}) = a - bq_{i,t} + \eta_{i,t} \tag{1}$$

where $a$ and $b$ are positive constants. Total inverse demand at period $t$ is

$$P_{N,t}(Q_t, \eta_{1,t}, \eta_{2,t}, \dots, \eta_{N,t}) = a - \frac{b}{N} Q_t + \frac{1}{N} \sum_{i=1}^{N} \eta_{i,t} \tag{2}$$

where $Q_t = \sum_{i=1}^{N} q_{i,t}$ is the total quantity demanded at price $P_{Nt}$ ($P_t \geq 0$). The random variables $\eta_{i,t}$ can move up or down in response to changes in the variables omitted from a correct demand specification, such as, for instance, interest rates, inflation, personal income, prices of other goods, etc. Much of this movement, however, might be due to factors, which are hard to capture, such as, for example, changes in the weather or in consumer tastes. Thus, in many cases it may be difficult (or even impossible) to explain fluctuations in demand through the use of a structural model. Moreover, it might happen that, even if statistically significant regression equations can be estimated, the result will not be useful for forecasting purposes (for example, when explanatory variables which are not lagged must themselves be forecasted). In such situations, an alternative means of obtaining predictions of $\eta_{i,t}$ have to be used. The easiest way is to predict changes in $\eta_{i,t}$ based on the analysis of their movements in the past. Such forecasts, however, are possible only if the random variables $\eta_{i,t}$ are observable and if they are correlated with their previous values.

To simplify the analysis, assume that random deviations from the expected values of individual demands $\eta_{i,t}$ ($i$ = 1,2,...,$N$) are independent[3] and described by identical stationary stochastic processes with a memory (e.g., by autoregressive processes of any order).[4] In other words, assume that for any individual demand, variances and covariances of random variables $\eta_{i,t}$ are invariant with respect to displacement in time (note that, by definition, mean values of random variables $\eta_{i,t}$ are equal to zero, $E(\eta_{i,t}) = 0$), i.e., $Var(\eta_{i,t}) = Var(\eta_i) = \sigma^2 > 0$, and $Cov(\eta_{i,t}, \eta_{i,t+s}) \neq 0$, for $\sigma = 0,1,...$, $i = 1,2,...,N$, and integer valued $t$ ($-\infty < t < +\infty$).

Since immediate computations are not possible and the firm's output-price decisions have to be made prior to the knowledge of the market price, the result computed in period $t$ can be used only in subsequent periods, i.e., deviations $\eta_t = \sum_{i=1}^{N} \eta_{i,t}$ can be estimated based on the results computed in the past, and, consequently, always with certain error. It has to be stressed, however, that the variance of the error in the estimation increases with the time elapsed from observations of individual demands to the moment when decisions are made (see Radner and Van Zandt, 1992, for a discussion). Therefore, the producer faces not only the rather standard problem of finding appropriate estimations of demand but also the problem of finding the optimal cost of these estimations, since data processing is inherently costly and the acquisition and analysis of more pieces of information (and in particular, more recent information) has to be weighed against the increasing costs of such an endeavor.

In general, the firm may find it advantageous to compute in subsequent periods (say, $t - m$, $m$ = 1,2,...) deviations from the mean values of random variables $\eta_{i,t-m}$ coming from different subsets of sources (say, $S_{t-m}$, $m$ = 1,2,...) and use them for the estimation of the total deviation from the expected demand in period $t$ (rational strategy requires that sources of demand should be analyzed cyclically one after the other) (see Cukrowski, 1996).

Denote the results computed in subsequent periods as $\eta_{t-m}^{S_{t-m}},...,\eta_{t-1}^{S_{t-1}}$. If the subsets $\{S_{t-m},...,S_{t-1}\}$ contain $n_{t-m},..., n_{t-1}$ ($n_{t-m} > 0,..., n_{t-1} > 0$) sources of individual demand, then there exits integer number $K$ ($N \geq K \geq 1$) such that $\sum_{i=1}^{K} \eta_{t-1} \leq N < \sum_{j=1}^{K+1} \eta_{t-1}$. Thus, the estimation of total deviation $\tilde{\eta}_t$ can be computed as

$$\tilde{\eta} = \sum_{i=1}^{K} \tilde{\eta}_t^{S_{t-i}} + \frac{N - \sum_{i=1}^{K} \eta_{t-i}}{\eta_{t-(K+1)}} \tilde{\eta}_t^{S_{t-(K+1)}} \tag{3}$$

where $\tilde{\eta}_t^{S_{t-m}}$ is a forecast (for period $t$) of the sum of the deviations from the mean values of random variables coming from the sources included in the set $S_{t-m}$ ($m$ = 1,2,..,$K$ + 1).

