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On the Pro-competitive Effects of Regional Trading Agreements

José L. Moraga-González
VU University Amsterdam and
University of Groningen
email: j.l.moragagonzalez@vu.nl

Jean-Marie Viaene
Erasmus University Rotterdam
email: viaene@few.eur.nl

Abstract. We explore the pro-competitive effects of trade policies in a model where a competitive fringe of domestic firms compete with a foreign duopoly exporting vertically differentiated goods. We show that discriminatory nonuniform tariff policies are preferred over the Most Favored Nation (MFN) clause because, besides extracting rents from foreign firms, they foster competition in the market. Regional Trading Agreements (RTAs), which favor members relative to non-members, are examples of such nonuniform tariff policies.

1 Introduction

The collapse of global trade talks in Cancun in September 2003 challenged the role of the World Trade Organization (WTO) and the multilateral trading system that it supports. The greater difficulty in reaching multilateral agreements provides countries with incentives to search for more effective ways to liberalize their trade, mainly via regional trading agreements (RTAs). In the last fifteen years, more RTAs have come into force than ever before. As a result of this trend, Mongolia was in July 2005 the only WTO member not being part of a RTA (see WTO website). Recent notifications of RTAs include the agreements between the USA and Morocco, Singapore and the Republic of Korea, Turkey and Tunisia, Moldova and Bulgaria, The EU and Egypt, etc.

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Differences in quality play an important role in international trade. For example, Hallak (2006) shows in a sample of 60 countries that there are large differences in the quality of products that are exported. This is also the key point in Greenaway et al. (1995) who show that intra-industry trade characterized by different levels of quality is a significant proportion of trade. As many of the new RTA proposals involve countries with different concerns for quality standards, the aim of this paper is to examine how quality considerations affect the desirability of RTA initiatives.

In our model, a competitive fringe of domestic firms compete with a foreign duopoly exporting vertically differentiated goods. A realistic feature of this type of models is that oligopolistic firms select product-design strategies to differentiate their goods from rivals prior to the market competition stage (see e.g. Motta *et al.* 1997; Herguera *et al.* 2002; Zhou *et al.* 2002; Moraga-González and Viaene 2005). We show that an importing country improves its welfare by levying a tariff on the country producing high quality or by subsidizing low-quality imports. These non-uniform trade policies are pro-competitive inasmuch as they lead to a decline in (hedonic) prices. It is important to note that in the literature on trade reforms, gains from trade rely traditionally on the pro-competitive effects caused by freer trade (Vousden 1990; Hertel 1994). In contrast, it is the imposition of particular trade policies that enhances social welfare and leads to more competitive market equilibria in our framework. To the best of our knowledge, this finding is novel.

RTAs, formally approved by the WTO, are examples of nonuniform trade policies due to the discriminatory treatment favoring members relative to non-members. We show that RTAs can lead to more competitive equilibria in the sector under study and thus contribute to a higher welfare level than under free trade. Product quality considerations provide a rationale for discrimination among sources of supply and it is just the discriminatory treatment of a RTA that makes it attractive from a welfare viewpoint.

The idea that international trade increases competition is old (see e.g. Helpman and Krugman 1989). However, much work has focused on the gains arising from firm selection and greater product variety (see e.g. Melitz 2003; and Arkolakis, Costinot, and Rodríguez-Clare 2012), while keeping markups constant. Gains from greater product variety are also present in our paper. We show that these gains can be made even larger using a discriminatory trade liberalization policy, which results in lower markups and higher quality products. Though our model is highly stylized, our focus on market power and vertical differentiation sets our paper apart from those studying the effects of trade liberalization on markups in monopolistically competitive environments

(see e.g. Melitz and Ottaviano 2008; and Arkolakis, Costinot, Donaldson and Rodríguez-Clare 2012).

The remainder of the paper is organized as follows. The next section describes the model and Section 3 derives the market equilibrium. Section 4 presents the analysis of trade policies and Section 5 considers the welfare implications of RTAs. Finally, Section 6 concludes. The Appendix contains the proofs to ease the reading.

2 The Model

Consider an international market consisting of a domestic economy and two foreign countries, the latter indexed $i = 1, 2$. Assume there is a population of measure 1 at home. A domestic consumer is characterized by a taste parameter θ , which is uniformly distributed over $[0, \bar{\theta}]$, $\bar{\theta} > 0$. The preferences of consumer θ are given by the quasi-linear utility function: $U = V + \theta q - p$, if he buys a unit of a good of quality q at price p . Consumers buy at most one unit.

Assume the domestic economy hosts a competitive sector, which produces a *numeraire* good at marginal cost. The quality of the numeraire is normalized to zero. Domestic firms face competition from exports by foreign firms. Assume each foreign country hosts a single firm, indexed $i = 1, 2$. Foreign firms choose the quality of their products. The fixed cost of quality development is $C_i(q) = c_i q^2/2$, $i = 1, 2$. Let $c_1 > c_2$, i.e., firm 2 has a more efficient R&D technology than firm 1. Once foreign firms determine the quality of their goods, production takes place at a common marginal cost. Let us normalize marginal costs to zero for simplicity.¹

We study a three-stage game. First, the domestic government acts as a Stackelberg leader vis-à-vis foreign firms and chooses a tariff (subsidy) policy t_i on imports from country $i = 1, 2$ to maximize national welfare.² Foreign firms, which act as followers and take tariffs as given, choose qualities in the second stage. Finally, firms export their goods to the domestic market and

¹This cost specification captures the distinctive features of pure vertical product differentiation models, where the costs of quality improvements mainly fall on fixed costs and involve only a small or no increase in unit variable costs (Shaked and Sutton 1982). The normalization adopted here is without loss of generality provided that the main bulk of costs falls on fixed costs rather than on variable costs.

²This timing of moves assumes that the government can credibly commit to a certain trade policy. In our model, in absence of commitment, the government would simply maximize revenues and firms would respond by not entering the market. Most international trade observers agree in that governments possess credible ways to commit (Brander 1995).

compete in prices with the local producers. We solve the model by backward induction.³

3 Market Equilibrium

We first derive the equilibrium of the price competition stage. Heterogeneity in consumer tastes implies that it is optimal for the two foreign firms to differentiate their goods by choosing different quality levels (Shaked and Sutton 1982). Let us denote high quality by q_h and low quality by q_l , $q_h > q_l$. Suppose also, for the moment, that $p_h > p_l$, i.e., high quality commands a higher price. Demands for low quality, for high quality and for the numeraire follow from straightforward calculations (see e.g. Motta *et al.* 1997; Moraga-González and Viaene 2005):

$$D_l(\cdot) = \frac{p_h - p_l}{\bar{\theta}(q_h - q_l)} - \frac{p_l}{\bar{\theta}q_l}, \quad D_h(\cdot) = 1 - \frac{p_h - p_l}{\bar{\theta}(q_h - q_l)}, \quad D_n(\cdot) = 1 - D_l - D_h. \quad (1)$$

Firm 1 might in principle choose to produce a variant whose quality is either lower or higher than that of the competitor. Assume, for the moment, that firm 1 produces low quality. Taking tariff rates (t_1, t_2) and quality choices (q_h, q_l) as given, firm 1 chooses p_l to maximize $\pi_1 = (1 - t_1)p_l D_l(\cdot) - c_1 q_l^2/2$. The rival firm sets p_h to maximize $\pi_2 = (1 - t_2)p_h D_h(\cdot) - c_2 q_h^2/2$. Solving the reaction functions in prices yields the subgame equilibrium prices of low quality and high quality:

$$p_h = \frac{2\bar{\theta}q_h(q_h - q_l)}{4q_h - q_l}, \quad p_l = \frac{\bar{\theta}q_l(q_h - q_l)}{4q_h - q_l}. \quad (2)$$

Consider now stage two where foreign firms select qualities. In this stage, firms take (t_1, t_2) as given, anticipate the continuation equilibrium prices in (2) and choose their qualities to maximize profits:

$$\pi_1 = (1 - t_1) \frac{\bar{\theta}q_l q_h (q_h - q_l)}{(4q_h - q_l)^2} - \frac{c_1 q_l^2}{2}, \quad \pi_2 = (1 - t_2) \frac{4\bar{\theta}q_h (q_h - q_l)}{(4q_h - q_l)^2} - \frac{c_2 q_h^2}{2}.$$

Since $q_h > q_l$, we can define the variable $\mu = q_h/q_l$, $\mu > 1$, which represents the *quality gap* between foreign firms. We shall see later that μ relates to the

³We are ignoring the possibility that foreign governments engage in *retaliatory* trade policies (Collie 1991; Bagwell and Staiger 1999). The rationale is that international firms often serve many markets and this impedes foreign governments to *target* retaliations against specific countries.

extent of price competition in the international market. Using μ , the ratio of first order conditions in qualities can be written as:

$$\frac{c_1(1-t_2)}{c_2(1-t_1)} = \frac{\mu^2(4\mu-7)}{4(4\mu^2-3\mu+2)}. \quad (3)$$

This equation gives an implicit relation between the equilibrium quality gap μ , the ad valorem tariffs and firms' development costs. There exists a unique real solution to this third degree polynomial for any parametrical point (c_1, c_2, t_1, t_2) which satisfies $\mu > 1.75$. It is easily seen that quality gap μ increases in c_1 and t_1 and decreases in c_2 and t_2 .

Once equilibrium μ is obtained from (3), it is straightforward to solve for equilibrium qualities, demands and prices:

$$q_l = (1-t_1) \frac{\bar{\theta} \mu^2 (4\mu-7)}{c_1 (4\mu-1)^3}, \quad q_h = (1-t_2) \frac{4\bar{\theta} \mu (4\mu^2-3\mu+2)}{c_2 (4\mu-1)^3} \quad (4)$$

$$D_l = \frac{\mu}{4\mu-1}, \quad D_h = \frac{2\mu}{4\mu-1}, \quad D_n = \frac{\mu-1}{4\mu-1} \quad (5)$$

$$p_l = \frac{\bar{\theta}(\mu-1)q_l}{(4\mu-1)}, \quad p_h = \frac{2\bar{\theta}(\mu-1)q_h}{(4\mu-1)} \quad (6)$$

Equation (3) along with (4)-(6) fully characterize the market equilibrium. The variable μ is central to our analysis. Taking the ratio of domestic prices in (6) yields: $p_h/p_l = 2\mu$. Thus, μ is a measure of domestic price competition among the two foreign firms: an increase in μ relaxes price competition and price differences rise. Moreover, both hedonic prices p_h/q_h and p_l/q_l , which follow from (6), increase in μ . As a result, we refer to a trade policy that leads to a decrease (increase) in μ as *pro-competitive* (*anti-competitive*). We also observe from (5) that the relationship between μ and the market shares of the foreign firms is negative. This is because, as the quality gap widens, higher prices lead more consumers to opt for the numeraire.

So far we have assumed that the quality produced by the foreign firm 1 is lower than that of the foreign firm 2. However, it may very well be that firm 1 produces high quality instead. The next result states the conditions under which the first assignment in qualities is the unique equilibrium of the subgame analyzed above.

Lemma 1 *If $c_1/(1-t_1) > c_2/(1-t_2)$, firm 1 produces low quality and firm 2 high quality in the unique equilibrium of the continuation game. If $c_1/(1-t_1) <$*

$c_2/(1 - t_2)$, firm 1 produces high quality and firm 2 low quality in the unique equilibrium of the continuation game. When $c_1/(1 - t_1) = c_2/(1 - t_2)$, firm 1 may produce either high or low quality.

The proof proceeds in two steps.⁴ We first show that when $c_2/(1 - t_2)$ is sufficiently low compared to $c_1/(1 - t_1)$, the assignment where high quality is produced by firm 1 is not subgame perfect because firm 2, which is highly efficient, finds it profitable to deviate and leapfrog the former firm. When the cost asymmetry between firms is small, the proof uses the risk-dominance criterion of Harsanyi and Selten (1988). This refinement selects away the equilibrium where firm 1 produces high quality provided that firm 2 is more efficient than firm 1 in relative terms. If $c_1/(1 - t_1) = c_2/(1 - t_2)$, the refinement has no bite and both quality assignments can be equilibria.

4 Trade Policy

Finally, in the first stage of the game, the domestic government maximizes domestic social welfare. We assume that the proceeds obtained from import taxation are uniformly distributed among the consumers. Therefore social welfare equals the (unweighted) sum of domestic consumer surplus and tariff revenues, i.e., $W = S + t_1 p_l D_l(\cdot) + t_2 p_h D_h(\cdot)$. Consumers surplus is given by:

$$S = V + \int_{\frac{p_h - p_l}{q_h - q_l}}^{\bar{\theta}} (x q_h - p_h) dx + \int_{\frac{p_l}{q_l}}^{\frac{p_h - p_l}{q_h - q_l}} (x q_l - p_l) dx$$

Employing μ , (6) and (4), consumers surplus can be conveniently written as:

$$S = V + \frac{\bar{\theta} \mu^2 (4\mu + 5) q_l}{2(4\mu - 1)^2} \quad (7)$$

Tariffs revenues obtained from imports are given by $R_1 = t_1 p_l D_l(\cdot)$ and $R_2 = t_2 p_h D_h(\cdot)$. Substitution of (5) and (6) yields:

$$R_1 = \frac{t_1 \bar{\theta} \mu (\mu - 1) q_l}{(4\mu - 1)^2}, \quad R_2 = \frac{t_2 4 \bar{\theta} \mu^2 (\mu - 1) q_l}{(4\mu - 1)^2} \quad (8)$$

Using the previous expressions we can write domestic social welfare as:

$$W(t_1, t_2; c_1, c_2) = V + A(\mu(t_1, t_2), t_1, t_2) * q_l(\mu(t_1, t_2), t_1) \quad (9)$$

⁴This and subsequent proofs are available from the authors upon request. They can also be downloaded from <http://www.tinbergen.nl/~moraga>.

where $A(\cdot) = \bar{\theta}[\mu^2(4\mu + 5)/2 + t_1\mu(\mu - 1) + 4t_2\mu^2(\mu - 1)]/(4\mu - 1)^2$ and q_1 is given by (4).

Let us now examine the effects of trade policy on the domestic economy. For this we consider free trade as the benchmark case. By virtue of Lemma 1, we know that under free trade low quality is produced in country 1 while high quality is produced in country 2.

Non-discriminatory Tariff Policy

Suppose the domestic government levies a common tariff on imports from countries 1 and 2, i.e., $t_1 = t_2 = t > 0$. From (3) it follows that the quality gap μ remains unaltered after this policy. As a result:

Proposition 2 *Starting from free trade, a small uniform tariff on all imports results in: (i) no change in competitive conditions, (ii) a downgrade in the quality of all imports, (iii) a decrease in the price of the imports, (iv) a decrease in consumer surplus, and (v) an increase in social welfare. Consequently, free trade is not optimal.*

A small uniform tariff against foreign firms is welfare enhancing because of a rent-extraction effect:⁵ income is taken away from foreign firms and given to the consumers. This effect is of first-order compared to the loss in consumer surplus caused by the downgrade in the quality of imports. We note that a *uniform* tariff policy does not change the competitive conditions in the market and thus the market share of the local industry remains unaltered.⁶ A straightforward extension of Proposition 2 is the Most Favored Nation (MFN) principle. Applying this principle here is equivalent to maximize welfare in (9) with respect to t . Solving for the MFN tariff yields:

$$t^{\text{MFN}} = \frac{1}{2} \left[1 - \frac{\mu(4\mu + 5)}{2(\mu - 1)(4\mu + 1)} \right],$$

where μ solves (3). The MFN tariff increases with the quality gap but is bounded below 25%. More importantly, it does not affect international competitive conditions.

⁵This is in line with Brander and Spencer (1981) and Helpman and Krugman (1989, ch. 4), who analyze a *homogeneous* product market.

⁶Since the intensity of competition does not change with a uniform tariff in our setting, this intervention leads to effects similar to those under *monopoly* (Krishna 1987; Das and Donnenfeld 1987). Next we show that a discriminatory policy can be designed to be either pro-competitive or anti-competitive.

Discriminatory Tariff Policy

In this case the government imposes distinct tariffs on imports proceeding from different countries. As mentioned above, a nonuniform trade policy alters the equilibrium quality gap and, besides extracting rents from foreign firms, it modifies the extent of competition between them.

