People smuggling syndicates: An oligopoly analysis in context of the Söderköping process

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În exemplul a) coeficienții de trafic pentru fiecare flux sunt mai mici ca 1 și \( p \) pentru tot sistemul care este mai mic ca 1 indică că nu se formează șiruri de așteptare de lungimi mari. Exemplul b) prezintă interes deoarece, deși coeficiențul de trafic pentru fiecare flux este mai mic ca 1, toți \( p \) sunt mai mari decât 1, ceea ce indică că în sistem se formează șiruri de așteptare nelinearitate. Exemplul c) indică o supraîncărcare a sistemului.

Prezintă interes sistemele cu mai multe fluxuri de intrare și o singură stație în care stația de servire necesită un „timp de orientare” pentru a putea trece de la servirea unei cereri de un anumit tip la servirea uneia din fluxul \( L_j \) care sunt de mai mare prioritate.

<table>
<thead>
<tr>
<th>( L_1 )</th>
<th>( L_2 )</th>
<th>( L_3 )</th>
<th>( \rho )</th>
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</thead>
<tbody>
<tr>
<td>a) ( \lambda_1=1,20 )</td>
<td>( \mu_1=3,90 )</td>
<td>( \rho_1=0,31 )</td>
<td>( \lambda_2=2,70 )</td>
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<tr>
<td>b) ( \lambda_1=2,20 )</td>
<td>( \mu_1=2,30 )</td>
<td>( \rho_1=0,52 )</td>
<td>( \lambda_2=0,30 )</td>
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<td>c) ( \lambda_1=10,00 )</td>
<td>( \mu_1=3,90 )</td>
<td>( \rho_1=7,69 )</td>
<td>( \lambda_2=3,00 )</td>
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Pentru acest tip de sisteme indicatorul de încărcare a sistemului se determină cu ajutorul metodelor numerice, deoarece în formulă de calcul a acestei expresii se conține o mărime care nu poate fi determinată analitic. Au fost elaborați algoritmi numerici care permit calculul măririlor necesare (vezi [6, 7]).

Bibliografia

In the period 1999-2001, more than 300 organised groups of migrants trying to get to Poland or the Baltic states were apprehended in Belarus. Over 200 channels for people smuggling were neutralized [8:19].

In 2004, 24 organised crime groups, specialising in people smuggling, were discovered by Belarusian authorities [8:25].

For Ukraine, the number of illegal immigrants has been growing in recent years. The total number of illegal migrants detained by the Ministry of Internal Affairs and the State Border Service units was 25,539 in 2004 and 32,726 in 2005 [12:10]. IOM estimates that only 5 to 10% of all migrants illegally transiting through Ukrainian territory are detained by the Ukrainian government [ibid]. Whereas in 2003 most of the illegal migrants were Africans and Southeast Asians, today 70% come from other CIS countries [12:10-11].

In comparison with other countries in the region, the number of apprehensions taking place at the green border is very high for Ukraine. In 2004-2005, most illegal migrants avoided official checkpoints. In addition, 99% of apprehended migrants are smuggled by transnational organised crime groups [7:2]. There is a strong presence of networks backed up by funding and equipment from trans-border crime groups [9:8].

In the period 2004-2006, 334 criminal organisations acting as channels of illegal migration were detected by Ukrainian authorities. The number of criminal organisations that were eliminated during the same time period was 240 [4:239].

People smuggling syndicates: Analytical model

There is evidence that syndicates are today the most common form through which the smuggling of migrants take place [6:6-7]. Consequently, many authors have outlined how they work. Syndicates are, for example, very skilled at adapting their modus operandi [4, 10]. One explanation for the efficiency of people smuggling syndicates is their organisational structure. People smuggling syndicates are simply horizontal networks operating on an international basis [1, 6, 13]. Typically, these networks are star-shaped, i.e. there is a masterminding organiser in the centre who delegates functions to many different “arms”. These arms, however, are independent and do not know about each other [6:7]. For a comprehensive overview of the division of labour in a people smuggling network, see [11].

Overall, there is reason to believe that these syndicates to a great extent resemble oligopolies [11]. For example, they tend to use product differentiation and charge different prices. However, when analyzing them, due to a lack of empirical data, it is difficult to say with certainty whether one duopoly model or another should be preferred. In the following model, I therefore consider both the Cournot and the Stackelberg case.