---

3) In general, specifications of stochastic processes describing individual demands should also include a "common noise" which could reflect aggregate demand shocks (i.e., which could equally affect all sources of demand), but to simplify the exposition we will disregard this common component.

4) Similar structure of demand has been assumed by Radner and Van Zandt (1992).

Since all the available predictions of partial deviations $\left(\tilde{\eta}_t^{S_{t-m}}, m = 1,2,\ldots,K+1\right)$ can be represented as linear combinations of the true values of corresponding partial deviations in the past, the expected error in the prediction of total deviation equals zero. Furthermore, its variance (assuming that deviations from the expected values of individual demands, $\eta_{i,t}$, are independent, identically distributed, and time invariant) is

$$\sigma_t^2 = \sum_{i=1}^{K} n_{t-i}\sigma_{t,i}^2 + \left(N - \sum_{i=1}^{K} n_{t-i}\right)\sigma_{t,K+1}^2 \tag{4}$$

where

$$\sigma_{t,m}^2 = E\left\{\left[\eta_{i,t} - \tilde{\eta}_{i,t}(m)\right]^2\right\} \tag{5}$$

is the variance of the error in the estimation (with lag $m$, $m = 1,2,\ldots, K + 1$) of the deviation of random variable $\eta_{i,t}$ ($i = 1,2,\ldots, N$) from its mean value, and $\tilde{\eta}_{i,t}(m)$ denotes the estimation with lag $m$ ($m = 1,2,\ldots, K + 1$) of the deviation of random variable $\eta_{i,t}$ ($i = 1,2,\ldots, N$) from its mean value.

The forecast of the inverse demand can be specified as $\tilde{P}_t(Q_t) = P(Q_t) + \frac{1}{N}\tilde{\eta}_t$, where $P_t(Q_t) = a - \frac{b}{N}Q_t$ denotes the expected demand curve in period $t$ ($-\infty < t < +\infty$). The prediction error equals $\tilde{\eta}_t / N$ where $\tilde{\eta}_t$ is given by (3) and its variance $\sigma_t^2$ by (4).

## 3. Optimal Behavior of the Monopolistic Firm

Taking into account that the variability of demand decreases the quality of output-price decisions (i.e., price-output decisions deviate from the optimal decision that would be made if the variance were equal to zero) and that the results of demand analysis can be used only after the end of the period in which they were computed, the smallest variance of the prediction error corresponds to the case when all sources of demand are analyzed in the preceding period. The analysis of the total demand in each period, however, requires a number of economic resources to be devoted to data-processing in the firm, i.e., it induces significant costs that cannot always be offset by the expected benefit from the output-price decision with a lower risk of error. Thus, instead of examining the demand coming from all sources in each period, the firm can sequentially analyze the demand coming from certain subsets of sources. In this case, however, the firm has to determine the optimal number of sources of demand that should be analyzed in subsequent periods.

Consider two firms: a monopolistic firm operating in large market ($L$) with $N_L$ sources of demand, and a monopolistic firm operating in small market ($S$) with $N_S$ sources of demand ($N_L >> N_S$). Suppose that both firms under consideration are managed according to the wishes of their owners who are typical asset holders, and the decisions in each firm are made by a group of decision-makers with sufficiently similar preferences to guarantee the existence of a group-preference function, representable by a von Neuman-Morgenstern utility function. Given these conditions assume risk aversion, so that utility functions of both firms ($U_x$, where $x \in \{L,S\}$) are concave functions of profits. The objective of the firms is to maximize the expected utility from profit (we assume that the firms set the volume of output supplied).

Assuming that each firm is able to predict demand and taking into account that the life of the firm is unlimited, the optimization task of the firm $x$ ($x \in \{L,S\}$) can be represented as the following infinite-horizon, discounted, dynamic programming problem:

$$\max_{Q_{x,t},n_{x,t}} \sum_{t=0}^{\infty} \beta^t \boldsymbol{E}\{U_x[\Pi_{x,z}(Q_{x,t},\sigma_{x,t},\eta_{x,t})]\} \quad (6)$$

where $\sigma_{x,t+1} = f(\sigma_{x,t},n_{x,t})$, with $\sigma_{x,0} = \sigma_0 = (N_x\varpi^2)^{1/2}$,
$\boldsymbol{E}$ is an expectation operator,
$U_x(\cdot)$ denotes the utility function of firm ($x \in \{L,S\}$),
$\Pi_{x,t}(\cdot)$ is the profit of the firm in the period $t$, $t = 0,1,...$, ($x \in \{L,S\}$),
$Q_{x,t}$ is a quantity supplied by the firm $x$ ($x \in \{L,S\}$) in the period $t$, $t = 0,1,...$,
$n_{x,t}$ denotes the number of individual sources of demand analyzed in firm $x$ ($x \in \{L,S\}$) in the period $t$, $t = 0,1,...$,
$\sigma_{x,t}$ is the standard deviation of the error in the prediction of the total deviation of the random variables $\eta_{i,t}$ ($i = 1,2,..., N_x$) in firm $x$ ($x \in \{L,S\}$) in the period $t$, $t = 0,1,...$,
$N_x$ is the total number of sources of demand, facing by firm $x$ ($x \in \{L,S\}$),
$\varpi^2$ is the variance of the stochastic process underlying each individual demand around its mean,
$\beta$ is the discount factor, $\beta \in (0,1)$.