Proposition 3 (i) *Starting from free trade, a small tariff on country 1 where the low-quality good is produced is anti-competitive and leads to: (a) a downgrade in the quality of both foreign goods, (b) an increase in the price of the high-quality product, (c) a reduction in the price of the low-quality good, (d) a fall in the imports from both countries and an increase in the market share of the numeraire good, (e) a reduction in consumer surplus and (f) a decrease in social welfare.*

(ii) *Starting from free trade, a small tariff on country 2 where the high-quality variant is produced is pro-competitive and leads to: (a) a downgrade in the quality and price of both foreign goods, (b) an increase in imports from both foreign countries and a decrease in the market share of the numeraire good, (c) a decrease in consumer surplus and (d) an increase in social welfare.*

The effects of an asymmetric tariff policy are sensitive to whether the low-quality or the high-quality firm is conferred a cost advantage as a result of the tariff. Both policies downgrade qualities, which tends to reduce consumer surplus in either case. However, a tariff on the low-quality producing country has two additional pervasive effects on welfare: price competition between the firms is relaxed thereby increasing hedonic prices and reducing the number of consumers who buy quality products. As tariff revenues are small, a tariff on the low-quality good ends up being welfare reducing. In contrast, a tariff on the high-quality firm fosters competition between firms thereby lowering foreign prices and reducing the market share of the numeraire good. Though the overall impact of a tariff on high quality is a fall in consumer surplus, tariff revenues more than offset this loss and welfare rises. In summary, a tariff levied on the imports from country 2 functions as a *pro-competitive* device; by contrast, a tariff levied on the imports proceeding from country 1 is *anti-competitive*. Thus, in the latter case, the domestic country improves its welfare by subsidizing low-quality imports.

5 Regional Trading Agreements

Consider now the formation of a RTA. In our framework there are two possibilities: the domestic economy can form a RTA with either country 1 or country 2. The objective of this section is to study the impact of each RTA on domestic welfare via the *particular sector* under consideration.

The principal feature of a RTA, formally approved by the WTO, is its discriminatory treatment favoring members relative to non-members: goods imported from a member country face a zero tariff while similar goods imported from a non-member country face a tariff distinct from zero. It is just this discriminatory nature of a RTA that leads to our main result:

Proposition 4 *As compared to free trade, (a) a RTA with country 2 and a subsidy on low-quality imports from country 1, or (b) a RTA with country 1 and a positive tariff on high-quality imports from country 2 are welfare improving.*

This proposition follows directly from Proposition 3. By adhering to a RTA, the domestic government affects the relative costs of the exporting firms in such a way that the quality gap decreases thereby fostering competition. A RTA with the low-quality producing country extracts rents from country 2 through a tariff and, in addition, is pro-competitive. By contrast, a RTA with the high-quality producing country is pro-competitive but at the cost of subsidizing low-quality imports. This suggests that the former RTA is preferred to the latter. This is also revealed by numerical simulations of the model. Moreover, when cost differences are not too small, these simulations show that only such RTA is welfare superior to the MFN clause.

The positive welfare effects of Proposition 4 can be explained in terms of standard partial equilibrium concepts of economic integration. Traditionally, the pros and cons of integration rest on the relative merits of trade creation and trade diversion, each with different welfare implications. Unlike trade creation, a trade diverting RTA can be welfare reducing. To check whether trade diversion arises in our framework, we refer the reader to (5) where D_l and D_h represent imports from the foreign suppliers. The following monotonicity results can be obtained:

$$\frac{dD_l}{d\mu} < 0, \quad \frac{dD_h}{d\mu} < 0 \quad (10)$$

When a RTA is formed with the low-quality producer, trade diversion can only arise if D_h drops as it represents the amount of trade diverted by this RTA. In our framework the contribution of a RTA is to reduce μ and, hence,

to increase both D_l and D_h . Trade diversion is therefore excluded and double trade creation is obtained instead.

6 Conclusions

This paper has explored the pro-competitive effects of trade policies in a model where a competitive fringe of domestic firms compete with a foreign duopoly exporting vertically differentiated goods. We have shown that discriminatory nonuniform tariff policies are preferred over the Most Favored Nation (MFN) clause because, besides extracting rents from the foreign firms, they foster competition in the marketplace.

Regional Trading Agreements (RTAs), which favor members relative to non-members, are examples of such discriminatory tariff policies. Our paper shows that RTAs can be welfare superior to free trade because firms end up competing more aggressively. The largest gains are obtained when the domestic economy joins the low-quality producing country.

Regional trading agreements often address other issues like labor mobility, foreign investment and competition policy. For example, Ethier (1998) argues that regional trading agreements give newcomers a marginal advantage compared to non-participating countries in attracting foreign direct investments, which then give access to a larger market. Hopefully, our model provides a suitable framework that can be extended to include some of these broader issues.

7 Appendix

Proof of Lemma 1: For any given pair of tariffs (t_1, t_2) , there may potentially be two equilibrium quality configurations in our continuation game. In the first equilibrium candidate, low quality is produced by firm 1, while in the second low quality is produced by firm 2. We shall refer to the first quality configuration as Assignment 1, and to the second as Assignment 2.

In the first case, μ is the solution to the equation $\mu^2(4\mu-7)/4(4\mu^2-3\mu+2) = k_1$, where $k_1 = c_1(1-t_2)/c_2(1-t_1) > 0$. Denote this solution as μ_1 . In the second case, μ is the solution to $\mu^2(4\mu-7)/4(4\mu^2-3\mu+2) = k_2$, with $k_2 = c_2(1-t_1)/c_1(1-t_2)$. Denote this solution as μ_2 . In addition, we define

$$f(x) = \frac{4x^2 - 3x + 2}{(4x - 1)^3} \text{ and } g(x) = \frac{x^3(4x - 7)}{4(4x - 1)^3},$$

with $f'(x) < 0$, $f''(x) > 0$, $g'(x) > 0$, and $g''(x) < 0$ for all $x \geq 7/4$.

We first we study the conditions under which Assignment 1 is an equilibrium. To do so, we prove that both firms' profits at the proposed equilibrium are non-negative and that no firm has an incentive leapfrog its rival's choice. Equilibrium profits under Assignment 1 can be written as:

$$\pi_{1,l} = \frac{\bar{\theta}^2(1-t_1)^2\mu_1^3(4\mu_1-7)(4\mu_1^2-3\mu_1+2)}{2c_1(4\mu_1-1)^6} \text{ and } \pi_{2,h} = \frac{16c_1(1-t_2)^2}{c_2(1-t_1)^2}\pi_{1,l}. \quad (11)$$

It is easy to check that $\mu'_1(k_1) > 0$; then, in equilibrium, for any parametrical constellation, it must be the case that $\mu_1 \geq 7/4 = 1.75$. This actually implies that q_l and q_h are positive and that firms' benefits are non-negative.

We now check the conditions under which no firm has an incentive to deviate by leapfrogging the rival's choice. The case of "downward" leapfrogging only makes sense if selling a low-quality good generates higher profits than a high-quality good, which is not the case here. There is, however, potential for "upward" leapfrogging. Suppose firm 1 deviates by leapfrogging its rival. In such a case, firm 1 would select $q \geq q_h$ to maximize deviating profits:

$$\tilde{\pi}_{1,h} = (1-t_1) \frac{4\bar{\theta}q^2(q-q_h)}{(4q-q_h)^2} - \frac{c_1q^2}{2}$$

The first order condition is:

$$(1-t_1) \frac{4\bar{\theta}q(4q^2-3qq_h+2q_h^2)}{(4q-q_h)^3} - c_1q = 0$$

Define $\lambda \geq 1$ such that $q = \lambda q_h = \lambda \mu_1 q_l$. Then, we can write:

$$q = (1 - t_1) \frac{4\bar{\theta}\lambda(4\lambda^2 - 3\lambda + 2)}{c_1(4\lambda - 1)^3} = \lambda q_h = \lambda(1 - t_1) \frac{4\bar{\theta}\mu_1(4\mu_1^2 - 3\mu_1 + 2)}{c_2(4\mu_1 - 1)^3}$$

From this equality, we obtain that λ must satisfy:

$$\frac{(4\lambda^2 - 3\lambda + 2)}{(4\lambda - 1)^3} = \frac{(4\mu_1^2 - 3\mu_1 + 2)}{(4\mu_1 - 1)^3} \frac{\mu_1 c_1}{c_2},$$

i.e., $f(\lambda) = f(\mu_1)\mu_1 c_1/c_2$. Denote the solution to this equation as λ_1 . Since $\mu_1 c_1/c_2 > 1$ and $f'(\cdot) < 0$, it follows $\lambda_1 < \mu_1$. Moreover, the larger c_1/c_2 , the greater is $\mu_1 c_1/c_2$ and the larger the difference between λ_1 and μ_1 .

We can now compare deviating profits $\tilde{\pi}_{1,h}$ with those at the proposed equilibrium $\pi_{1,l}$. Deviating profits can be written as:

$$\tilde{\pi}_{1,h} = (1 - t_1)^2 \frac{8\bar{\theta}^2 h(\lambda_1)}{c_1}$$

with $h(x) = (x^3(4x - 7)(4x^2 - 3x + 2)) / (4x - 1)^6$, and $h'(x) > 0$. Equilibrium profits are:

$$\pi_{1,h} = (1 - t_1)^2 \frac{\bar{\theta}^2 h(\mu_1)}{2c_1}$$

Dividing these two expressions we get:

$$\frac{\tilde{\pi}_{1,h}}{\pi_{1,l}} = \frac{16h(\lambda_1)}{h(\mu_1)}$$

Firm 1 does not deviate whenever $\tilde{\pi}_{1,h} \leq \pi_{1,l}$, i.e., if and only if $16h(\lambda_1) \leq h(\mu_1)$. Since as c_1/c_2 increases μ_1 increases while λ_1 decreases, it is clear that there exists some critical level of c_1/c_2 for which the inequality above holds and firm 1 has no interest in deviating. To complete the proof we need to show that the parametrical space for which the equations above have real well-defined solutions and the above inequality is fulfilled is not empty. We prove this by providing an example. First, note that equation (3) is cubic in μ and that its RHS increases in μ . Therefore, since any valid set of parameters (c_1, c_2, t_1, t_2) satisfies $\frac{c_i(1-t_j)}{c_j(1-t_i)} > 0$, $i, j = 1, 2$, $i \neq j$, there is always a real solution to (3) satisfying $\mu \geq 1.75$. Notice now that there also exists a solution to equation $f(\lambda) - kg(\mu) = 0$, which is also cubic in λ , and can be written as $(4\lambda^2 - 3\lambda + 2)/kg(\mu) = (4\lambda - 1)^3$. Since the LHS is ever positive, the solution

satisfies $\lambda \geq 1$, as required. It can be shown that primitive parameters exist for which Assignment 1 is an equilibrium of the continuation game. Suppose $c_1 = 1.1$ and $c_2 = 1$ and a MFN clause tariff policy ($t_1 = t_2$). Then, $\mu_1 = 5.6335$, $\lambda_1 = 1.2578$ and therefore $16h(\lambda_1)(1 - t_h)^2 = -4.1582 \times 10^{-3} < 0 < h(\mu_1)(1 - t_1)^2 = 3.1208 \times 10^{-3}$. This proves that for sufficiently large cost differences Assignment 1 is an equilibrium. Similarly, it is easy to prove that when the cost asymmetry between the firms is large, Assignment 2 is not an equilibrium. We omit this proof to economize on space.

In the second part of the proof we apply the risk-dominance criterion of Harsanyi and Selten (1988) to show that Assignment 1 is the unique refined equilibrium if and only if $c_1/(1 - t_1) > c_2/(1 - t_2)$. Again, consider first Assignment 1. This is the case fully developed in the main body of the paper. In this candidate equilibrium, product differentiation is given by the solution to (3) and demands, qualities and prices obtain from (5)-(4). Consider now Assignment 2. In this case a new candidate equilibrium can be derived following exactly the same steps outlined in Section 3. In this case, the equilibrium product differentiation is given by the solution to:

$$\frac{c_2(1 - t_1)}{c_1(1 - t_2)} = \frac{\mu^2(4\mu - 7)}{4(4\mu^2 - 3\mu + 2)}. \tag{12}$$

We note that equations (3) and (12) are equal except for the LHS; therefore, they yield different solutions. Let $\tilde{\mu}$ denote the solution to (12). Under Assignment 2, firm 1 (the most inefficient) produces high quality given by

$$\tilde{q}_h = (1 - t_1) \frac{4\tilde{\theta}\tilde{\mu}(4\tilde{\mu}^2 - 3\tilde{\mu} + 2)}{c_1(4\tilde{\mu} - 1)^3} \tag{13}$$

while firm 1 produces low quality given by

$$\tilde{q}_l = (1 - t_2) \frac{\tilde{\theta}\tilde{\mu}^2(4\tilde{\mu} - 7)}{c_2(4\tilde{\mu} - 1)^3}. \tag{14}$$

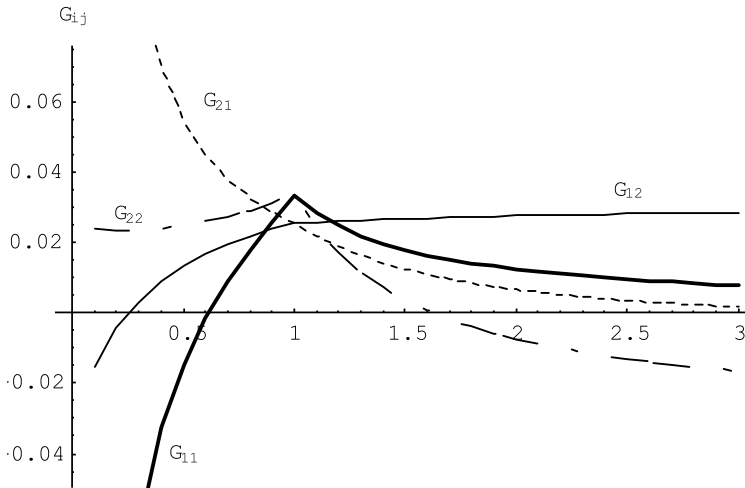
Given any pair of tariffs (t_1, t_2) , firms must choose between Assignment 1 and 2. This choice is represented in the following matrix:

		Firm 2	
		q_h	\tilde{q}_l
Firm 1	q_l	$\pi_l(q_h, q_l), \pi_h(q_h, q_l)$	$\pi_l(\tilde{q}_l, q_l), \pi_h(\tilde{q}_l, q_l)$
	\tilde{q}_h	$\pi_l(q_h, \tilde{q}_h), \pi_h(q_h, \tilde{q}_h)$	$\pi_h(\tilde{q}_h, \tilde{q}_l), \pi_l(\tilde{q}_h, \tilde{q}_l)$

where $\pi_l(\tilde{q}_l, q_l)$ and $\pi_h(\tilde{q}_l, q_l)$ denote the payoffs to firm 1 and firm 2, respectively, when the former chooses to produce the low-quality given by Assignment 1 and the latter chooses to produce the low-quality given by Assignment 2. Payoffs $\pi_l(q_h, \tilde{q}_h)$ and $\pi_h(q_h, \tilde{q}_h)$ are similarly interpreted.

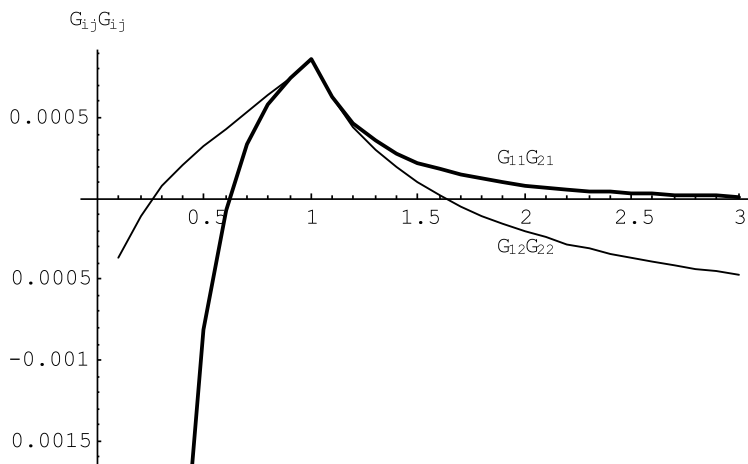
Let $G_{11} = \pi_l(q_h, q_l) - \pi_l(q_h, \tilde{q}_h)$ be the gains firm 1 obtains by predicting correctly that firm 2 will choose Assignment 1. Likewise, $G_{12} = \pi_h(\tilde{q}_h, \tilde{q}_l) - \pi_l(\tilde{q}_l, q_l)$ denotes the gains firm 1 derives by forecasting correctly that firm 2 will select Assignment 2. Similarly, for firm 2 we have $G_{21} = \pi_h(q_h, q_l) - \pi_h(\tilde{q}_l, q_l)$ and $G_{22} = \pi_l(\tilde{q}_h, \tilde{q}_l) - \pi_h(q_h, \tilde{q}_h)$. It is said that Assignment 1 risk-dominates Assignment 2 whenever $G_{11}G_{21} > G_{12}G_{22}$.