1 Deterministic approach

For the first people smuggling syndicate we have the following profit function:

$$\Pi_1 = (a - b(q_1 + q_2))q_1 + \xi - a_0q_1 - a_0$$

where $q_i > 0$, $i = 1, 2, 3$. $\xi$ is a random income variable that has been included in the function in order to reflect the fact that syndicates often, on a parallel basis, smuggle other commodities as well, such as narcotics [11:15]. We assume that the risk, i.e. the cost for the syndicate, increases jointly with $q_1$. In other words: The more migrants there are to be smuggled, the higher would be the risk (cost). Consequently, the cost function is quadratic and looks as shown in fig.1:

$$\text{Fig. 1}$$

The profit for syndicate 1 is to be maximized by choice of $q_1$.

The first order condition for a maximum is

$$\frac{\partial \Pi_1}{\partial q_1} = [a - b(q_1 + q_2)] - bq_1 - bq_2q_1 - 2a_0q_1 - a_0 = 0 \quad (1)$$

The Cournot analysis of duopoly is based on the assumption that the conjectural variation $\frac{\partial q_2}{\partial q_1}$ is zero. The Cournot equilibrium is then defined to be that pair of

$(q_1, q_2)$ which is obtained under assumption of zero conjectural variation.

From the first condition we have

$$[a - b(q_1 + q_2)] - bq_1 - 2a_0q_1 - a_0 = 0.$$ 

Solving this equation we obtain

$$q_1 = \frac{a - a_0}{3b + 2a}.$$ 

By symmetry

$$q_2 = \frac{a - a_0}{3b + 2a}.$$ 

The equilibrium market price is

$$p = \frac{ab + 2a_0q_1 + 2bq_1}{3b + 2a},$$ 

and industry output is

$$q = \frac{2(a - a_0)}{3b + 2a}.$$ 

The dynamics of the Cournot approach can be analysed by using reaction curves, showing the optimal output for each syndicate, given the output of the competitor. From the above equation for the Cournot equilibrium, assuming a one period lag, the reaction curves are
\[q_1(t + 1) = \frac{(a - a_1 - bq_2(t))}{2b + 2a_2}, \quad (2)\]
\[q_2(t + 1) = \frac{(a - a_1 - bq_1(t))}{2b + 2a_2}. \quad (3)\]

The reaction curves are shown in Fig. 2.

Let us now consider the Stackelberg analysis of duopoly. Suppose that syndicate 1 believes that syndicate 2 would react along the Cournot reaction curve:
\[q_2 = \frac{(a - a_1 - bq_1)}{2b + 2a_2}. \quad (4)\]

The conjectural variation is then
\[\frac{\partial q_2}{\partial q_1} = \frac{-b}{2b + 2a_2} \quad (5)\]
so using (1)
\[\frac{\partial \Pi_1}{\partial q_1} = \left[ a - b(q_1 + q_2) \right] - bq_1 + \frac{b^2}{2b + 2a_2} - a_2 q_1 - a_1 = 0, \quad (6)\]
and the reaction curve for syndicate 1 is
\[q_1 = \frac{a - a_1 - bq_2}{2b + 2a_2}. \quad (7)\]

The outcome for both syndicates depends on the behavior of syndicate 2. If syndicate 2 is using the Cournot reaction curve, as syndicate 1 believes, then the solution is the Stackelberg equilibrium for syndicate 1:
\[q_2 = \frac{(2b + 2a_2)^2 - b^2}{2b + 2a_2} \left( a - a_1 \right) \quad (8)\]
\[q_1 = \frac{(2b + 2a_2)^2 - b^2}{(2b + 2a_2)^2 - 2b^2} \left( a - a_1 \right) \quad (9)\]

If we suppose that syndicate 2 is not using the Cournot reaction curve but is also using the Stackelberg reaction curve, so that each syndicate incorrectly believes that the other is using the naïve Cournot assumption, then the result is the Stackelberg disequilibrium
\[q_1 = q_2 = \frac{(a - a_1)(2b + 2a_2)}{(2b + 2a_2)^2 - b^2 + b(2b + 2a_2)} \quad (10)\]