Assuming that all the parameters of the model are stationary over time, the optimal solution to an infinite-horizon, discounted, dynamic programming problem is time-invariant (see, e.g., Sargent, 1987). Thus, in the problem considered, the optimal output and demand-predicting strategy is stationary, i.e., $Q^*_{x,0} = Q^*_{x,1} = Q^*_{x,2} = ... = Q^*_x$ and $n^*_{x,0} = n^*_{x,1} = n^*_{x,2} = ... = n^*_x$ ($x \in \{L,S\}$). This implies that the optimal value of the standard deviation ($\sigma^*_x$) of the error in the prediction of the total deviation of the random variables $\eta_{i,t}$ ($i = 1,2,..., N$) from their means is stationary and depends only on the number of individual demands analyzed in each period, $\sigma^*_x = \sigma_x(n^*_x)$. It follows that the unique one-period cost of data-processing can be related to each value of the standard deviation $\sigma_x(n^*_x)$, i.e., the costs of data processing in each period can be represented as a function of the standard deviation in the steady state.

Assume, for simplicity, that a standard deviation is the following function of the cost of data processing $\sigma_x = \sigma_{x,0}\, e^{-\lambda G_x}$, where $G_x$ is a total cost of data processing, and $\lambda$ ($\lambda > 0$) is a parameter describing the current state of information processing technology. Consequently, for any $\sigma_x < \sigma_{x,0}$, the cost of data processing is specified as $G_x(\sigma_x) = -(\ln\sigma_x - \ln\sigma_{x,0})/\lambda$.

The consideration above shows that the optimization problem of the firm $x$ ($x \in \{L,S\}$) can be solved in two steps. First, the optimal quantity $Q^*_x$ and the optimal value of standard deviation $\sigma^*_x$ can be determined, and, second, knowing $\sigma^*_x$, the optimal size of the cohorts of data summarized in each period can be found.

Thus, in the first stage the firm $x$ ($x \in \{L,S\}$) chooses the steady-state quantity of output $Q_x$ and the value of the standard deviation $\sigma_x$ which maximize the following objective function

$$\max_{Q_x,\sigma_x} E\{U_x[\Pi_x(Q_x,\sigma_x)]\} \quad (7)$$

To simplify the analysis, assume that the steady-state error in prediction of the total demand is a normally distributed random variable with zero mean and variance $\sigma^2_x$ (this corresponds to the case when random deviations follow stochastic processes with normally distributed random terms such as, for example, the autoregressive process of any order).[5] Since the distribution of the total random deviation from

5) It should be stressed that, although the assumption of the normal distribution of the random deviations from the expected demand corresponds to the wide class of stochastic processes that would govern stochastic demand, it is chosen solely for simplicity and clarity, and no attempt is made at generality. We

the mean value of demand is normal, the total deviation can take positive or negative values, each having probability 1/2 (the expected value of positive deviation equals $\sigma_x / N_x \sqrt{2\pi}$ and the expected value of negative deviation equals $-\sigma_x / N_x \sqrt{2\pi}$.[6)] Consequently, the total inverse random demand in any period $t$ ($-\infty < t < +\infty$) can be approximated as $\tilde{P}_N(Q_x, \sigma_x) = a - \frac{b}{N_x} Q_x + \vartheta_{N_x}(\sigma_x)$ where $\vartheta_{N_x}(\sigma_x)$ is a random factor (not known ex-ante) which with probability 1/2 equals $\gamma_{N_x}(\sigma_x)$ and with probability 1/2 equals $-\gamma_{N_x}(\sigma_x)$ where $\gamma_{N_x}(\sigma_x) = \sigma_x / N_x \sqrt{2\pi}$. Consequently, one can say that with probability 1/2 an inverse market demand is $\underline{P}_{N_x}(Q_x, \sigma_x) = a - \frac{b}{N_x} Q_x - \gamma_{N_x}(\sigma_x)$, and with probability 1/2 is $\overline{P}_{N_x}(Q_x, \sigma_x) = a - \frac{b}{N_x} Q_x + \gamma_{N_x}(\sigma_x)$. The expected market demand curve is determined as $P_{N_x}(Q_x) = a - \frac{b}{N_x} Q_x$.