Unfortunately, the theoretical application of this criterion to our game is difficult because the solution to equations (3) and (12) –and by implication the maximizers of $\pi_l(q_h, q_l)$, $\pi_h(q_h, q_l)$, $\pi_l(\tilde{q}_l, q_l)$, $\pi_h(\tilde{q}_l, q_l)$, $\pi_l(q_h, \tilde{q}_h)$, $\pi_h(q_h, \tilde{q}_h)$, $\pi_h(\tilde{q}_h, \tilde{q}_l)$ and $\pi_l(\tilde{q}_h, \tilde{q}_l)$ – cannot be obtained explicitly. Thus, we have chosen to solve our model numerically for several values of the ratio $c_1(1 - t_2)/c_2(1 - t_1)$. Figure 1 depicts the gains G_{11} , G_{21} , G_{12} and G_{22} as a function of this ratio.



Inequality $G_{11}G_{21} > G_{12}G_{22}$ can be evaluated by observing Figure 2. This graph shows $G_{11}G_{21}$ and $G_{12}G_{22}$ as a function of relative costs. It can be seen that $G_{11}G_{21} > G_{12}G_{22}$ if and only if relative costs are greater than 1. This implies that Assignment 2 is ruled out whenever domestic firm is (relatively) less efficient than foreign firm. Otherwise, assignment 1 is selected away. We have

conducted a number of simulations with different polynomial cost functions and the selection criterion remains valid.



□

Proof of Proposition 2: Since μ is insensitive to t , statements (ii) and (iii) follow directly from inspection of equations (4) and (6). Since q_l falls, observation of (7) reveals that consumer surplus declines, which proves (iv). Since consumer welfare decreases with the tariff, this intervention can only be socially desirable if and only if it allows government to extract a sufficiently large amount of foreign rents. When the tariff policy is uniform social welfare reduces to:

$$W = \frac{\bar{\theta}\mu q_l}{(4\mu - 1)^2} \left[\frac{\mu(4\mu + 5)}{2} + t(\mu - 1)(1 + 4\mu) \right] \quad (15)$$

From (4), it follows that $dq_l/dt = -q_l/(1 - t)$. Then,

$$\frac{dW}{dt} = \frac{\partial W}{\partial q_l} \frac{dq_l}{dt} + \frac{\partial W}{\partial t} = \frac{\bar{\theta}\mu q_l}{(1 - t)(4\mu - 1)^2} \left[-\frac{\mu(4\mu + 5)}{2} + (1 - 2t)(\mu - 1)(4\mu + 1) \right] \quad (16)$$

The sign of dW/dt depends on the sign of the expression in square brackets. In a neighborhood of free trade ($t = 0$), we have $\text{sign}\{dW/dt|_{t=0}\} = \text{sign}\{2\mu^2 - 5.5\mu - 1\} > 0$ for all $\mu > 3$. We now note that since $c_1 > c_2$ and tariff rates are equal, the solution in (3) is bounded above 5. To see this, note that the RHS of (3) is increasing in μ , while its LHS is constant; therefore, the lowest value

of μ solving (3) obtains when $c_1 \simeq c_2$. In such a case, μ is approximately equal to $5.25123 > 5$. Therefore, it follows that $dW/dt_1|_{t_1=0} > 0$. This completes the proof. \square

Proof of Proposition 3: (i) First, notice that from (3), $\partial\mu/\partial t_1 > 0$. (a) Note that $dq_h/dt_1 = (\partial q_h/\partial\mu)(\partial\mu/\partial t_1)$. From (4) we have $\partial q_h/\partial\mu = -(1 - t_2)8\bar{\theta}(5\mu + 1)/c_2(4\mu - 1)^4 < 0$. Thus, $dq_h/dt_1 < 0$. Since $q_l = q_h/\mu$, and q_h falls while μ increases with t_1 , then $dq_l/dt_1 < 0$. (b) Using (4) and (6), we can rewrite $p_h = (1 - t_2)8\bar{\theta}^2\mu(\mu - 1)(4\mu^2 - 3\mu + 2)/c_2(4\mu - 1)^4$. Note that $dp_h/dt_1 = (\partial p_h/\partial\mu)(\partial\mu/\partial t_1)$. Since $\partial p_h/\partial\mu = (1 - t_h)8\bar{\theta}^2(12\mu^3 - 19\mu^2 + 14\mu + 2)/c_2(4\mu - 1)^5 > 0$, it follows that $dp_h/dt_1 > 0$. (c) From (6) we have $p_l = p_h/2\mu$. Then, $p_l = \bar{\theta}(\mu - 1)q_h/\mu(4\mu - 1)$. Observe that $\bar{\theta}(\mu - 1)/\mu(4\mu - 1)$ decreases with $\mu \geq 5.25123$, and so with t_1 . Note also that q_h falls with t_1 . Thus, $dp_l/dt_1 < 0$. (d) This follows from the fact that $dD_i/d\mu < 0$, $i = 1, 2$ (see equation (5)). (e) Consumer surplus can be written as $S = \bar{\theta}\mu(4\mu + 5)q_h/2(4\mu - 1)^2$. It can be seen that both factors $\bar{\theta}\mu(4\mu + 5)/2(4\mu - 1)^2$ and q_h fall with μ . Therefore $dS/dt_1 < 0$. (f) Using (4), (7) and (8), the relevant expression of social welfare is $W = \bar{\theta}^2\mu^3(4\mu - 7)(1 - t_1)(\mu(4\mu + 5) + 2t_1(\mu - 1))/2c_1(4\mu - 1)^2$. We need the sign of

$$\frac{dW}{dt_1}\Big|_{t_1=0} = \frac{\partial W}{\partial t_1}\Big|_{t_1=0} + \frac{\partial W}{\partial\mu} \frac{\partial\mu}{\partial t_1}\Big|_{t_1=0}.$$

We note that

$$\begin{aligned} \frac{\partial W}{\partial t_1}\Big|_{t_1=0} &= -\frac{\bar{\theta}^2\mu^3(4\mu - 7)(4\mu^2 + 3\mu + 2)}{2c_1(4\mu - 1)^5} < 0 \\ \frac{\partial W}{\partial\mu}\Big|_{t_1=0} &= \frac{\bar{\theta}^2\mu^3(16\mu^3 - 24\mu^2 + 45\mu + 35)}{c_1(4\mu - 1)^6} > 0 \end{aligned}$$

From equation (3) we have that

$$\frac{\partial\mu}{\partial t_1}\Big|_{t_1=0} = \frac{c_2\mu^3(4\mu - 7)^2}{4c_1(16\mu^3 - 24\mu^2 + 45\mu - 28)} > 0.$$

Using again (3) to substitute c_2/c_1 in this expression, yields

$$\frac{\partial\mu}{\partial t_1}\Big|_{t_1=0} = \frac{\mu(4\mu - 7)(4\mu^2 - 3\mu + 2)}{16\mu^3 - 24\mu^2 + 45\mu - 28} > 0.$$

Now we are ready to compute the total derivative

$$\left. \frac{dW}{dt_1} \right|_{t_1=0} = -\frac{\bar{\theta}^2 \mu^3 (4\mu - 7)(128\mu^6 + 32\mu^5 + 40\mu^4 - 154\mu^3 + 79\mu^2 - 370\mu + 56)}{c_1 (4\mu - 1)^5 (128\mu^4 - 224\mu^3 + 408\mu^2 - 314\mu + 56)} < 0.$$

This completes the proof of (i). The proof of (ii) is analogous and omitted to save space. \square

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A Cross-Country Nonparametric Analysis of Bahrains Banking System

David Grigorian
International Monetary Fund
email: dgrigorian@imf.org

Vlad Manole
Rutgers University
email: vm286@andromeda.rutgers.edu

Abstract. Bahrains financial sector development strategy succeeded in building a leading regional banking center, which has become one of the main engines of growth and sources of employment. Based on bank-level productivity estimates obtained using non-parametric estimation, the paper concludes that Bahrain continues to occupy a front-runner position among sample GCC countries. Results also reveal that: (i) banks in Bahrain still lag behind their Singaporean counterparts (included in the study as a benchmark), and (ii) there is strong competition from other countries in the region. The results appear to be robust with respect to changes in the sample size and model specifications.

1 Introduction

The banking sector in Bahrain has grown rapidly in recent years, becoming one of the main engines of growth and sources of employment. This expansion was facilitated by rapid regional growth and the need to intermediate the substantial regional oil-related capital flows. While Bahrains financial sector development strategy succeeded in building a leading regional banking center, there have been constant challenges on the way. External shockssuch as the uncertainties related to international oil markets, regional instability, and volatility in the international financial marketshave tested Bahrains financial sector. Competition from other GCC countries has put pressure on

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Key words and phrases: Data Envelopment Analysis, banking efficiency, Bahrain

the Bahraini financial industry to develop new products and instruments. The development of the financial sector in the region during recent years has been characterized by a significant build-up of capacity in various regional financial centers, including Bahrain, but also Dubai, Qatar, Kuwait and Riyadh. While these centers in part serve the domestic market, the size of that market is less than 35 million people, requiring these centers to specialize in particular services for the international markets. For example, looking at each of the centers strengths for example, Bahrain on Islamic Finance, Qatar on Project Financing, Kuwait on Asset Management, Dubai on Investment Banking niche products could be developed to offer services globally¹.

The motivation behind the paper is straightforward: it attempts to assess the performance of the banking sector in Bahrain through a comparison with banks in the region and Singapore, a major Asian financial center. Such an assessment of efficiency and competitiveness (within regional and international contexts) can be important for a future reform agenda in Bahrain. This paper looks beyond the conventional measures of performance of banks. In doing so, it compares the efficiency indicators of banks in Bahrain with that of their counterparts in Kuwait, Qatar, the United Arab Emirates, and Singapore, obtained by using a nonparametric estimation method called Data Envelopment Analysis (DEA). The DEA is a linear programming technique that constructs an efficiency frontier based on best performing banks, which is then used to assess the relative performance of other banks. One of the main advantages of this methodology is that it does not impose any functional forms and/or assumptions on the structure of the banks objective function or the error term. As a result, it allows one to model other functions performed by the banks apart from production of loans such as liquidity and services provision. By treating every bank as a single decision-making entity, the paper defines a set of inputs and outputs and uses the most recent data to arrive at overall efficiency indexes for the sample banks. It then decomposes these indexes between purely technical and scale-related, thus offering additional insights with policy relevance. The data used in the paper is obtained through BankScope database, and in the case of Bahrain, also contains updates and additions from the Bahrain Monetary Agency (BMA).

¹For more information on the structure of the banking sectors in the Gulf region, see van Ark et al, 2008 and Al-Hassan et al, 2010.

2 Methodology

During the past few decades, banking sectors around the world experienced profound regulatory and technological changes. Advanced applications in computer and communications technology, together with the introduction of new financial instruments, have significantly modified the technology of bank production and efficiency. This subsequently altered the way economists look at the functions performed by the banks and measure their efficiency. One of the methods used in the literature to evaluate productivity and performance of banks is the Data Envelopment Analysis, a nonparametric method that allows one to account for a wide range of functions performed by banks. This method compares relative performance of decision-making units (DMU) in this case, banks by building a frontier comprised of the most efficient DMUs and focusing on how close other DMUs are to this frontier.

The method was first proposed by Farrell (1957), who suggested constructing the frontier as a piece-wise linear combination of the most efficient units. He also defined the most efficient DMUs to be those for which no other DMU or a linear combination of DMUs has as much or more of every output (given a fixed amount of inputs, for an output-oriented model) or as little or less of every input (given a fixed amount of outputs, for an input-oriented model). The efficiency frontier formed by connecting these best practice observations would yield a convex production possibility set. The DMUs falling inside the frontier are termed inefficient, and their performance would be measured vis-à-vis the frontier DMUs. Thus this method provides a measure of relative efficiency. In practice, DEA was first implemented by Charnes, Cooper, and Rhodes (1978), who used a linear-programming method to identify the efficient DMUs and coined the term Data Envelopment Analysis (DEA).²

Data Envelopment Analysis was used extensively in studies of banking industry in developed market economies. On U.S. data alone the method was used in more than 30 published articles³. The method was also applied for Norway, Spain, U.K., and several other countries⁴. There is a vast literature that uses Data Envelopment Analysis for inter-countries comparisons⁵. The

²Their method is based on the assumption that the production units have constant returns to scale. Banker, Charnes, and Cooper (1984) later relaxed the assumption and proposed a model with units of production with variable returns to scale. Theoretical extensions of these methods and empirical applications are discussed in Cook and Zhu (2005), Cooper, Seiford, and Zhu (2004) and surveyed in Murillo-Zamorano (2004).

³See Alam (2001), Wheelock and Wilson, (1999).

⁴See Berger and Humphrey (1997) for a detailed survey.

⁵We mention just studies by Bergendhal (1998), Bukh et al. (1995) and Berg et al. (1993)

integration effort of European Union countries is analyzed by several studies like Casu and Molyneux, (2003) that finds relatively small improvement in bank efficiency levels and no convergence after 1992 or Lozano-Vivas, Pastor and Iftekhar, (2001) that identifies Spain, Denmark and Portugal with the most efficient banking sector in European Union. Two papers analyzing Central and Eastern European countries, find that the efficiency of their banking sector is correlated with the level of integration in European Union (Grigorian and Manole, 2006 and Stavarek 2006).

The banking sector from developing countries is also examined with the help of DEA. For India and Pakistan, economic reforms tend to increase the efficiency of the banking system (Ataullah, A., and Le, H., 2006, and Ataullah, A., Cockerill, T. and Le, H., 2004). Financial liberalization in the 1980s increased bank efficiency in Turkey (Isik and Hassan, 2003) and financial crises affected the efficiency in the second half of the 1990s (Ozkan-Gunay and Tektas 2006). Closer to the region analyzed in this paper, Limam, (2001) studies the technical efficiency of GCCs banks in 1999. He finds that Bahrain and Saudi Arabia have the most efficient banks and that a larger bank size is associated with better efficiency. Several country studies from the region examine the effect of financial reforms. Maghyereh, (2004) shows that financial liberalization in Jordan increased the efficiency of the banking sector. For Kuwait, Saad and EL Moussawi, (2006) examines banks efficiency in a period of structural reforms.

To arrive at basic specification of a linear-programming model underlying the DEA, we assume that there are K inputs and M outputs for every DMU. For the i^{th} DMU the inputs and outputs are represented by vectors x_i and y_i , respectively. For each DMU the method aims to obtain a measure of the ratio of all outputs over all inputs, such as $u_i'y_i/v_i'x_i$, where u_i and v_i are vectors of weights. To select the optimal weights, the following linear-programming

for Nordic countries. In a broader context Pastor et al. (1994), applied DEA for 427 banks from 8 developed countries. Also see the Berger and Humphrey (1997) survey.

problem is typically proposed:

$$\begin{aligned}
 & \max_{u_{ik}, v_{im}} \frac{u_i' y_i}{v_i' x_i} \\
 & \text{s.t. } \frac{u_i' y_j}{v_i' x_j} \leq 1 \\
 & \quad u_{ik}, v_{im} \geq 0 \\
 & \quad i, j = 1, 2, \dots, N \\
 & \quad k = 1, 2, \dots, K \\
 & \quad m = 1, 2, \dots, M
 \end{aligned} \tag{1}$$

A problem with this formulation is that it has an infinite number of solutions. This can be avoided by introducing a constraint $v_i' x_i = 1$, and obtaining the multiplier form of the linear programming problem:

$$\begin{aligned}
 & \max_{\mu_{ik}, \sigma_{im}} \mu_i' y_i \\
 & \text{s.t. } \sigma_i' x_i = 1 \\
 & \quad \mu_i' y_j - \sigma_i' x_j \leq 0 \\
 & \quad \mu_{ik}, \sigma_{im} \geq 0 \\
 & \quad i, j = 1, 2, \dots, N \\
 & \quad k = 1, 2, \dots, K \\
 & \quad m = 1, 2, \dots, M
 \end{aligned} \tag{2}$$

where vectors u_i and v_i are replaced with μ_i and σ_i . Using the duality property of this linear programming problem, Charnes, Cooper, and Rhodes (1978) derive an equivalent envelopment form as:

$$\begin{aligned}
 & \min_{\theta, \lambda} \theta_i \\
 & \text{s.t. } -y_i + Y\lambda_i \geq 0 \\
 & \quad \theta_i x_i - X\lambda_i \geq 0 \\
 & \quad \lambda_{in} \geq 0
 \end{aligned} \tag{3}$$

where λ is an $(N \times 1)$ vector; and $\theta_i \in [0,1]$ a scalar, is the efficiency score for the i^{th} DMU.⁶ Essentially, θ_i is an indicator of how close a bank is to the

⁶ $X = [X_1, \dots, X_N]$ is a $(K \times N)$ input matrix with columns x_i and $Y = [y_1, \dots, y_n]$ is a $(M \times N)$ column output matrix with columns y_i .

efficiency frontier, with $\theta_i < 1$ implying that the bank is inside the frontier (i.e., it is an inefficient bank), while $\theta_i = 1$ implying that the bank is on the frontier (i.e., it is an efficient bank). Due to a fewer number of constraints, the formulation presented in equation 3 is typically used for computations.