In this section we assume that the numbers of migrants, i.e. the clients of the syndicates, are random variables with some probability distributions that have a known type. Let \(q_i, \ i = 1, 2, \) be a random number of migrants that will choose for their border crossing syndicate \(i \). We suppose that \(q_i, \ i = 1, 2, \) has the probability distribution \(p(x, \theta)\), where \(\theta = (\theta_1, \theta_2, ..., \theta_n)\) is a vector of unknown parameters. Let
\[E[q_i] = m_i(\theta), \quad (4)\]
\[Var[q_i] = D(\theta), \quad (5)\]
denote the expectation and the variance of the random variable \(q_i, \ i = 1, 2, \). The syndicate \(i \) tends to maximise the expected profit
\[E[I_i] = E\left[ (a - b(q_1 + q_2))q_i - a_1 q_i^2 - a_2 q_i - a_3 q_2 \right] \quad (6)\]
We can believe that the competition between the syndicates establishes such values of the distribution parameters that the expected profits of both syndicates will be maximised. We would like to stress that the equilibrium in this case is the distribution. The previous deterministic approach is a special case of the stochastic one, when the distribution is concentrated in one point. Using (4-6) we can obtain the expected profit for the first syndicate
\[E[I_i] = a_1 m_i(\theta) - bE[D(\theta) + m_i^2(\theta)] - b m_i(\theta)m_i(\theta) - a_2, \quad (7)\]
The first order condition for the first syndicate has the form
\[a_1 \frac{\partial m_i}{\partial \theta_i} - b \frac{\partial D}{\partial \theta_i} - a_2 \frac{\partial D}{\partial \theta_i} - a_3 \frac{\partial m_i}{\partial \theta_i} = 0, \ i = 1, 2, ..., m. \quad (8)\]
Solving (7) for \(\theta_i\) we obtain the optimal solution.
Example 1. Let \( q_i, \ i = 1, 2 \) have Poisson distributions with the parameters \( \lambda_i \):

\[
P(q_i = k) = \frac{\lambda_i^k}{k!} \exp(-\lambda_i), \quad k = 0, 1, 2, \ldots
\]

Then

\[
E[\Pi_i] = a\lambda_i - b(\lambda_i + \lambda_i^2) - b\lambda_i \lambda_2 - a_2 (\lambda_i + \lambda_i^2) - a_1 \lambda_i - a_2.
\]

In this case the conditions (7) take the form:

\[
\frac{\partial E[\Pi_i]}{\partial \lambda_i} = a - 2b\lambda_i - b\lambda_i \frac{\partial \lambda_i}{\partial \lambda_i} - b\lambda_2 - 2a_1 \lambda_i - a_2 - a_1 = 0.
\]

Under the assumption \( \frac{\partial \lambda_i}{\partial \lambda_i} = 0 \), by symmetry, the analogue of the Cournot equilibrium is

\[
\lambda_1 = \lambda_2 = \frac{a - b - a_2 - a_1}{3b + 2a_2}.
\]

In comparison with the deterministic case, we can see the additional term in the numerator, \(-b - a_2\), and the profit of the syndicates is lower.

"Average" reaction curves can be found from (8)

\[
\lambda_1(t+1) = \frac{a - b - a_2 - a_1 - b\lambda_2(t)}{2b + 2a_2},
\]

\[
\lambda_2(t+1) = \frac{a - b - a_2 - a_1 - b\lambda_1(t)}{2b + 2a_2}.
\]

They are shown in Fig. 3

![Fig. 3](image)

Example 2. Let \( q_i, \ i = 1, 2 \) have binomial distributions with parameters \( n_i \) and \( p \):

\[
P(q_i = k) = \binom{n_i}{k} p^k (1 - p)^{n_i - k}, \quad k = 0, 1, 2, \ldots, n_i.
\]

This assumption could be explained in the following way. There are \( n_1 + n_2 \) migrants in the border area. Every migrant from the first \( n_1 \) uses syndicate 1 with the probability \( p \) independently of others, and every migrant from the second \( n_2 \) uses syndicate 2 with the probability \( p \), also independently of others. Then \( q_i \) is the number of migrants using syndicate \( i \), and obviously these numbers have binomial distributions. In this case the expected profit for the first syndicate is

\[
E[\Pi_1] = an_1 p - b(n_1 p (1 - p) + (n_1 p)^2) - bn_2 p - a_2 (n_1 p (1 - p) + (n_1 p)^2) - a_1 n_1 p - a_2.
\]

The first order condition is

\[
\frac{\partial E[\Pi_1]}{\partial n_1} = ap - bp(1 - p) - 3bp^2 - bp^2 n_1 - bn_2 p^2 - a_2 p - a_1 = 0.
\]

Then if \( \frac{\partial n_1}{\partial n_1} = 0 \) we have, by symmetry

\[
n_1 = n_2 = \frac{ap - bp(1 - p) - a_2 p (1 - p) - a_2 p - a_1}{3bp^2 + 2a_2 p^2} = \frac{3bp + 2a_2 p}{3bp^2 + 2a_2 p^2}.
\]

"Average" reaction curves can be found from (9)

\[
n_1(t+1) = \frac{ap - bp(1 - p) - a_2 p (1 - p) - a_2 p - b_2 n_1(t)}{2bp^2 + 2a_2 p^2},
\]

\[
n_2(t+1) = \frac{ap - bp(1 - p) - a_2 p (1 - p) - a_2 p - b_2 n_1(t)}{2bp^2 + 2a_2 p^2}.
\]

We find that under the condition \( p = 1 \) we have a deterministic case.

References