Using this approximation, the optimization problem of firm $x$ ($x \in \{L, S\}$) can be represented as

$$\max_{Q_x, \sigma_x} \Psi_x(Q_x, \sigma_x) = \max_{Q_x, \sigma_x} \left\{ \frac{1}{2} U_x\left[\overline{\Pi}_x(Q_x, \sigma_x)\right] + \frac{1}{2} U_x\left[\underline{\Pi}_x(Q_x, \sigma_x)\right] \right\} \tag{8}$$

where $\overline{\Pi}_x(Q_x, \sigma_x) \equiv Q_x \overline{P_{N_x}}(Q_x, \sigma_x) - F_x(Q_x, \sigma_x)$, and $\underline{\Pi}_x(Q_x, \sigma_x) \equiv Q_x \underline{P}_{N_x}(Q_x, \sigma_x) - F_x(Q_x, \sigma_x)$, $F_x(Q_x, \sigma_x)$ denotes a cost function of the firm $x$.

## 4. Informational Asymmetry

Assume that the cost function of firm $x$ ($x \in \{L, S\}$) is $F_x(Q_x, \sigma_x) = cQ_x + G_x(\sigma_x)$, where $Q_x$ denotes the volume of output produced, $G_x(\sigma_x)$ denotes the cost of data processing, $c$ is the marginal cost (for the sake of simplicity we assume that fixed cost equals zero). Moreover, to simplify the analysis assume that the exact shape of the utility function $U_x$ is specified as follows:

$$U_x(\Pi_x) = \begin{cases} u_1 \Pi_x & \text{if } \Pi_x < \Pi_x^0 \\ u_2 \Pi_x + (u_1 - u_2)\Pi_x^0 & \text{if } \Pi_x \geq \Pi_x^0 \end{cases} \tag{9}$$

where $u_1 > u_2 > 0$ and $\underline{\Pi}_x < \Pi_x^0 < \overline{\Pi}_x$.[7)]

The interior solution to the optimization problem (8) exists if

---

believe, however, that many of the qualitative results would hold also in more general, and, consequently, more complicated models.

6) Expected values of positive and negative deviations are computed as $\frac{1}{N_x} \int_0^{\infty} \frac{\tilde{\eta}}{\sqrt{2\pi\sigma_x^2}} e^{\frac{-\tilde{\eta}^2}{2\sigma_x^2}} d\tilde{\eta}$ and $\frac{1}{N_x} \int_{-\infty}^{0} \frac{\tilde{\eta}}{\sqrt{2\pi\sigma_x^2}} e^{\frac{-\tilde{\eta}^2}{2\sigma_x^2}} d\tilde{\eta}$, respectively.

7) Note that a function defined is concave and twice differentiable if $\Pi_x \in (-\infty, \infty) \backslash \Pi_x^0$.

$$\lambda \geq \frac{2b/N_x}{[(a-c)/2]^2} \tag{10}$$

*Steady state utility maximization problem of monopolistic firm operating in the single commodity market with stochastic demand.* The objective function of the monopolistic firm $x\,(x \in \{L,S\})$ can be approximated as

$$\max_{Q_x,\sigma_x} \Psi_x(Q_x,\sigma_x) \equiv \frac{1}{2}u_1\left[Q_x\left(a - \frac{b}{N_x}Q_x - \frac{\sigma_x}{N_x\sqrt{2\pi}}\right) - cQ_x - \left(\frac{\ln\sigma_0}{\lambda} - \frac{\ln\sigma_x}{\lambda}\right)\right]$$
$$+\frac{1}{2}\left\{u_2\left[Q_x\left(a - \frac{b}{N_x}Q_x - \frac{\sigma_x}{N_x\sqrt{2\pi}}\right) - cQ_x - \left(\frac{\ln\sigma_0}{\lambda} - \frac{\ln\sigma_x}{\lambda}\right)\right] + (u_1 - u_2)\Pi_x^0\right\}$$

where $Q_x$ denotes the volume of output supplied, and $\sigma_x$ is the steady state standard deviation of demand. The first order conditions to the above optimization problem can be represented as

$$\frac{\partial\Psi_x(Q_x,\sigma_x)}{\partial Q_x} = \frac{1}{2}u_1\left(a - 2\frac{b}{N_x}Q_x - \frac{\sigma_x}{N_x\sqrt{2\pi}} - c\right) + \frac{1}{2}u_2\left(a - 2\frac{b}{N_x}Q_x + \frac{\sigma_x}{N_x\sqrt{2\pi}} - c\right) = 0$$
$$\frac{\partial\Psi_x(Q_x,\sigma_x)}{\partial \sigma_x} = \frac{1}{2}u_1\left(-\frac{Q_x}{N_x\sqrt{2\pi}} + \frac{1}{\lambda\sigma_x}\right) + \frac{1}{2}u_2\left(\frac{Q_x}{N_x\sqrt{2\pi}} + \frac{1}{\lambda\sigma_x}\right) = 0$$