The efficiency indexes calculated in such a way are termed overall technical efficiency (OTE) indexes. These can subsequently be decomposed into pure technical efficiency (PTE) and scale efficiency (SE) indexes, to help identify the source of inefficiency of each DMU in the sample. Skipping the details of the formulation, this relationship could be presented as:

$$\text{OTE}_i = \text{PTE}_i \cdot \text{SE}_i \quad (4)$$

To conceptualize this, note that the PTE index is calculated relative to a frontier characterized by variable returns to scale (i.e., either increasing, decreasing, or constant), while OTE is calculated relative to a frontier characterized by only constant returns to scale. Consequently, the SE index captures the scale efficiency (i.e., due to increasing or decreasing returns to scale), while the PTE index captures nonscale and nonscope inefficiencies.⁷

Following the recent literature and bearing in mind the functions performed by commercial banks,⁸ three inputs to the banking production process are selected for the analysis: (i) personnel expenditures, to proxy for labor input, (ii) fixed assets, to proxy for premises, branch network, and equipment, and (iii) interest expenditures, to proxy for the amount of leveraged funds used in the process of intermediation. Next, we specify the following three outputs, which the above inputs are used to produce: (i) revenues, defined as the sum of interest and non-interest income; (ii) net loans, defined as loans net of loan loss provisions; and (iii) liquid assets, defined as the sum of cash and treasure bill holdings as well as balances with monetary authorities. Holding the outputs and two other inputs constant, the lesser amount of the third input used in the production would imply higher efficiency. Even though profit maximization is not implicitly modeled in equations 1-3, from the way the inputs and outputs are selected, one could think of the banks objective as conditional or constrained profit maximization. Here the banks can be thought

⁷For functional forms as well as definitions of PTE, SE, and inefficiencies of scope, refer to Rezvanian and Mehdian (2002), who utilize the framework developed in Fre, Grosskopf, and Lovell (1985).

⁸There are five widely recognized functions performed by banks: profit maximization, risk management, service provision, intermediation, and utility provision (see, for instance, Bergendahl, 1998).

of as maximizing their revenues subject to a fixed level of costs and other outputs. For a given level of costs, maximizing revenues would be identical to maximizing profits.

3 Results of efficiency analysis

3.1 Baseline Specification

The analysis presented below is based on publicly available data compiled by BankScope. The set contains comprehensive financial data on a large number of banks from Bahrain, Kuwait, Qatar, the United Arab Emirates, and Singapore, the distribution of which by is shown in Table 1.⁹ For each sample country, the number of available banks represents a vast majority of domestically incorporated commercial banks, both conventional and Islamic. Given the stage of development of the banking sectors in the sample countries, no major issues related to data quality and reporting standards are expected.

The results of DEA analysis by countries using the efficiency indexes estimated from equation 3, and their subsequent breakdown per equation 4, is presented in Figure 2. Table 2 reports the number of efficient banks in the sample by country and year. These results are largely consistent with ones expectations of relative performance of sample countries, and shed some light on potential sources of inefficiencies. A number of observations are worth noting in this regard. First of all, as expected, at least when it comes to overall efficiency and pure technical efficiency indexes, Singaporean banks on average appear to be ahead of the curve. Although based on a somewhat different set of inputs and outputs, the results are consistent with those reported by Rezvanian and Mehdian (2002). For the period of 1991-1997, this study finds that the average values of OTE, PTE, and SE indexes are 0.74, 0.86, and 0.87, respectively, for a sample of ten Singaporean banks. Corresponding values based of our sample of 16 banks for 1997-2002 are 0.70, 0.88, and 0.81.¹⁰

Second, Bahrain appears to be ahead of the GCC sub-group, although there seems to be a tight competition from the United Arab Emirates and Qatar, as

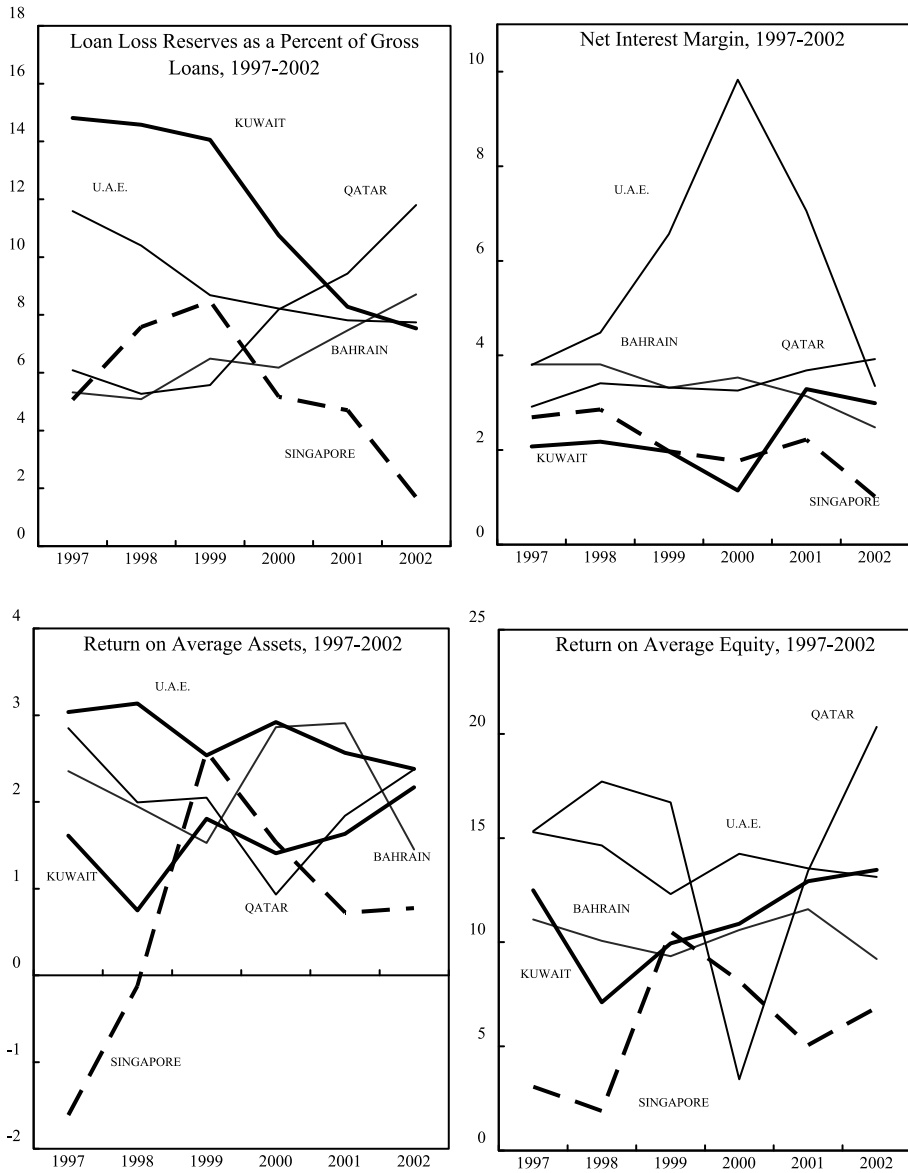
⁹As indicated earlier, the set contains 2003 data for four Bahraini banks provided by the BMA.

¹⁰An important caveat is in order here. Comparison of the results across these studies should be made with caution given the presence of non-Singaporean banks in our sample. However, the existence of GCC banks in the sample is relevant only to the extent that they are on the efficiency frontier (see Table 2). If all of them were located inside the frontier, they would not have changed the DEA outcome for Singaporean banks, making the comparison across studies more meaningful.

Table 1: Number of Sample Banks by Country, 1997-2003

Country	Year	No. of Banks
Bahrain	1997	8
Kuwait		5
Qatar		2
Singapore		14
United Arab Emirates		3
Total		32
Bahrain	1998	10
Kuwait		5
Qatar		4
Singapore		13
United Arab Emirates		10
Total		42
Bahrain	1999	9
Kuwait		6
Qatar		5
Singapore		12
United Arab Emirates		10
Total		42
Bahrain	2000	10
Kuwait		6
Qatar		5
Singapore		16
United Arab Emirates		12
Total		49
Bahrain	2001	8
Kuwait		6
Qatar		7
Singapore		12
United Arab Emirates		12
Total		45
Bahrain	2002	6
Kuwait		6
Qatar		6
Singapore		8
United Arab Emirates		12
Total		38
Bahrain	2003	4
Grand Total		252

Figure 1. Conventional Indicators of Bank Performance, 1997-2002



Source: BankScope

hypothesized above. Based on average overall indexes for 1997-2003, banks in

Table 2: Number of Efficient Sample Banks by Country and Year 1/

	1997	1998	1999	2000	2001	2002	2003
Bahrain	0	0 (1)	1	2	0 (1)	1	1 (2)
Kuwait	0	0	0	0	0	0	...
Qatar	0	0	0	0	0	1	...
United Arab Emirates	0	1	0	0	0	2	...
Singapore	1	1 (2)	2	0 (1)	3 (4)	4	...

1/ Number of banks with OTE = 1. Numbers in parentheses represent the number of banks with OTE > 0.9, if different from number of banks with OTE = 1.

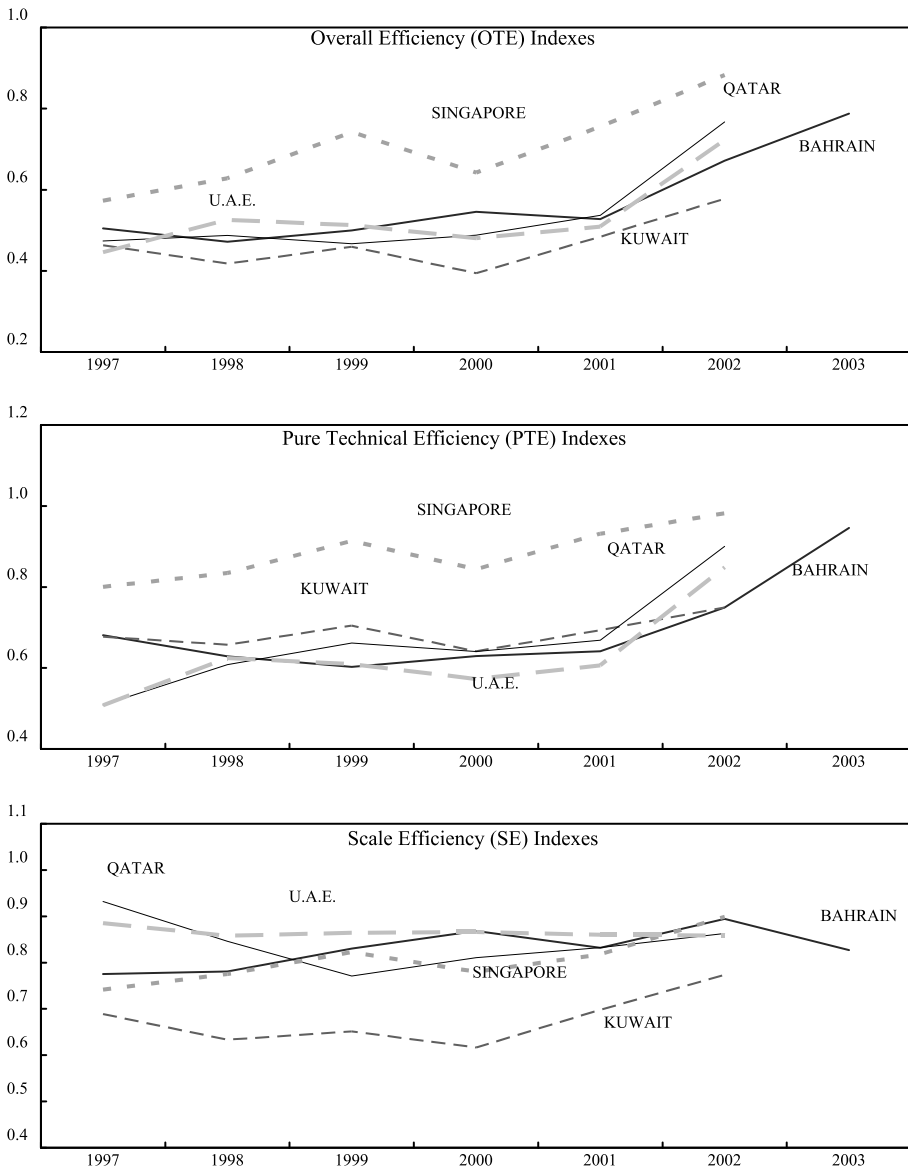
Bahrain could be 43 percent more cost effective (i.e., use less inputs to produce the same amount of output, as their most efficient counterparts). That number for (a shorter period of) 1997-2002 for the United Arab Emirates and Qatar are 47 and 46 percent, respectively.

Third, *relative performance* of sample banks by countries is not uniform across the efficiency measures (panels 2 and 3 of Figure 2). Even though banks in GCC countries appear to lag behind their Singaporean counterparts in terms of overall efficiency, the results for the United Arab Emirates, Bahrain, and Qatar appear to be at least as strong if measured by the SE index. Hence, the U.A.E. banks produce an average SE index of 0.87 for 1997-2002, while those in Singapore generate an average index of 0.81. The averages for Bahrain, Qatar, and Kuwait are equal to 0.83, 0.84, and 0.68, respectively.

Fourth, in terms of *absolute performance*, the inefficiencies seem to be largely caused by purely technical inefficiencies and to a lesser extent by scale inefficiencies (i.e., banks operating either on the increasing or decreasing returns to scale portion of their underlying production functions). The average SE index for the sample banks in Bahrain for 1997-2003 is 0.83, while the PTE index is equal to 0.70.

Fifth, at least when it comes to the PTE index, there is a trend improvement for all sample countries, reducing the main source of inefficiency. This is largely consistent with new across-the-board developments in the information technology area and of new banking instruments and products (since the trend holds for all countries in the region), but also possibly through country-specific policies and developments (such as larger marginal impacts of capital account and financial sector liberalization, since some countries, such as Qatar and the United Arab Emirates, register growth rates well in excess of those in

Figure 2. Cross Country Comparison of Efficiency Indexes, 1997-2003



Source: own calculations.

Singapore).

Table 3: Distribution of Efficiency Indexes by Types of Banks

		OTE	PTE	SE
Conventional Banks	Average	0.54	0.69	0.80
	Maximum	1.00	1.00	1.00
	Minimum	0.33	0.43	0.50
	St. Deviation	0.19	0.22	0.17
Islamic Banks	Average	0.57	0.61	0.91
	Maximum	1.00	1.00	1.00
	Minimum	0.30	0.37	0.57
	St. Deviation	0.27	0.24	0.14
	T-test 1/	0.11	-0.31	0.66

1/ Test for equal sample averages across conventional and Islamic banks.

Sixth, as indicated in Table 3, there appears to be no statistically significant difference between efficiency indicators for conventional and Islamic banks.

3.2 Robustness Tests

To check the robustness of the above results, a test on a sub-sample of Bahraini and Singaporean banks was performed. In addition to limiting the sample to only two countries, the number of inputs and outputs was reduced to two. These now include fixed assets and interest expenditures as inputs, and revenues and liquid assets as outputs.

The results plotted on Figure 3 provide a solid consistency check for the DEA results discussed earlier. The relative pattern between the average Singaporean and Bahraini banks is preserved, and so is the breakdown of the overall efficiency index between pure technical and scale efficiencies. However, the analysis also suggests that once loans are excluded as an output and personnel expenditures excluded as an input, the gap between efficiency indexes among the sample of Singaporean and Bahraini banks declines. Generally this could imply a combination of: (i) inefficiencies related to scope of operations/products (in this case, loans) or (ii) inefficiencies related to use of inputs (in this case, employment resources). Both of these could have policy implications for Bahrain as they are likely to be a result of: (i) relatively large share of nonperforming loans (and as a result low net loan amounts) as well as the relative unattractiveness of loans as products, or (ii) a combination of inefficient use of labor and high wages and benefits.¹¹

¹¹Unfortunately, the available data do not allow us to differentiate between the price

4 Conclusions

The linear programming technique and the results presented above provide a useful framework for analyzing Bahrains banking sector performance and its competitiveness in the regional context. Although the simulations suggest that Bahrain occupies a front-runner position among the sample GCC countries, they also reveal that: (i) as expected, banks in Bahrain still lag behind their Singaporean counterparts, and (ii) there is strong competition from other countries in the region. The paper also finds that in terms of scale efficiency, banks in Bahrain operate at the same level as banks in Singapore and their closest competitors in Qatar and the United Arab Emirates. The results appear to be robust with respect to changes in the sample size and model specifications.