The second order conditions to this maximization problem require the Hessian of the objective function

$$\begin{pmatrix} \dfrac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial Q_x^2} & \dfrac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial Q_x\partial\sigma_x} \\ \dfrac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial Q_x\partial\sigma_x} & \dfrac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial \sigma_x^2} \end{pmatrix}$$

to be negative definite (it guarantees that the objective function is strictly concave). This Hessian is negative-definite (the objective function is strictly concave) if

$$\frac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial Q_x^2} < 0 \text{ and } \frac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial Q_x^2}\frac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial \sigma_x^2} - \left(\frac{\partial^2\Psi_x(Q_x,\sigma_x)}{\partial Q_x\partial\sigma_x}\right)^2 > 0$$

Taking derivatives and rearranging, we conclude that the second order conditions are satisfied if

$$\lambda < \frac{4\pi b N_x}{(k\sigma_x)^2}$$

where $k = (u_1 - u_2)/(u_1 + u_2)$, $k \in (0,1)$ for the risk averse firm.

Rearranging the first order conditions, we obtain two possible values of output which maximize the objective function considered

$$Q_{x,1} = \frac{N_x}{2b}\left(\frac{a-c}{2} + \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{2b}{N_x\lambda}}\right)$$

$$Q_{x,2} = \frac{N_x}{2b}\left(\frac{a-c}{2} - \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{2b}{N_x\lambda}}\right)$$

assuming that $\left(\frac{a-c}{2}\right)^2 - \frac{2b}{N_x\lambda} \geq 0$, i.e., $\lambda \geq \frac{2b/N_x}{[(a-c)/2]^2}$. If $\lambda$ goes to infinity (the current technology is very advanced), the firm knows demand almost perfectly, and the optimal volume of output goes to optimal volume of output without uncertainty $(a - c)/(2b/N_x)$. Consequently, the optimal quantity of output supplied $Q^*_x$ is determined by the first expression i.e., $Q^*_x = Q_{x,1}$.

Steady state standard deviation which maximizes the objective function considered is given as

$$\sigma^*_x = \frac{2b\sqrt{2\pi}}{k\lambda}\left(\frac{a-c}{2} + \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{2b}{N_x\lambda}}\right)^{-1}$$

Taking into account the results above and rearranging expression for $\lambda$ we get that if $\lambda \geq \frac{2b/N_x}{[(a-c)/2]^2}$, $Q^*_x$ and $\sigma^*_x$ correspond to the maximum of the objective function.

Assuming that the primitives of the model: $a, b, N_x, c, \lambda$ satisfy the condition above, the optimal steady state values of the volume of output supplied $Q^*_x$ and the standard deviation of the demand $\sigma^*_x$, are determined as

$$Q^*_x = \frac{N_x}{2b}\left(\frac{a-c}{2} + \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{2b}{N_x\lambda}}\right) \quad (11)$$

$$\sigma^*_x = \frac{2b\sqrt{2\pi}}{k\lambda}\left(\frac{a-c}{2} + \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{2b}{N_x\lambda}}\right)^{-1} \quad (12)$$

where $k = (u_1 - u_2)/(u_1 + u_2)$, $k \in (0,1)$ for the risk averse firm.[8)]

Since $\sigma^*_x$ is inversely related to $N_x$, just after integration of two separated markets the firms under consideration (even if they have the same cost structures) will have different knowledge about demand in the integrated market (the firm operating in the large market will have much better position after integration than its competitor).

## 5. Industry Structure in Integrated Market

Assume that in the period following integration both firms produce the same product, have the same production and information processing cost structure, and face the same demand conditions. In particular, assume that the total inverse market demand is given by expression (2) where $N$ ($N = N_L + N_S$) denotes the size of the integrated market (as before, it is assumed that both firms know the form of the demand function and the characteristics of the stochastic processes underlying demand in its sources). Moreover, the attitude of both firms toward risk is characterized by the same utility function specified by (9). Therefore, the firms are identical, however, they have different knowledge about an integrated market accumulated in the past.

After the integration of two separated markets into a single market with $N = N_L + N_S$ sources of demand both firms have to find their new steady state strategies, taking into account an optimal strategy of the competitor (i.e., to consider the standard problem of Cournot doupoly). Following the preceding section, the optimization problem of the firm $x$ ($x \in \{L,S\}$) operating in integrated market can be represented as

8) Coefficient $k$ characterises the attitude towards risk and increases with risk aversion.

$$\max_{Q_x,\sigma_x}\Psi_x\left(Q_x,Q_x^*,\sigma_x\right)\equiv\max_{Q_x,\sigma_x}\left\{\frac{1}{2}U_x\left[\overline{\Pi}_x\left(Q_x,Q_x^*,\sigma_x\right)\right]+\frac{1}{2}U_x\left[\underline{\Pi}_x\left(Q_x,Q_y^*,\sigma_x\right)\right]\right\} \tag{13}$$

where $y \in \{L,S\}$ and $y \neq x$, $\overline{\Pi}_x\left(Q_x,Q_y,\sigma_x\right)\equiv Q_x\overline{P}_N\left(Q_x+Q_y,\sigma_x\right)-F_x\left(Q_y,\sigma_x\right)$, and $\underline{\Pi}_x\left(Q_x,Q_y,\sigma_x\right)\equiv Q_x\underline{P}_N\left(Q_x+Q_y,\sigma_x\right)-F_x\left(Q_x,\sigma_x\right)$ where $F_x(Q_x, \sigma_x)$ denotes a cost function of the firm $x$, $Q_y^*$ is an optimal response of the competitor, and $N = N_L + N_S$.

Since in the steady state the firms are identical in all respects (after certain number of periods following integration informational asymmetry between firms disappears), the optimal steady state strategies of both firms operating in integrated market are given as

$$Q_x^*=\frac{N}{4b}\left(\frac{a-c}{2}+\sqrt{\left(\frac{a-c}{2}\right)^2-\frac{4b}{N\lambda}}\right), \tag{14}$$

$$\sigma_x^*=\frac{4b\sqrt{2\pi}}{k\lambda}\left(\frac{a-c}{2}+\sqrt{\left(\frac{a-c}{2}\right)^2-\frac{4b}{N\lambda}}\right)^{-1} \tag{15}$$

*Steady state utility maximization problem of firms operating in integrated market with stochastic demand.* Since both firms operating in the market are identical and in the long run there is no any difference determined by past behavior (each firm supplies $Q_x$), the objective function of firm $x(x\in \{L, S\})$ can be approximated as

$$\max_{Q_x,\sigma_x}\Psi_x\left(Q_x,\sigma_x\right)\equiv\frac{1}{2}u_1\left[Q_x\left(a-\frac{2b}{N}Q_x-\frac{\sigma_x}{N\sqrt{2\pi}}\right)-cQ_x-\left(\frac{\ln\sigma_0}{\lambda}-\frac{\ln\sigma_x}{\lambda}\right)\right]+$$

$$+\frac{1}{2}\left\{u_2\left[Q_x\left(a-\frac{2b}{N}Q_x+\frac{\sigma_x}{N\sqrt{2\pi}}\right)-cQ_x-\left(\frac{\ln\sigma_0}{\lambda}-\frac{\ln\sigma_x}{\lambda}\right)\right]+\left(u_1-u_2\right)\Pi_x^0\right\}$$

where $Q_x$ denotes the volume of output supplied, and $\sigma_x$ is the steady state standard deviation of demand. The first order conditions to the above optimization problem can be represented as

$$\frac{\partial\Psi_x\left(Q_x,\sigma_x\right)}{\partial Q_x}=\frac{1}{2}u_1\left(a-2\frac{2b}{N}Q_x-\frac{\sigma_x}{N\sqrt{2\pi}}-c\right)+\frac{1}{2}u_2\left(a-2\frac{2b}{N}Q_x-\frac{\sigma_x}{N\sqrt{2\pi}}-c\right)=0,$$

$$\frac{\partial\Psi_x\left(Q_x,\sigma_x\right)}{\partial \sigma_x}=\frac{1}{2}u_1\left(-\frac{Q_x}{N\sqrt{2\pi}}+\frac{1}{\lambda\sigma_x}\right)+\frac{1}{2}u_2\left(\frac{Q_x}{N\sqrt{2\pi}}+\frac{1}{\lambda\sigma_x}\right)=0$$

The second order conditions to this maximization problem require the Hessian of the objective function to be negative definite (it guarantees that the objective function is strictly concave). The Hessian is negative-definite (the objective function is strictly concave) if

$$\frac{\partial^2\Psi_x\left(Q_x,\sigma_x\right)}{\partial Q_x^2}<0 \text{ and } \frac{\partial^2\Psi_x\left(Q_x,\sigma_x\right)}{\partial Q_x^2}\frac{\partial^2\Psi_x\left(Q_x,\sigma_x\right)}{\partial \sigma_x^2}-\left(\frac{\partial^2\Psi_x\left(Q_x,\sigma_x\right)}{\partial Q_x\partial\sigma_x}\right)^2>0$$

Taking derivatives and rearranging, we conclude that the second order conditions are satisfied if $\lambda<\frac{8\pi bN}{\left(k\sigma_x\right)^2}$ where $k = (u_1 - u_2)/(u_1 + u_2)$, $k\in (0,1)$ for the risk averse firm.