Further analysis would be required to pinpoint the exact type of inefficiencies in the sector, by looking at, among other things, the product mix and scope inefficiencies present in the banking sector in Bahrain. It will also be useful from the policymakers perspective to look at the underlying sources of differences in performance among banks across countries, such as macroeconomic and prudential environments, size and concentration of the sector, banks ownership structure, and other institutional factors.¹² Follow-up studies should focus on the differences across these categories among GCC countries, Bahrains main competitors. Sustaining regional competitiveness would require continuous streamlining of regulatory restrictions, entry and exit rules, and collateral-related bureaucratic practices to limit their potential detrimental effect on banking efficiency. Optimal architecture of the banking sector would also require regional and international integration to guarantee transfers of new skills and technology through competitive pressures and the search for more profits.

and the quantity of inputs used (in this case labor), thus limiting our inferences about the efficiency of their use only to the overall value.

¹²See Grigorian and Manole (2006) for an application of this approach in the case of banks from 17 East European transition countries.

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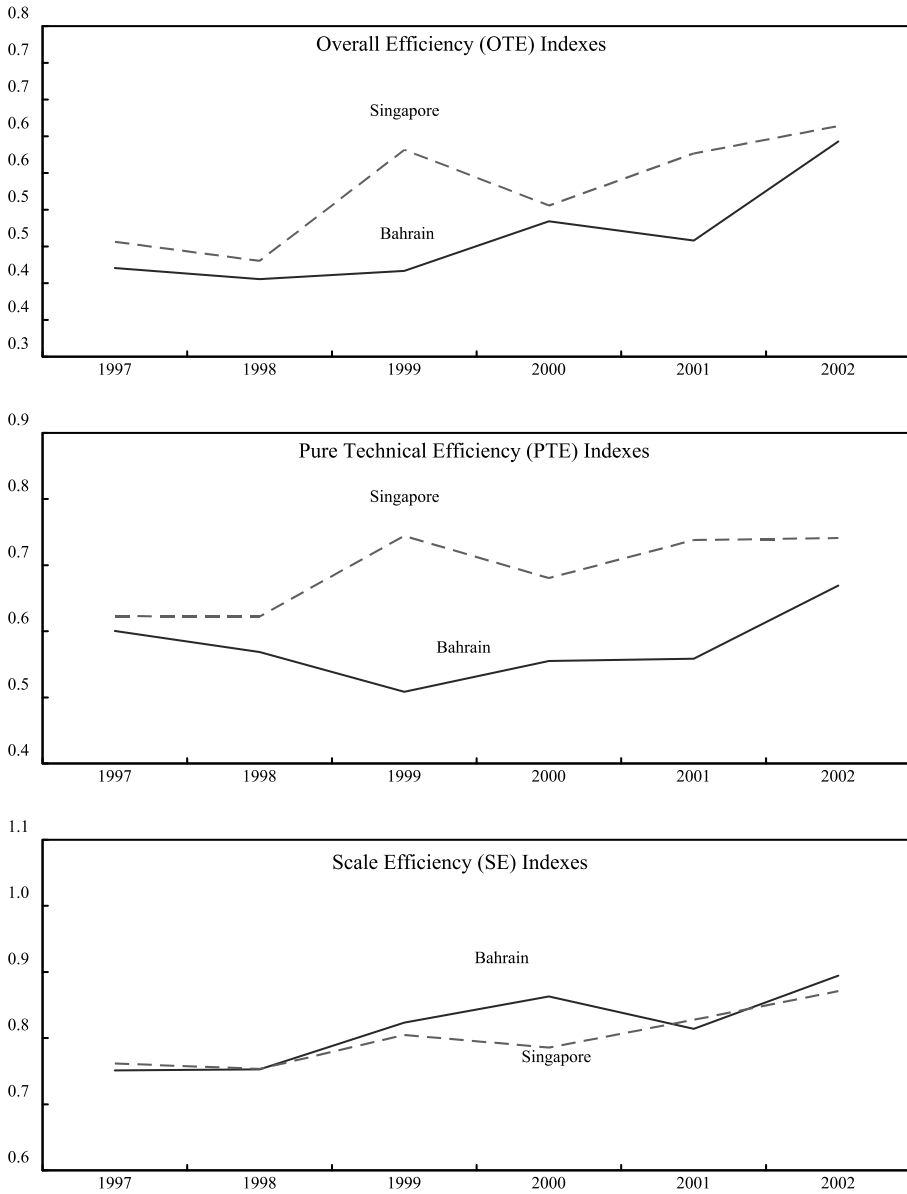
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Figure 3. A Robustness Test: Two-Input-Two-Output Case
(Sample includes banks in Bahrain and Singapore, 1997-2002)



Source: own calculations.



Constructivist Views of Cooperation along the Border

Attila Fábián

University of West Hungary

Faculty of Economics, Institute of International
and Regional and Economics, Sopron, Hungary

email: afabian@ktk.nyme.hu

Abstract. The present essay makes an attempt to examine the socio-cultural field with a constructivist approach, which gives an opportunity to interpret the concept of “border” in a discursive way. This approach emphasises the importance of the role of the ideas and values related to the creation and the development of cross-border regions. The essay places great emphasis on security and cultural communities that are necessary for cross-border cooperation and sustainable regionalism. According to constructivism, security means the communities are in a mutual multi-level connection and people try to avoid conflicts with dialogue, cooperation and socialization. A cultural community along a border is a community created by border societies whose members mutually influence each other. Because of these two aspects, a good neighbourly relation can develop along the border, which may have beneficial effects on the economy of the whole country.

1 Introduction

The notion of “border” has been defined by many people in many ways. In my opinion, border is a dimension of the cultural landscape. A border may influence the socio-economic picture of neighbouring areas, and has a psychological effect on the attitude of the population along the border; therefore it cannot be disregarded in the course of the examination of the origin and influences of

JEL Classification: R11

Key words and phrases: cross-border cooperation, constructivist approach, security communities, cultural communities

cultural exchanges. Borders affect the way of framing and accomplishing national policies, since their sheer existence affects the mental map and strategic views of political actors.

There have been clearly distinguishable periods in Hungarian border research until the evolution of the current system of research criteria. The first studies date back to 1988, when the document entitled “Regional and Settlement Development Problems of Regions in Special Situations” was published with the support of the National Midterm Research and Development Plan. This was the first work that paid remarkable attention to the specific characteristics of border regions (Enyedi 1988), (Erdősi 1988), (Kovács, T. 1988). In the same year, János Rechnitzer discussed the connection system of border regions for the first time (Rechnitzer, J. 1988). International cooperative investigation of the Hungarian border regions started in the early 1990s, first on the Austro-Hungarian border (Seger, M., Beluszky, P. 1993). Ten years later, József Nemes-Nagy defined four functions of this specific area: *separating module*, *filter zone*, *edge and buffer zone* and a *contact, confrontation and interference zone* (Nemes Nagy 1998). This new classification pointed out that growing attention needs to be paid not only to the description of connections and the exploitation of technical cooperation but to the diffuse processes and social, economic and socio-cultural analyses as well.

The results of the following decades research are synthesized by László Kürti (2006). In his opinion, problems of 20th-century territoriality include not only artificially drawn nation state borders but also the territorial expansion of national and ethnic-regional areas or border cultures which penetrate into and through these borders. In his recently published work, Béla Baranyi points out a paradigm shift in cross-border connections. The so-called “mini Euro-regional” cooperation, based on the cooperation between subregions and between towns, gains importance in terms of developing together (Baranyi, 2009).

Naturally, it is not only in Hungary that border research stands in the centre of scientific interest. In international specialised literature, the approaches of scientists of political geography (e.g., Prescott 1987, Agnew 1994, Foucher 2009), cultural anthropology (e.g., Donnan and Wilson 1999) and international relations (e.g., Albert 1998) deserve special attention. Region-building across borders, however, is a process that started only a little longer than a decade ago and was subjected to thorough research, for example in the case of North American borders (Blatter 2001, 2004, Perkmann 2003) and internal European borders (Anderson et al. 2003).

Besides these approaches, I think, the implementation of the socio-cultural

approach and deep study are necessary in those border areas which are increasingly sensitive and vulnerable in a social sense. After its accession to the EU, Hungary concentrated mainly on infrastructural developments and achieved success in that field, while sustainable social cooperation proved to be less effective. The motivating effect of joint tenders weakened after the grants was used up, while fragmentation remained. The future of the implemented projects depends mainly on the evolution of a common social capital of people living on both sides of the border. This can be regarded as a socialisation and cultural process based on trust and security. Therefore, in my work I attempt to examine the areas along the border in a constructivist approach.

In Section 2 I discuss about the importance of the conflicts fields in cross-border regions, with the examination of security communities which will define the new type of societies. I emphasize that the cooperation is not created only along by rational economic needs, but can also be defined by cultural heritage. In Section 3 I focus on the importance of cultural communities. In Section 4 I examine the question of how the constructivist theory can be integrated in the regional paradigm. In Section 5 I conclude.

2 Conflict Areas along Borders

Obviously, during the examination of the origin of cross-border region building the historical background of the given borderland needs to be taken into consideration. Attention needs to be paid to the fact that “border” has a different meaning for those people who got to know the notion during their historical studies but have never lived in a borderland and for those for whom actual local, social movements and local intercultural practices are part of everyday life”, says Zoltán Ilyés in his example of the “thousand-year-old border” (Ilyés 2004).

The postmodern or, to put it more precisely, constructivist approach has characterised the mainstream literature of the cross-border cooperation and the way cross-border regions were institutionalised for decades. Constructivism offers suitable tools to reveal historical layers and reinterpret the changes of East European borders. In addition, the constructivist reading of border regions gives the possibility to interpret the semiotics of the border which forms the mutual concepts of “me” and “the other” in an anthropological, discursive way (Newman and Paasi 1998). These mental maps, which are, in fact, the representations of common geopolitical concepts, strengthen outwardly oriented communities in those areas where an artificial border divides an oth-

erwise homogenous ethnic and language group. These maps can also isolate the “closed communities” from their neighbours. Similar phenomena can be seen in those cases, where persistent diplomatic tensions permanently inhibit local initiatives aimed at cross-border cooperation.

Constructivist approaches emphasise the important role of ideas and (European) values in the creation and development of cross-border regions, and, as a consequence, researchers underline that the aim of region building is to “terminate borders” and they point out subsequent re-territorialisation, which is a characteristic feature of borders within the EU/the Schengen area (Turnock 2002). New concepts for example, “de-territorialisation” (Newman and Paasi 1998) and “de-bordering” (Blatter 2001) have been worked out to describe those multi-dimensional forces which are thought to obscure European borders as a consequence of the enlargement of the EU. The latest research projects that deal with the characteristics and changes of the outer (more specifically, Eastern) borders of the EU attempt to augment the efforts made to work out theories with interdisciplinary and cross-national perspectives.¹

I share the view of constructivist researchers of international relations according to which borders influence the structure of identity, since border regions are areas where the unique customs and efforts of two or more neighbouring yet different cultures meet. Naturally, constructivism does not aim at exclusiveness; when posing questions as a part of research, one must remain on the ground of reality. Moreover, a key message of the postmodern view which represents the whole era is that there is no exclusive method which leads to the truth. In other words, there is methodological pluralism.

Constructivism is hence insufficient for interpreting the processes in border regions, since in these areas a pragmatic, realistic way of thinking characterises foreign policies, and cross-border cooperation is examined with adequate circumspection, usually laying stress upon security or the maximisation of benefits, that is, without philosophical conceptions directed simply at building up identity. Through constructivism, social interest and ideational factors ideas, norms and values are upgraded, while the materialistic (production) abilities and the importance of external interests decrease. The constructivist approach, when examining cross-border cooperations, undertakes the examination of se-

¹See e.g. the following trans-national projects: EXLINEA, whose topic is “Borderlines, which Serve for Exclusion, as the Battlefields of Cooperation: The transformation of the outer Borders of Europe Politics, Practices and Perceptions” (<http://exlinea.ctc.ee/>), EUDimensions, whose topic is: “The Dimension of a wider European neighbourhood: The Establishment of a Political Community with the help of Cross-Border Cooperation and Discussions” (<http://www.eudimensions.eu/>).

curity communities (Archarya 2001). According to constructivism, if there is no war and there is a reliable social atmosphere in security communities, then it is due not only to the fact that the power is distributed with regards to foreign policy relations, but also and primarily to the fact that the communities have mutual multi-level connections, including building up identities, socialisation, etc. In security communities it is demonstrable that the conflict avoiding attitude is based on dialogue, cooperation, socialisation, norm definition and building up identities, rather than on forces outside these processes (e.g. the distribution of power). The connection between norms and constructivism is interesting inasmuch as norms offer ways and methods not only with regard to the regulation of the behaviour of the state but also in terms of redefining national interest and developing collective identities. Through them, a switch from “regulating” to “redefining” becomes possible. In fact, a typical factor of this is the creation of new habits, which means more than simply assuming a legal obligation to realize something in order to avoid a power which is able to exert force.

It follows that constructivism can heavily rely on the message of those articles by Deutsch which claim that security communities need a certain extent of loyalty to each other, in other words, a share from the common identity (Deutsch 1968). The latter concept includes the emergence of the feeling of “this is us” and those processes which encourage and enhance the experience of belonging to a community. If this feeling arises, security community will become a social habit. To sum up, a new social identity is being created along the borders right now. Consequently, it can be hoped that there evolves a security community which makes an effort to solve problems in foreign and domestic politics in a constructive way. Due to security communities, regional cohesion becomes a long lasting and standing communal value which is based on mutual adaptation and trust. The constructivist approach to regional integration is therefore much more comprehensive than the rational approaches.

In the last decade, numerous case studies were published on cross-border cooperation and Euro-regions. There are interpretations which state that on these borders the revival of personal relations, the establishment of new horizontal networks of the cooperation and the multiplication of the number of participants who take part in cross-border partnerships lead to “re-interpretation” and “crossing” the borders after the cold war, which changes the whole regional geopolitics of wider Europe.

East of Schengen, however, no one believes that borders have lost their importance. Russian researchers prefer interpreting borders as dividing lines which can become places of conflict between the former Soviet neighbours, or

as lines which serve to “keep” the given country “away” from the EU (Malfliet et al. 2007).

Although in the process of building a cross-border region the dimension of historical remembrance may exist, the documents about the establishment of the Euro-region emphasise instrumental tasks. Hence the identity-creating dimension of the establishment of the Euro-region is subordinated to other, more pragmatic aims such as infrastructural developments whose sustainability is sometimes questionable. This statement conveys that instead of the “founding myths of the Euro-regions”, aimed at giving a symbolic meaning to Euro-regions, it is the actual practice of cross-border cooperation (as observed in the Euro-regions) that must be focussed on.

3 The Importance of Cultural Communities

Borderlands are not only economic geographical areas but also security communities, scenes of social contacts perceived by individuals where conflicts arise and where different cultures are in contact without losing their traditions and characteristic features. It is also true that this interaction may affect social preferences as well. Borders (wherever they may be) are places where different cultures which do not intend to give up their specificness engage in interaction. Thus “contact zone” can be interpreted as a place where the linguistic, personal and cultural interactions of two adjacent language areas or cultural areas are extremely strong (Keményfi 1994) and cannot be divided into sharply separated units (Barth 1996).

Postmodern anthropologists describe borderlands as temporary zones of uprooting and de-territorialisation which form the identity of people living there (Gupta and Ferguson 1992). The most easily observable interaction is crossing the border, which is a standardised, regulated activity perceptible in the customary patterns of neighbouring societies and states. Due to the numerous rituals connected with border-crossing, anthropologists think that a border is the contact place between symbols and politics which catalyzes the inner paradox of border. In the contact area of “we” and “the other person”, it can be observed how cross-border cooperation leads to the changing of values connected with identity in the case of those who cross the border physically and thus “terminate” the border (Donnan and Wilson 1999). Among those people who regularly cross borders, there are commuters, public servants, tourists, students and shopping tourists. They are deliverers of two-way cultural changes, since they deliver certain consumer goods and cognitive patterns parts of

the cultural landscape of one country to the other. The exhaustive technical literature on cross-border consumption confirms that border crossing changes the value and meaning of goods. Since every border plays an important role in production, trade and consumption, borders themselves become marketable goods: consumer goods which must be wrapped or shown in a way which ensures that they are able to maintain other economic processes and present a positive image of those concepts of the given country's life which serve as a gate to a country itself (Donnan and Wilson 1999).

The homogenisation of consumer habits and fashion trends, the export of eating habits or tastes in music and the spreading of information are just a few examples for the cultural influence exercised by border crossers. Furthermore, on another level, business culture and the behaviour norms of service activities are transmitted from one country to the neighbouring area via cross-border cooperation.