Rearranging the first order conditions, we obtain two possible values of output which maximize the objective function considered

$$Q_{x,1} = \frac{N}{4b}\left(\frac{a-c}{2} + \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{4b}{N\lambda}}\right)$$

$$Q_{x,2} = \frac{N}{4b}\left(\frac{a-c}{2} - \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{4b}{N\lambda}}\right)$$

assuming that that $\left(\frac{a-c}{2}\right)^2 - \frac{4b}{N\lambda} \geq 0$, i.e., $\lambda \geq \frac{4b/N}{(a-c/2)^2}$. If $\lambda$ goes to infinity, the firm knows demand almost perfectly, and the optimal volume of output goes to optimal volume of output without uncertainty $(a - c)/4b/N$. Consequently, the optimal quantity of output supplied $Q_x^*$ is determined by the first expression i.e., $Q_x^* = Q_{x,1}$.

Steady state standard deviation which maximizes the objective function is given as

$$\sigma_x^* = \frac{4b\sqrt{2\pi}}{k\lambda}\left(\frac{a-c}{2} + \sqrt{\left(\frac{a-c}{2}\right)^2 - \frac{4b}{N\lambda}}\right)^{-1}$$

Taking into account the results above and rearranging expression for $\lambda$ we get that if $\lambda \geq \frac{4b/N}{[(a-c)/2]^2}$, $Q_x^*$ and $\sigma_x^*$ correspond to the maximum of the objective function.

However, in the first several periods after integration informational differences (resulted from the past market research) will affect the market behavior of the firms. To show it, assume that in the period following integration both firms found their optimal steady state strategies characterized by the optimal steady state output and optimal steady state standard deviation. To achieve the long run knowledge of the market corresponding to the optimal steady state standard deviation, starting from the first period after integration each firm has to devote the same resources to market research. Thus, after integration both firms will face the same cost of market research, but in the transition period, due to the knowledge of the market accumulated in the past, the firm operating prior to integration on the large market ($L$) will be able to predict market demand better than the firm ($S$) operating before integration on the smaller market. In particular, in the period following integration market information of both firms will be summarized by standard deviations $\sigma_L^\circ$ and $\sigma_S^\circ$ such that $\sigma_L^\circ < \sigma_S^\circ$ (fully determined by the results of market research accumulated in the past). Consequently, in the first period after integration firm $x$ ($x \in \{L, S\}$) will face the following optimization problem

$$\max_{Q_x} \Psi_x\left(Q_x, Q_y^*\right) \equiv \frac{1}{2} u_1 \left\{ Q_x \left[ a - \frac{b}{N}\left(Q_x + Q_y^*\right) - \frac{\sigma_x^\circ}{N\sqrt{2\pi}} \right] - cQ_x - G_x^* \right\} + \\ + \frac{1}{2} \left\{ u_2 \left[ Q_x \left( a - \frac{b}{N}\left(Q_x + Q_y^*\right) - \frac{\sigma_x^\circ}{N\sqrt{2\pi}} \right) - cQ_x - G_x^* \right] + \left(u_1 - u_2\right)\Pi_x^0 \right\} \tag{16}$$

where $x, y \in \{L, S\}$ and $y \neq x$, $Q_y^*$ is an optimal response of the competitor, $\sigma_x^*$ is a parameter determined by past behavior, $c$ is a marginal cost, $G_x^*$ is the optimal steady state cost of market research, and $N = N_L + N_S$. The solution to the optimization problem above can be represented as

$$Q_x^* = \frac{a - c - \left(2\sigma_x^\circ - \sigma_y^\circ\right)k / N\sqrt{2\pi}}{3b/N} \tag{17}$$

*The utility maximization problem of firms operating in the integrated market with stochastic demand in the period following integration.* The objective function of the monopolistic firm $x(x \in \{L,S\})$ can be represented by expression (16). The first order conditions are given as

$$\frac{\partial \Psi_x\left(Q_x, Q_y^*\right)}{\partial Q_x} = \frac{u_1}{2}\left(a - \frac{2b}{N}Q_x - \frac{b}{N}Q_y^* - \frac{\overset{\circ}{\sigma}_x}{N\sqrt{2\pi}} - c\right) + \frac{u_2}{2}\left(a - \frac{2b}{N}Q_x - \frac{b}{N}Q_y^* - \frac{\overset{\circ}{\sigma}_x}{N\sqrt{2\pi}} - c\right) = 0$$

Solving the system of equations specified by the expression above when $x = L$ ($y = S$) and $x = S$ ($y = L$), we get [9)]

$$Q_x^* = \frac{a - c - \left(2\overset{\circ}{\sigma}_x - \overset{\circ}{\sigma}_y\right)k / N\sqrt{2\pi}}{3b/N}$$

where $k = (u_1 - u_2)/(u_1 + u_2)$, ($k \in (0,1)$ for the risk averse firm).

Since $\sigma_L < \sigma_S$, the optimal output of the firm operating before integration on the large market $Q_L^*$ is greater than the optimal output of the firm operating before integration in the smaller market $Q_S^*$. In the extreme case, when firms are very risk averse ($k$ is high) or/and the difference in the quality of the demand predictions is significant (i.e., the difference between $\overset{\circ}{\sigma}_S$ and $\overset{\circ}{\sigma}_L$ is high enough), the firm operating before integration in the smaller market would find it optimal to produce nothing. However, to be able to survive in the market in the future this firm will have to conduct costly market research. Therefore, in the first period after integration firm $S$ may have to make loses in order to survive in the market in the long run. Similar situation may happen in several subsequent periods (until the prediction of the demand is done based only on the market data collected after integration, and both firms predict demand with the same quality).

Loses associated with low level of output and costly market research in the first several periods after integration may cause the firm, which has not been aware of an unavoidable information asymmetry, to quite the market. Note, however, that it could not be the case, if the firm operating in the small market and anticipating informational problems after integration, devotes some additional resources to market research in pre-integration periods (sacrifices some profit before integration) in order to prepare itself for the long term operations in the large market.

## 6. Conclusion

The purpose of this contribution was to examine the possible impact of market research and demand forecasting prior to integration on the industry structure in unified market. The analysis was focused on a single commodity monopolistic markets with uncertain demand in small and large countries. The results derived indicate that risk-averse firms always devote resources to demand forecasting, and, in particular, that the optimal demand forecasting strategies of the firms (operating in infinite time and maximizing the expected utility from profit) are stationary, i.e., the same resources should be devoted to market analysis in each period. Moreover, the analysis shows that the optimal amount of resources devoted to market research is proportional to the market size (i.e., firms operating in a larger market devote more resources to market analysis than firms operating in smaller one). It implies that firms operating before integration in different markets have different information

---

9) Note, that for $x,y \in \{L, S\}$ and $y \neq x$ $\partial \Psi_x\left(Q_x, Q_y^*\right)/\partial Q_y^* < 0$, $\partial^2 \Psi_x\left(Q_x, Q_y^*\right)/\partial Q_x \partial Q_y^* < 0$, consequently, volumes of output of both firms are strategic substitutes.

about integrated market demand just after integration (firms operating in larger market have much better information about the integrated market than firms operating in smaller one). Since the investment in market research made in the past (embodied in data about demand fluctuations in the past) lowers the cost of current forecasts, firms coming from larger markets have a cost advantage (even if there is no difference in production and data-processing technology). Moreover, informational asymmetry (just after integration) affects the structure of the integrated market. In particular, if fluctuations of demand are large enough (as in toys industry or fashionable cloths market) (see Johnson, 2001), highly risk-averse firms joining European common market can find that the best they could do would be to quit the market. At the same time an analogous firms already operating on the common market (which are able to predict integrated market demand with smaller variance of the prediction error) can still make profit. Informational asymmetry can be depleted (or fully eliminated) if a small country's firms analyze European market before integration. Such necessity, however, needs to be recognized and supported by policy makers of both European Union and acceding countries.

## References

**Cukrowski, J.** (1996), "Demand Uncertainty, Forecasting and Monopolistic Equilibrium." Prague, CERGE-EI Working Paper No. 97.
**Ghosal, V.** (1996), "Does Uncertainty Influence the Number of Firms in an Industry?" *Economics Letters*, 50, pp. 229-236.
**Johnson, E. M.** (2001), "Lessons in Managing Supply Chain Risk from the Toy Industry". *California Management Review*, 43(3), pp. 106-125.
**Leland, H. E.** (1972), "Theory of the Firm Facing Uncertain Demand." *American Economic Review*, 62, pp. 278-291.
**Lim, C.** (1980), "Ranking Behavioral Modes of the Firm Facing Uncertain Demand." *American Economic Review*, 70, pp. 217-224.
**Nelson, R. R.** (1961), "Uncertainty, Prediction, and Competitive Equilibrium." *Quarterly Journal of Economics*, 75, pp. 41-62.
**Radner, R., Van Zandt, T.** (1992), "Information Processing in Firms and Return to Scale." *Annales d'Economie et de Statistique*, 25/26, pp. 265-298.
**Sandmo, A.** (1971), "On the Theory of the Competitive Firm under Price Uncertainty." *American Economic Review*, 61, pp. 65-73.
**Sargent, T. J.** (1987), *Dynamic Macroeconomic Theory*. Cambridge, MA: Harvard University Press.
**Zabel, E.** (1970), "Monopoly and Uncertainty." *Review of Economic Studies*, 37, pp. 205-220.