An example for this phenomenon is Europeanization, by which I mean the dynamic and continuous process of cross-border influences on a material and intellectual level which help European formal rules and common cultural values reach societies outside the EU. A wider interpretation allows for the examination of the institutional/functional dimension of Europeanization – the way the *acquis communautaire* is transposed into the legislation of a non-EU country, and the way it is strengthened in local civic culture through public policy which respects the guidance of Brussels. Secondly, Europeanization includes the less tangible dimensions of external influence of the EU, that is, the transmission and incorporation of (Western) European or EU values into non-European or “less” European cultural outer areas, which finally lead to a pro-Europe attitude to foreign policy.

The cultural landscape of border regions surpasses the political one (Anderson et al. 2003). The outer borders develop their own culture which is mainly formed by regionalisation. This refers to the changing effect of dynamic borders, which in favourable conditions can become a driving force in the evolution of nations and states. Presently, it is seen that most local actors try to make use of the opportunities offered by multilateral cross-border cooperation in a committed way and in a spirit of good neighbourly relations

If these processes are examined through the lens of constructivism, the border can be interpreted as an institution created by society through which people living in border regions mutually influence each other and which affects the self-perception of people living there (in terms of identity, values and interests.) The basis of personal relationships, cross-border cooperation and cultural interactions which characterise borderlands is the feeling that

good neighbourly relations are necessary and beneficial for the economy of the whole country. These intercultural relations build new feelings of belonging to somewhere where people living along the border make themselves mutually at home. The feeling of “we” starts to develop among the population along the border.

Borders are formed not only by a states security policy, controlling policy and image building. Borders are created in films, novels, memorials and public events (Newman and Paasi 1998), that is, in everyday cultural life which informs researchers dealing with borders about the relative permeability and real (social) cognitive-imaginative situation of borders. The social construction of border can be affected by the new meanings and truths about borders created by historiography, journalism and cinema

With the help of varied and widespread communication tools, discussions and images about the border change the attitudes of the borderlands population towards their neighbours. These discussions and images hybridize the collective ideas of border communities about their border. Thus a different identity of border communities develops which does not necessarily match the habits and mentality of people living in the “centres” (Budapest, Vienna or Brussels.) This differentiation is beneficial inasmuch as they contribute to colourful, culturally many-folded and rich international relations; however, “rural” mentality may cause conflicts as well.

Thus the interactions among the inhabitants of the border area may change peoples social expectations towards central political decisions makers, more specifically, make people more critical towards decision makers. In this sense, the cross-border “diplomatic” behaviour of border regions can filter through from border regions to the central power organisations; and the bottom-up effect of these local economic and social relations have a favourable influence on the nature of interstate relations. In other words, cross-border cooperation and interaction strengthen as Robert Frost says in his poem “Mending Wall” the “good fences” of good neighbourly relations, The population along the border looks after the border collectively and in doing so they force the central governments of the two states to work out more cooperative policies and more integrated frameworks (Frost R. 1914).

The “multiple personality” of the population living along the border implies that a strategy aiming at multiple identities will be developed. This motivates cross-border projects, and involves sub-state participants into the bilateral game with central authorities and external partners. Cross-border cooperation enables local leaders to establish para-diplomatic networks and thus influence central decision makers. Living along the borders enables local authorities to

build so to say a moral border between themselves and the will of the state by involving European norms and behaviour principles connected to identity.

4 The Dilemma of Regionalism

Cross-border cooperation is getting stronger between neighbouring areas which formerly were alienated from each other. This fact unambiguously contravenes Jean Gottmann's statement made three decades ago, namely that "history proves that the political borders drawn on geographical grounds have always been and remained the sources of tensions and conflicts" (Gottmann 1980, cited by Newman and Paasi 1998). Political geographers Newman and Paasi corroborate the relevance of the constructivist approach; they are convinced that postmodern and constructivist schools offer suitable tools for the examination of today's borders. They agree with Gottman on the fact that borders play a central role yet regard them as places of cross-border innovations (interaction and socialisation) rather than as conflict zones.

The sovereignty of the state in a conventional sense is ending because of the multiplication of transnational processes which eliminate borders from the equation of territory, identity and sovereignty. The EU and the local executors of cross-border cooperation also take part in the changing of borders; consequently, there evolve places of interaction where regionalisation meets regionalism, that is intention meets the society characterised by a common identity. However, the borderland is not only the model of a conflict-free contact zone but the generator of growth, a trade bridge and a transit corridor as well, because the border itself was attributed a high priority during the distribution of EU funds in the last decade.

The lesson drawn is that regionalism and regulation are equally necessary for cross-border cooperation, so national and international rules are essential. Cross-border cooperation sustains regionalism instead of ending it. However, one peculiarity must be mentioned. In terms of social action, cross-border interactions eliminate regional borders and change the borders of cultural identity. For the communities living along the border, the proximity of a border is a factor which, in a certain sense, re-territorialises regional identity, moving it away from the centre, and re-orientates local interests toward the outer world.

Regional integration (in our case, cross-border integration) affects the stabilisation of democracy and every field of social life of the neighbouring countries. A basis of future research can be the assumption that the constructivist approach is relevant and more suitable than the rationalist approach. The

question is whether it is an “absolute requirement” for the explanation of regional integration. In accordance with the feeling of “this is us” in security communities and with the process of interactions among people, the approach which can give a trans-national explanation for regionalism will most probably coordinate ideational factors.

In my opinion, a productive process is a dynamic process of adaptation characterised by socio-cultural feedback rather than a static model of an economic mainstream related to financial capacities and based on the perspectives of rational choices.

From a constructivist approach, the cross-border integration process seems to be a field which can be further analyzed. The innovative cooperation of researchers from Győr, Pécs and Sopron offers an excellent opportunity to research this issue; the cooperation may reveal the conflicts of Croatian-Slovenian-Austrian borderlands and may find the possibilities for building up constructive security communities. The theoretical-methodical conclusions of this research could be utilised in the future for analysing the integration processes of other borderlands as well. In my opinion, the shared development of “borderless” social capital could give a new dynamism to the region of the Carpathian Basin. The experience of the series of lectures entitled “The Regions of the Carpathian Basin Introduce Themselves” organised by the Free University of Regional Development of Sopron supports this demand unambiguously.

The performance of this task involves the evaluation of vulnerable points or points which can be criticised and the elimination of deficiencies. Naturally, there are several factors of uncertainty which need to be taken account, such as:

- conventional methods of examining international relations,
- the rational approach to the regional interpretation process,
- the methodology itself, because it is not yet a fully developed holistic method but an approach whose research methodology is still to be elaborated.

5 Conclusions

The 21st century has seen the rise of social tension and the lack of constructive co-thinking in communities living along state borders. At the same time, in developed national economies, creativity, innovation and cooperation based on trust are the main drivers of value production and social change. Therefore, a way must be found to project these favourable processes to border regions

in terms of society, economy and politics and, on this basis, generates societies that extend over national frameworks and have a developing network-like structure.

Consequently, short-term and profit-oriented integration that involves the formal elimination of borders and brings but temporary results will not suffice a multidisciplinary approach is needed that includes fine-tuned socio-cultural drawing closer to each other.

Rationalist simplifications support the centralist integration practice of the state and result in social isolation. Integration remains but a formal tool to protect national interests on the international stage. Albeit political rationalism contributes to the conclusion of certain agreements and/or the introduction of cooperative systems, profit-orientation and a relative lack of trust resulting from competition remain. The sense of community, the feeling of this is us” is moving into the background.

With regard to regional integration, rationalists emphasise the importance of power structure, which, at the same time, is an economic force that affects the short-term competitiveness of border regions. In my study, I point out the opposite: that it is not power-based competition but constructive cooperation that may generate sustainable and long-term social and economic profit.

Thus, economic co-dependence and competitiveness has only short-time effects, while in the long run results in conflict and a defensive, marginalised and passive role. A long-term strategy that prioritises common interests and, above all, common values, may create security communities where conflicts are resolved and an efficient co-development starts. Consequently,

- the integration of border regions is not only of economic nature but of political, social and cultural nature at the same time;
- the communities of border regions where transnational civil society is rooted promote the convergence of values;
- economic and competition-related advantages are easier to be created with the constructive and cooperative utilisation of resources;
- economic success depends on the cooperative ability of the societies in border regions and is based on a strong trust capital or trust communities;
- demand for cooperation is rational and constructive at the same time;
- value production does not exclude maintaining the value of social capital.

In my opinion, the multifunctional “laboratories” of border regions also entail an opportunity for national and supranational building.

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Evaluation and Measurement in Local Public administration

Marianna Dobó
Eszterházy Károly College,
Department of Political Sciences
email: domar@ektf.hu

Abstract. The judgement of self-governmental operation and the evaluation of providing public services have been focused on since the democratic transformation. By the 1st of January 2012 (CXCIX/2011. and CLXXXIX/2011. law) amendment of the Hungarian on civil servants, the civil servants work performance evaluation system has been introduced with the consideration of the principles of the civil servants carrier programme. The purposes of this evaluation system are made in order to grow the workers management efficiency in the field of public service, and also to improve their work standards.

1 Introduction

In Hungary, modern bureaucracy began to develop on central and local levels in the democratic transformation period. The establishment of local governments, which has been declared by different laws for twenty years by the Legislative, was connected to state development. This division of tasks and labour meant the fundamental of local administration and contributed to the new type of local society organization. In addition, it is very important to mention that the tightening scope of public services, which are provided directly by the state, had a favourable impact on the development of local governments. As a result of this more and more occurred tasks; these were transferred to the local governance during the emerging division of labour. At the same time

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local governments keep referring to their tightened financial scope for action that is a barrier to governance.

"Local governments can be characterized by considerable traditions in Hungary - although noble counties as the traditional elements of public administration had a much narrower scope for action". (Böhm 1998). Local self-government enables that constituent local communities can manage their local matters independently and democratically through local governments. Self-government, which is thought as the synonym of autonomy, played a key-role in the development of a democratic political system. The main characteristic principle of local governments, subsidiarity - local tasks have to be handled at local level - is not yet enough. (Kákai 2008) This is also proved by the fact that people as citizens get into contact especially with local governments from the governmental levels and there is an opportunity for direct representation of interests and citizen participation.

The success of self-governmental system can be ensured by its stability demands and ability to change. This can be established by the right management of decision-making process. The judgement of self-governmental operation and the evaluation of providing public services have been focused on since the democratic transformation. By the 1st January 2012 (CXCIX/2011. and CLXXXIX/2011. law) amendment of the Hungarian on civil servants, the civil servants work performance evaluation system has been introduced with the consideration of the principles of the civil servants carrier programme. The purposes of this evaluation system are made in order to grow the workers management efficiency in the field of public service, and also to improve their work standards.

Range of Subjects:

- a.) Evaluation aspects: who evaluates whom, what, when and why? How far is evaluation widespread in practice? Has it got separable models?
- b.) What is the motivation in the establishment of a performance increasing method - does this method focus on pre-decision and/or execution? To what extent can its effects be measured?
- c.) Can this method be adapted to increase the representatives' efficiency and their formation?

The study consists of two parts. Initially, I examine the legal background, which basically determines the regulations. Everyone gave the same complex answers to the important questions; who, when why. The difference is due

to the fact that shows the filled requirements with different content, as the leaders of the settlements implemented them. In the second parts I analyse the changes in Hungary, the latest, the 2011 Act, the creation and of districts and the consequences of it.

The altering construction, result of the changing laws modifies the work and the evaluation methods of office systems. The characteristic feature of the administrative reform is to develop a complete system comprehension. They want to change in order to create a modern public administration, which is able to respond to changes, and serve the society effectively. The preparation of these administrative reforms has its laws, however, the materialization come about in practice, at the level of individual municipalities.

My study differs from previous studies. This one gives the decision theory aspect of the administrative reforms by case studies. For the analysis I have studied the decision-making process of local government of Heves. I have also observed the division of labour among public officials and politicians as well as the strategic process.

In this thesis, I introduce the methods of performance measurement and evaluation and their impacts at local governments in Hungary - explicitly in Heves County, North-Hungary - relying on document analysis and interviews. Preparing this study, I examined the organizational and operational regulations, as well as the regulations and decisions that deal with the principles of assessment. I also attended the board meetings where the public officials gave summary account.

These observations and the available papers will help me to write further case studies (transformation of public administration, strategic planning processes, etc.), and also a policy and comparative analysis (education policy, youth policy, economic policy, local local governments and the role these public officials, etc.).

Making workers at the organizations comes up to expectations what can be achieved by different methods. Regulation tasks ensure the actual and expected behaviour that meet each other as best as possible. The regulation has to serve two things: the norms (standards have to be given and requirements must be defined); motivation and pressure must be raised so that workers will follow the example. The performance measurement, and evaluation in the case of local governments create motivational situations but it can be also demoralizing at the same time.

2 Laws concerning performance measurement and goals of the evaluation

The exercise of local governments - public services have got concrete products in their internal and external services - can be measured. The local government performance and decision-making can be defined after the operationalization of concepts. The performance is determined by three points of view: economy, effectiveness and efficiency. Tamás M. Horváth has distinguished four content elements of performance dimension: economy, effectiveness, efficiency and quality. (M. Horváth 2005) He emphasizes to make the difference between concepts because the exercise of local governments can only be interpreted correctly in this way. Steve Rogers wrote about performance management of local governments and separated two applied models. (Rogers 1990) One common point of them is that performance is not connected to only one exercise but it is always a common characteristic of more different type of exercises or functions. Thus, it can be rather regarded as an organisational performance measurement.

Performance indicators and standards are distinguished in the models. The performance indicators are regarded as pre-determined characteristics according to which performance is measured - in one of the models they are presented, while in the other model they do not appear. The performance standards are the measures that if they are achieved, we can ascertain of goal access. In the simple model efficiency lies in the centre and it focuses on citizens. Needs can be regarded as opportunities because they are the factors which form the market. At the evaluation of the effects the subjects of investigation can be the changing needs, the results of activities or citizens opinions. In the complex model decision-making is weaved through complementary services which favourable or negative effects - if there is no complementary service - causes the appearance of a need for resources. These two models above provide performance measurement opportunities in practice while general normative model can be used in theory. In the latter case measures, criteria and output indicators are linear and well-separable. Steve Rogers considers this model, which characterization of measures and effects one by one becomes both exclusive and important in the control, as well as in the in-theory evaluation (Rogers 1990). He uses different market tests, which human resources are also investigated with, for economy measurement. In the study of effectiveness average unit costs and productivity rates are applied. This type of effectiveness analysis that connects the input and output sides, provides comparative analysis

at two alternative indicators. Goal achievements in efficiency are examined through public opinion researches.

The role of performance evaluation does not have to be over-dimensioned but the lack of performance evaluation leads to such situations where control is completely eliminated from decision-making and implementation process. In addition, decisions have to be made when potential effects cannot be predicted and tasks cannot be solved.

The steps and methods of measurement are not easy to set up. In the United States of America, organizations make performance evaluation and flow charts; such methods as connect to them the local governments. (Based on the authors data gathering, performance measurement in Burlington - NC, USA, 2004). In parallel with the decision making process, the important fields of effects with criteria of success begin to be determined, then the selection of performance indicators based on experts opinions starts. Identification of the current situation and attainable serve purpose change help the designation of objectives. After data consideration, information appears in the labour process that is examined and the evaluation of the effects comes at last. In the evaluation, attention is called to the fact and suggestions cannot be made only with the help of objective indicators, but evaluation of subjective elements are also important, thus outsider and top-controlled characteristics of the decision-making can be prevented and decisions can be transmitted to the local society more easily.

Measurement is an integral component of any drive to improve productivity. Measurement of service performance is notoriously difficult but possible. Local authorities form a significant part of the service sector. Performance measurement in a local authority is a complex task because local authorities offer a wide range of services with both tangible and intangible outputs; customers rarely pay an economical price for the services; there is no profit measure and there is no apparent direct link between services and the cost to the electorate (Gobbadyan and Ashorth 1999).

The controlling character sums up comprehensively if the local government works effectively and efficiently. It is not a task composed of one action but it means a compound, complex task. After the acceptance of the decision proposal, the evaluation covers the examination of the whole process and its effects. The ideal period for this kind of decision revision is budgeting. The purpose of performance control is offering different public services is the investigation of the realization of the three Es - economy, effectiveness and efficiency - , the assurance of economical public funds use and the assertion of "value for money" principle (Palmer 1993).

“The Economy - the terms and conditions under which an organization acquires human and material resources, an economic organization acquires these resources in appropriate quantity and quality and at least cost. The Efficiency - the relationship between the goods and services produced and the resources used to produce them, an efficient organization produces the maximum output for any given set of resource inputs, or minimizes the inputs necessary to produce given the quality and quantity of outputs. The Effectiveness - the extent to which the defined task or work programme has been accomplished in relation to overall aims.” (Palmer 1993)

Regulation that is often identified with the so-called regulatory system is an inherent part of the management system. The regulation influences the whole management, thus it is not a single mechanism but it appears in different fields of cooperation. The regulation has got several principles; one of the most important principles is the (external and internal) system of written legal norms.

The basic dilemma of regulation is the ratio and the role of manipulation also what the constraining should be; because the nature of legal norms is enforcement. In addition, it is not insignificant what should be regulated. Different goals can be achieved if the regulation is substantially or detailed, it investigated in the past, the present or the future, it concentrates on the process or the results, and it handles every occurrence equally or examines only exceptional cases. The essence of effective regulation is that the demanded effect is obtained with the smallest intervention and restriction while auto-guided processes are given ground.

Johnsen has proposed a set of ideal indicators, which need to satisfy the following criteria: consistency, comparability, clarity, controllability, contingency, relevance and feasibility. He takes the criteria of relevance as the most important. Many applications require specific relevant to special needs conditions (Johnsen 2005).

In Hungary several laws and government decrees have been passed since the democratic transformation, in order to performance evaluation in the public sphere could adopt the European norms. The law on civil servants (Law no. 23/1992 and 36/2001) have been published in 1992, in 2001 and in 2011 a law was passed on workers legal relations in the public administration (Law 72/2006). In 2006 the amendment about performance evaluation has affected many areas: decisions on salary payments must be made with the evaluation of civil servants professional work; it reversed the regulation that says the rules of performance measurement do not have to be used if the civil servants job turnaround does not exceed six months in the actual year. Out of turn

qualification is prescribed if it is presumable that the civil servant does not fulfil or just fulfil to a small degree at low level (Law 72/2006, Act 34, Section B). With another legislation (Law 121/2006, Law CLXXXIX/2011) in 2006 performance measurement rules have been extended over executive officers and counsellors. This law established the legal basis of the new performance measurement system. The law was wanted to be strengthened by a government decree (Government decree 301/2006 (XII. 23.) which is also about the rules of rewarding.

It is always difficult to fulfil the legislative change. The new and the old rules insertion cause interpretation problems, not the following of the changes. This is particularly true if the earlier system of rules will be replaced by a new law, which in practice is not evolved yet.

The Government Personnel Strategy was created, which affects the careers goals and directions.

The civil service still needs the specialty of the public policy; administration and public management, - these are the starting points of the agenda.

The purposes of the implementation of performance evaluation are that requirements need to be determined and executives are constrained to revise job descriptions and other organizational documents regularly. The performance evaluation helps to motivate civil servants and rewards individual efforts as well as the professional work in order to develop the workers abilities in the interests of organizational achievements.

The performance evaluation owns a compulsory evaluation aspects, and principles that are written in the Law on civil servants means the qualification of the civil servants right and the employers commitment. The evaluation of professional performance and the measurement of performance influential knowledge, and also the abilities, and characteristics as well as the professional progress are made in the first place. The civil servants performance evaluation must be done within every four years, it is also compulsory when they are ranked above. The legal consequence is the acceleration or retardation of their progress.

The performance evaluation can be divided into phases: as the first step the qualification system is prepared, an aspect system is set and outlined to the civil servants. The document has to be given to the valuated person after the evaluation, who can complain the text and the preparation circumstances then. Besides interest representation, the organizations have commenting rights or the evaluation can be contested in court, because of incorrect or untrue statements that violate private rights.

To completely revise and change local and internal rule systems of each local

government - which would mean their total rethinking in practice - is unnecessary and almost impossible. The important approach occurs maybe if the most necessary changes are implemented. The need for rule changing has to be sought along new elements in the whole rule system. The implementation and systemic character of the conceptionally rethought regulation means primary importance during the formation of performance evaluation.

Activity regulation and organization of local governments meant the prescription of internal and external legal norms (rights, commitments, responsibilities and sanctions) which institutionalize the operational system, and accidentally make it enforceable. Major purposes are laid in this system. The body of representatives decides on them and they are always connected to the operation and economy of the local government or administrative cases. The purposes are usually decided upon the following fields; the programme of local government session, the annual program of the body of representatives, the rules of organization and operation, the settlement development conception, the development strategy of public services, and also the task plans that connected to it. Besides it can be influenced by the examination of local cooperation opportunities or determinations of the National Audit Office.

Law number CLXXXIX/2011 includes the civil servant's works capacity is rated in a writing assessment by the employer. Performance evaluations have compulsory and recommended parts.

At least four performance evaluations compose the qualification result of the civil servants. It is necessary to consider in each year. The Ministry of Public Administration and Justice release a methodological recommendation to support the evaluations process.

Taking into consideration the sentences above, since March 1, 2012, the employer has been continues to make the performance evaluation of a pre-defined performance requirement.

The focus of evaluation method can be summed up in five questions: who, whom, when, why and how evaluate?

WHO? - The evaluator is in most cases the direct superior of the evaluated person or he is the subordinate or the more superior worker in some cases. If it is exist, the evaluator is the human resource organization. In Hungary the evaluation right is in the employers authority, it is also relevant to local governments.

WHOM? - Every civil servants are evaluated by determining rotation and in appointed time. The evaluation of certain groups or occasional communities can affect the work positively. In more local governments, that type of evaluation promotes performance better than the individual evaluation, because of

the stimulating effect of workers comparison that may motivate the individuals performance. The only occurring venture - which must be avoidable - are the emerging conflicts and their resolution.

WHAT? - The most accurate information about the evaluation aspect system is the most visible requirement before the evaluation. The evaluation gets several substances in its centre such as the individual opinion about the objective; the public servants level of cooperation and knowledge; his or her responsibility besides the conflict management skills, as well as the professional experience and motivation. It is also essential that possible future opportunities and developments relates to these conclusions.

WHEN? - Examinations in every four years are too rare to be effective. It can be the base of personal decisions related to the case of more negative results condemnation and/or exemption may come. This question is the significance of evaluation in many times.

HOW? - Two types of methods are used; on the one hand, the affected people are evaluated separately, in the other hand, groups are usually evaluated (according to its advantage, the better and the worse performers can be identified in the group, too). The evaluation is based on actual data (these may be more objective) and opinions (subjective factor). In 2001 György Hajnal established two methodological approaches; measuring - evaluating and developing and, in addition the supporting. The data of evaluations are given in terms of numbers and the reward or punishment are issued by their values. Sometimes the objective data show less information, what can cause serious stress both the executive and the evaluated persons, therefore this means the disadvantages of that method. It can lead to alienation or causes lack of motivation. In the developing - supporting method, the stress defines the communication between the evaluator and the evaluated persons. Discussion of problems and the methods can help enhance the work performance. There are several disadvantages such as the lack of objective data that can show the necessary staff decisions. The mixture of the two methods exists in practice. However, they cannot be mixed with each other to any length because Hajnal showed the case of huge consequences honesty in communication falls.

3 The experiences of the performance measurement system at local governments in Heves county (case study)

The group evaluation was rarely applied at the local governments; instead of this method, individuals were evaluated one by one strictly according to the specific legal framework. Evaluators aspired to objectivity; however, sometimes it was ostensible. Most of the civil servants performed well or excellently and nobody failed the exam in that period which was found unfair by a lot of affected workers. The performance evaluation happens in the following way at examined local governments:

- At the local governments, the body of representatives decides on priority goals which will be the base of performance requirements (Law on civil servants, Article 34, Section 3)
- According to the goals that are appointed by the local government and the civil servant's job descriptions the public notary on his/her employers authority - as the Hungarian practice, the public notarys employer the mayor itself - determines the performance requirements needed for the evaluation of civil servant's work performance in a written document every year in forward. (Law on civil servants, Article 34 (1), (4), (5), (6))
- With the consideration of the primary goals and job descriptions, the employer evaluates the civil servant's work performance in a written annually by acting in his/her discretionary jurisdiction. The notary's performance is evaluated by the mayor who informs the body of representatives of the evaluation. (Law on civil servants, Article 34 (1), (4) and (6))
- The goal of performance evaluation is to raise the level of civil servants' professional work; civil servants work in accordance with the intentions of the local government and in conformity with the actual administrative requirements.
- On the one hand the performance evaluation establishes possibilities for a higher financial recognition to civil servants; on the other hand it gives an opportunity to lower under-performing civil servants' salary.

The Mayor's Offices have to do the following tasks to manage their exercises that are connected to the exercises of public functions, pre-decision and implementation of a higher standard:

1. To modernize public services continuously and provide local quality public services.
2. To strengthen service characteristic in the administration and effectiveness of citizen friendly administration means and methods (the application of the new law on the rules of public administration and public proceedings, the lowering of administration time-limits, giving complete information to clients and raising of legal standards of administration).
3. To establish an IT base of the public administration in order to implement document management according to legislative prescriptions and make administration procedures appropriate for e-Administration.
4. To arrange parliamentary and local elections legally and professionally in 2010.
5. To collect taxes especially communal ones and ensure a smooth switch of trade tax transfer to Hungarian Tax and Financial Control Administration.

The local governments determined goals in order to implement these tasks:

- The practice of local government rights has to be supported with well-established local authority pre-decisions and also must ensure permanent control of implementation especially at decisions about settlement development, public service management and the raising of quality level;
- To manage the local government funds; ensure the protection and renewing of the institutional buildings in regard to the establishment of the settlement - image;
- During the implementation of the local government budget in 2010 the conformity of rules has to be ensured in financial management; purposive, effective and economic aspects connected to financial management that must have been emphasized. Rational financial management is also needed.
- Financial and accounting discipline has to be strengthened and continuous executive control has to be provided.

- The effectiveness of internal control needs further development.
- General legal practice must be established with the implementation of the law and amendments to the general rules of administrative procedures and services 140/2004. E-administration and electronic document management must be extended in stages.
- Better recognition of enactments has to be promoted and codifications of local legislation areas have to be provided.
- The local governments have to pay great attention to the organization and arrangement of parliamentary and local elections.
- There is need an adequate client information, besides make the IT backgrounds more suitable for e-Administration and the development of settlement websites must be continuous.
- The establishment and implementation with the corrections of official control methods have to be better harmonized by control systems; serious sanctions and legal consequences are defined by the local governments that have to make a firm stand against unlawful citizens and organizations.
- The opportunities for national and EU proposals and funds need to be continuously watched.
- If it is necessary, the local governments have to conduct reconciliation of interests, social consultation or population forums.
- Increased attention is needed to the modernization of official registration, document management system and archival work.

The performance evaluation in determining the underlying goals are usually taken into account in addition to the city's medium-term development plan, concept development, and citizen-friendly, service and legal expectations against the office operation.

Although the existing legislation -regarding to the accomplishment demand -does not contain a clause according to which the basic aims of the accomplishment demand must be decided by the Representative Body

Having regard to the fact that the Mayor's Office annual performance requirements of 2013 include the municipal functions, it was important for the leaders of the settlements that the Board of Representatives approve the aims.

At the examined local governments the performance evaluation occurs according to a closed qualification system: aspects and dimensions are pre-determined and the evaluation has to be done quantified. There are several disadvantages of this practice: it is inflexible and it cannot be adapted to certain job descriptions. An advantage of the system is the comparable work performance (so that staff decisions can be taken more easily), however, its negative side is more prominent because the results are not collected or systematized, and thus the qualification is rather symbolic. There is no unambiguous output, the measurement system, the indicators and the expected performance are often unreal and in many cases performance measurement is not followed by salary discounts. In addition, adjustment is difficult to short-term goals and more difficult to medium-term period programmes, especially because they are more unclear.

The criticism of the system appears related to the rarely happens qualifications, and performance evaluation takes place annually, therefore changes in inappropriate behaviour and motivation are uneasy. The communication of executives judgement to employees, career decisions, management of documents about discipline or removal, forwarding of organisational decisions to personal level are all difficult. There is no progress and the implementation of performance measurement system causes stress and conflicts.

4 Summary

The study demonstrates that the performance management is a process that controlled by the organization's leaders, and determines the individual actors duties in order to achieve the strategic purposes. For this reason, they try to augment the systemic and the individual performance, alike the performance evaluation system with the motivational system, they also expand the competence development and quality assurance, as well as the remuneration decisions.

The individual departments and the employees need to know how to contribute to the organizational goals in order to fulfil the organization's strategic goals. The individual goals, however, are not constant, they are revised regularly. The performance management allows the leader and the employee to re-think the job description, and modify it together if it is necessary.

The measurement and the evaluation are becoming increasingly important in the public administration system. On 1 January, 2013, the evaluation system was transformed. Zoltan Magyaris administration-development program serves

the development of Hungarian public administration for the renewal of public administration as well as its staff, implementing a high level of professional knowledge and the development of new staff career modes which are defined as priority areas.

Further questions that can be investigated: what forced paths appear in the exercise of local governments, how these paths can be prevented? What mean the consequences of the deficit of the Hungarian management reforms through the eyes of EU member states? Can performance evaluation and increase can be adapted to the local government representatives?

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evaluation, measurement in Heves County



Moral Organisation: Dream Or Reality

Andrea Hornyák
University of West Hungary,
Faculty of Economics, Sopron, Hungary
email: andrea.hornyak@t-online.hu

Abstract. In the area of the financial services, the contracts are not between equal signatories to a treaty. On one side there is a professional financial institution while on the other side there is a client with lack of information and weak ability to enforce interest. The high school student age group is in a rather exposed situation because they have to make very serious financial decisions. As far as Hungary concerned, a negative social mood towards banks is accompanied by poor financial literacy, and therefore, financial institutions have a lot to do in order to gain confidence in the young generation. However, in the long term, a financial institution can only achieve market success if it can integrate moral viewpoints into its corporate policy.

1 Introduction

The corporate policy goal of financial institutions is nothing but dynamic balancing among all-time profitability, liquidity and safety as well as providing steady growth, by taking the risk-taking capability in the background into consideration. The question arises as to whether the appearance of morality has any right to exist in the economic thought in Hungary and in the result-oriented management of financial institutions, that is, how the profitability aspects of banks can be reconciled with the less rational values of morality. I am of the opinion that “the moral human being, feeling the spirit of time, is capable to express it within the limits he undertakes voluntarily without waiting for the legislation to do the same” (Etzioni 1993). This idea is still

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valid today, and can be associated not only with individuals but also financial institutions.

In international researches the examination of the contact between profitability and ethics appear in the strengthening of the financial consumer protection or in the change of the banks business behaviour. In my study I attempt to connect these two viewpoints and complete it with the extension of the financial knowledge of the young age group. In the course of my primer research I survey the financial knowledge of the high school student age group, the cognition areas and I try to define those areas to be developed that can help to solve the oblique situation between the suppliers and the consumers.

Lets take a closer look at how the basic questions of morality integrated into the economic thought!

Various definitions have been used to determine the terms of morality and business ethics. In the present study, “business ethics covers the complexity of behavioural standards of business players not determined by legal enforcement, that is, legality norms and standards” (Török 2000). The appearance of moral questions forming the basics of ethics is as old as the evolution of economics. Even in Ciceros time the question arose as to whether factual information is the moral responsibility of business players: At that time there was a huge lack of crops in Rhodes, and a merchant sold his crops at a good price. But this merchant also knew that after that even more ships would arrive with huge loads of crops from Alexandria. Should he share this information with the local residents in Rhodes or should he rather keep it a secret to maximize his own profits?

The economists according to whom moral aspects play a significant role in different business transactions turned up from the 1880s therefore economic analyses must also deal with the ethical side of human behaviour by all means (Toronyai et al. 2004). Etzioni (1988) tries to prove in his book that moral considerations having developed as a result of ethical socialization play an important role in economic decisions as the market and the legal environment. Considering the aspects mentioned above, it might happen that sometimes market players act against their own interests interpreted in the narrow sense of the word and in the short term.

A new notion appeared in public awareness in the 1970s, that is, the terminology of “worthy ethics.” This concept tries to harmonize and link rationality and ethical aspects in individuals and organisations decisions (Bertk-Bécsi 2007). Committed followers are trying to convince the “morally insensitive “management of the fact that the profits of today are nothing but the moral loss of tomorrow and the multiplied financial loss of the day after tomorrow

(Zsolnai 1997). The idea is still valid today, that is, “The decision of a manager influenced by social responsibility is not different from what the demand for long-term profits requires” (Gulyás 2002). For the time being, business ethics can be regarded as one of the latest auxiliary sciences of business management.

Based on the difference between stakeholders and shareholders, the notion attempts to broaden the originally share-minded mentality of managers in order to enable them to accept the different interests of all the players of the different organizations and financial institutions such as employees, clients, creditors, owners and social environment. (Török 2000).

According to this notion, the recognition concerning the social responsibility of the financial institutions and the conscious use of competition edge based on ethical image can be connected. Therefore the question arises as to whether bank efforts focused on improving moral levels can really contribute to an increase in the competitiveness of banks.

Plenty of negative examples can be mentioned to prove how unethical behaviour of businesses or financial institutions can lead to a significant decrease in market share. I would just mention two concrete examples, namely a foreign example, Nestles infant formula marketing scandal in the 3rd world, and a Hungarian example, the VIP list of the former “Post Bank” /Postabank in Hungarian/ aiming at distinguishing bank clients. The latter can be mentioned as the most striking example of unethical banking administration method. Although there was a complete bank management and image change after the scandal broke out, it all took place in vain since the earlier positive bank image could not be revived again. Although the misdemeanours were committed by the old management, the new management and in the longer term the whole bank had to pay for the ethical costs because Post Bank is not among the financial institutions any more.

In my study I examine the contact between the financial institutions profitability and the ethic aspects from the viewpoints of the self-adjusting behaviour codex, authority control, appearance of the ethical bank and low financial culture. In my article I try to systematize and connect the different factors that affect the moral attitude of the banks. The former researches have examined these factors separately, but the important connection between them hasnt been analysed yet.

In my publication I examine what is the attitude of the different people towards the moral behaviour of the banks, and whether the self-regulatory code or the control is more effective method. The poor financial literacy of the population should not be a cause of taking advantage, furthermore, it need to be improved. This should be started in the secondary school. The money

that is spent on this issue will be returned, as a well-informed customer knows and uses more products of the banks, which influences the profitability of the financial institutions in a positive way.

Section 2 introduces the self-regulatory code of the financial banks, Section 3 discusses the connection between financial literacy of the population and the moral behaviour of banks, and Section 4 emphasizes the role of the control. However, does a moral bank really exist? This question is the topic of Section 5. Section 6 is about the primary research, and it is followed by a concluding discussion.

2 Role of self-regulatory code of ethics in the operation of financial institutions

Far and foremost, out of the several negative effects of the economic crisis, the huge loss of public confidence in financial institutions both abroad and in our country must be mentioned. However, the use of banking products cannot lack the existence of complete public trust in service providers. Banks must make maximum effort to change the current situation.

Over the past few years, various relevant impact assessments and analyses in the circle of the current and future clients have been prepared. As examples here are a few of them as follows: 42% of the Hungarian retail clients have lost faith in the banking sector over the past year, and only 5% rely on banks more than earlier - according to the latest international survey of Ernst and Young, focusing on customer satisfaction with banks and factors influencing banking relations.

In such a market environment, agreements specifying guidelines for responsible service providers conduct and behaviour and the various codes of ethics play an increasingly bigger role. According to Act XLVII of 2008 on the Prohibition of Unfair Commercial Practices against Consumers, “Code of Conduct” means an agreement or set of rules created in the framework of market self regulation, which determines behavioural rules in relation to a particular commercial practice or business sector for undertakings that undertake to be bound by the code (hereinafter referred to as “compliance with the code of conduct”).

Concerning the agreements about relationships between financial institutions and clients, I would like to deal with “The Code of Conduct” (September 19, 2009) signed by almost half of the financial institutions. In this voluntary agreement the banks undertake that they commit themselves to responsible

and transparent lending to their retail customers, during their lending proceedings. It is important to highlight that this kind of behaviour is granted not only during the entire term of the credit but also during the period preceding the lending transaction and upon the occurrence of payment difficulties. The accumulation of the huge portfolios of foreign currency loans could have been avoided or at least reduced with the help of clear and careful information contextualised in harmony with banking clients financial literacy. The financial institutions signing and joining the Code of Conduct undertake the observance of three basic principles during their lending transactions.

According to the principle of transparency, the accessibility to the required information is provided for each client in an understandable and comprehensible way. According to the principle of compliance, the signatory creditors record their lending procedures in by-laws. According to the principle of symmetry, the financial institutions do not only react to adverse and unfavourable market events by increasing the interests, fees or costs payable by the customer, but also effect changes to the benefit of the customer upon favourable changes in the circumstances.

This Code of Conduct serves as the self-regulatory tool of financial institutions, that is, not replacing the Hungarian rules and regulations in force, but completing them with the consideration of ethical norms and standards. A significant factor is that the Hungarian Financial Supervisory Authority has also published a list with the names of the financial institutions who did not sign the self-regulatory announcement. It can be regarded as a sign by all means, in the circle of current and potential future banking clients likewise. The institutions having signed the Code of Conduct continuously accept the control of the Hungarian Financial Supervisory Authority as well as the statements and resolutions of the organisation. The Supervisory Authority can initiate different sanctions in the event of misleading and fraudulent commercial practice as follows:

- Prohibition of further conduct of unlawful behaviour
 - Ordering termination of unlawful state
 - Ordering termination of revealed irregularities, by specifying deadlines
 - Possible prohibition of further conduct of unlawful activity
 - Imposition of consumer protection penalties from HUF 15,000 to HUF 2 billion
- To sum up, this Code of Conduct lays down the basics of moral

banking behaviour, however, further improvement is without doubt necessary. I regard education of morally-sensitive bank managers and personalities as important because they are the ones who can recognise if a situation needs further moral treatment besides ordinary approach.

- Another significant factor is moral decision-making that measures ethics and observance of standards in individuals actions.
- All the above-mentioned can play a significant role in relieving financial worries of families having a hard time as well as in restoring faith in financial institutions

3 Connection between poor financial literacy of the population and moral behaviour of banks

Hungary also joined the international survey coordinated by the Financial Literacy Team of the Organisation for Economic Co-operation and Development /OECD/. The survey was aimed at measuring the financial literacy of the population in terms of the information necessary for their financial decisions.

36% of the interviewees are not interested in financial market news, and 14% never even keep themselves informed about the issue. 50% of the population admits that they watch financial TV programs at least once a week, and 36% listen to business information on radio. A correlation between the interest in economic issues and age, education, dwelling place and income can be revealed: middle-aged graduates with relatively higher income from larger country cities show the greatest interest.

Although awareness of financial products can be regarded as relatively high, their use does not show a positive picture: e.g. 69% of the interviewees have a current bank account but only 40% of them are active current account users. 37% of the consumers compare several service providers products when it comes to choosing financial products, while almost the same percent do not make any previous comparisons.

Only every third interviewee creates a family budget although it is badly needed since the expenditures of 36% of the population have exceeded incomes over the past 12 months. Furthermore, it is very unfavourable that 52% of the respondents do not have any savings at all, and two-third of them could not survive an average unemployment period of 3-6 months when losing their jobs.

It is visible from the research data that although the Hungarian population knows increasingly more financial products, they know rather little about their

use. Since the individuals do not have thorough financial knowledge, families undertake too much, they keep spending more than their incomes, and are not aware of long-term risks. Due to their poor economic experience, even those holding savings choose the old forms of savings, although there would be more favourable products available for them.

Andras Simon, Head of Communications, Magyar Nemzeti Bank (the central bank of Hungary) aptly points out that “in a financial sense the Hungarian population is still using landlines while we are living in a world of wireless internet.”

Although we have tried to pay more and more attention to the improvement of financial literacy over the past few years in Hungary, there are still major shortcomings in the area. Under such circumstances banking clients are left at the mercy of financial institutions while using banking services. On these markets agreements are made between unequal parties: outstanding professional expertise of service providers versus clients lack of knowledge and weak advocacy skills. In such a situation moral behaviour of banks can be by all means expected in the interest of increasing consumer faith and expanding client-focused markets.

4 Role of control over moral behaviour of banks

It might be a long-term objective to broaden consumers financial literacy. However, in the short run, one can mention the changes in the field of financial control, which ease the problems and are beneficial for consumers. As the aftermath of the economic crisis, the power of the Hungarian Financial Supervisory Authority has been extended, and as a result, it has also been operating as a financial consumer protection authority since 1 January, 2010. It is needed because the complicated composition of the different financial products are often incomprehensible for clients who do not possess a substantial knowledge of finance essential for making well-considered and conscious decisions.

The Hungarian Financial Supervisory Authority participated in the professional cooperation which led to a significant restrictions on unilateral amendments to agreements prejudicial for consumers, the terms and conditions of amendments due to change in interest rate have been regulated, and a couple of rules and regulations have been modified in the interest of foreign currency mortgage debtors under the influence of the motion of the Authority. In terms of the consumer protection scope of authority, the Authority is entitled to civil litigation claim or litigation for claims. The impact goes far beyond individual

interests since the demand considered and awarded by the claims brought by individual consumers can be made accessible for the complete consumer circle involved.

As a result of ongoing control, the total penalty imposed by the Authority amounted to HUF 133 million in 2010, and as much as HUF 242 million in 2011. As the Vice President of the Authority emphasizes “The goal is not to impose an increasingly higher fine, the goal is to change mentality, that is, financial institutions should regard consumers as important, and quality of client service should be integrated into corporate policy.”

I regard the establishment of the Financial Arbitration Board operated by the Hungarian Financial Supervisory Authority as highly important. The Financial Arbitration Board is an independent professional alternative dispute resolution forum because it has been providing a faster and less expensive solution for dispute settlement between consumers and financial service providers than court civil proceedings since July 11, 2011. The following complaint and dispute settlement forums on finance services are accessible for clients raising objections:

- Handling complaints against financial service providers
- Public announcements, proceedings of state authorities
- Private law disputes
- Alternative dispute settlement: Financial Arbitration Board
- Process of civil litigation
- Cross-border disputes: FIN-Net

The impartial proceedings of the Financial Arbitration Board and the independence of the Board are granted during the proceedings of the individual cases. During the decision-making process the Financial Arbitration Board acts as a 3-member committee. Its legal obligation is to treat the parties equally and to provide the opportunity for the parties to present their positions and legal pleadings. During one year of operation, consumers turned to the Financial Arbitration Board in 820 cases, and more than 60 financial institutions made a voluntary statement. I am of the opinion that all the financial institutions who work on the basis of moral and ethical standards, feel obliged to observe the resolutions of the Financial Arbitration Board.

5 Here comes the moral bank! Can it be the solution?

Does the moral bank have any right to exist or can the result-oriented activity of the financial institutions be reconciled with the observation of unspoken rules of moral norms and standards?

The first community banks were already established in Western Europe a couple of decades ago. They carry out their activities on the basis of sustainable development and observation of basic principles of business ethics, putting an end to the traditional banking model. Among others, e.g. Triodos Bank in the Netherlands and GLS Gemeinschaftsbank eG in Germany attract more and more clients year by year.

Besides the traditional banks, MagNet, the Hungarian Community Bank /the legal successor of HBW Express Bank/ as the first “newbank” started its operation in Hungary on April 30, 2010. “The term “newbank” does not mean that we are new to the banking sector. We are a “newbank” because with us you can fundamentally change your attitude towards money and the environment” - according to the basic banking philosophy.

The operation of the “newbank” as the collective term for moral, community, eco, green and alternative banks, can be characterised as follows:

- Application of responsible lending and investment rules (positive and negative filters)
- Striving for great transparency (without breaching banking secrecy)
- Active social role playing
- More moderate financial profit expectations, and the appearance of social and environmental profit aspects, at last and already in the area of basic banking services

The MagNet Hungarian Community Bank is a real consumer-focused financial institution, treating its clients as partners because it creates the opportunity for investors to support local communities actively through their decisions as well as to carry out projects important for them. The new types of deposits elaborated by the financial institution serve the above-mentioned objective because the deposit holder can choose and specify which goal connected to sustainable development he would like to support. In terms of MENTOR deposits, the loan is provided to a specified business project on the basis of the clients decision, that is, deposit holders can specify which borrower they wish

to promote and the Bank will finance only that borrower from their deposits. According to the principle of transparency, MagNet Bank informs its clients about the amount with which the given client contributed to the generation of the Bank's annual profit. Within the framework of the Community Donation Programme (CDP), customers are given the opportunity to decide on the use of 10% of MagNet Bank's yearly profits and also the right to choose which civil organisations should share that 10% profit.

I am of the opinion that the appearance of MagNet Hungarian Community Bank opened a new chapter in the life of the Hungarian financial sector. I also find it important to mention that at last we have such a financial institution which bears social and environmental values in mind besides more moderate profit expectations. Although I know well that "One swallow doesn't mean the summer is here", the existence of the bank is by all means suitable for calling attention of the other financial institutions to moral, client-focused and environmentally conscious behaviour. Others are of the same opinion since this bank received the Award "Really Responsible Business" in 2011.

I can see the notion of business ethics coming true with MagNet Hungarian Community Bank since the bank attempts to keep each involved party's interests in mind (individuals, colleagues, deposit holders, creditors, civil and business partners). The bank educates responsibility and consciousness and builds community, that way allowing the realisation of long-term, sustainable development, satisfying social demands.

6 Primary research

The goal of my research was to assess high school students' general financial literacy, economic habits and attitudes toward banks. I carried out the primary data collection from spring 2011 to summer 2012 in several secondary school institutions. I am also planning to compare students studying in different regions of Hungary therefore I collected the data in Budapest, in Eastern Hungary (Miskolc, Debrecen, Nyíradony) and in Western Hungary (Sopron). In all the three regions secondary grammar school students, economic high school students and other secondary school students were represented in the selected sample because I wanted to examine the effects of vocational education in this age group. The method of interviewing was questionnaire survey. I sent the paper-based survey questionnaires to the students and asked them to answer every question if possible. I received 573 questionnaires out of the total of 600, 21 were not assessable, therefore I processed 552.

The questions of the questionnaire can be divided into two big groups: attitude assessment questions and knowledge test. The first part of the questionnaire includes the topics of attitudes to financial products, information, attitudes to financial institutions, aspects of bank choice, habits of bank card use and attitudes to lending while the second part of the questionnaire focuses on students general financial literacy. Concerning the latter, they did not have to determine terms exactly, but they had to choose the right answer.

The sample size I examined is as follows: 52.2% girls and 47.8% boys, from whom 41.5% were studying in Eastern Hungary, 40% in Western Hungary and 18.5% in Budapest. According to their age, the biggest group 35.9% was represented by the 17-aged, while 33% of the interviewees were 16 years old, 19.7% were 18 years old or over, and 11.4% were 15 years old at the time of the survey. According to school type, 35.3% of the interviewees studied in secondary grammar school, 33.3% in other secondary school, and 31.3% in economic high school at the time of the survey. 36.8% of the respondents had a family member with background in economic education.

74% of the interviewees found financial news and information important, but only 39.7% regarded themselves as well-informed. In terms of secondary school students attitudes, 57.4% recognised the significance of savings while 30.6% did not regard savings for future real-life situations necessary. The latter might be significantly influenced by the interviewees families, that is, if parents do not show positive examples, it might affect the behaviour of the youth. 34% of the students possessed their own money which most of them kept cash at home and only 2% held it in savings accounts at the time of the survey.

On a national level, the rate of students showing interest in economic news was the same as that of those not showing any interest. However, the differences can be detected according to school types, since 68.8% of the students in economic high schools showed interest, while this rate was only 10.3% in other secondary schools.

According to the result of the processed data, 40.3% - 71.2% of the respondents gave a correct answer to the questions in the knowledge test. However, the rate of the respondents giving the right answer to three questions was pretty poor, that is, the rate does not reach even 30%. Concerning the remaining questions, the number of respondents giving the right answer does not significantly differ from the rate of the respondents giving a wrong answer.

On the basis of my thorough examination concentrated on secondary school students knowledge of banking products, I can draw the conclusion that they have the most thorough knowledge of bank cards and current accounts, while

Students' financial attitude, knowledge

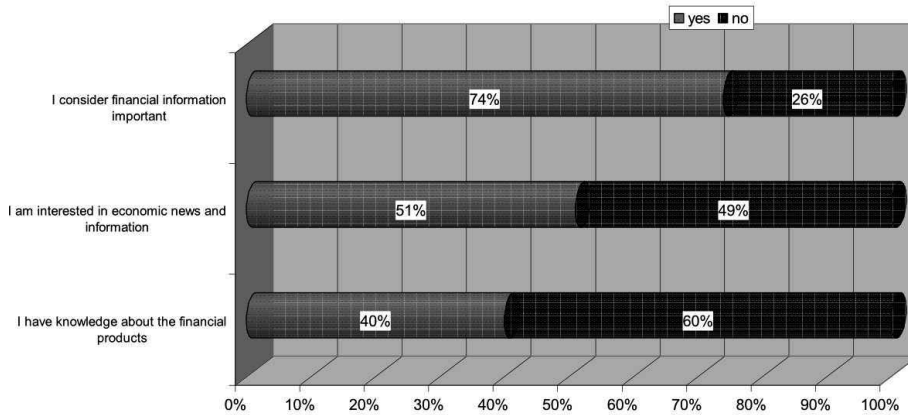


Figure 1.: Students' financial attitude, knowledge
Source: on the basis of my own research (2012)

they know about credit cards and investment securities the least. No-one indicated a thorough knowledge of investment securities and credit cards, and in addition, it also comes to light from the processed data that there is a significant difference between students knowledge according to school types. When it comes to knowledge of investment securities, 11% of economic high school students regard it as good, 35.3% regard it as moderate and 42.7% regard it as minimal, while the rest of the students do not actually know anything about this form of investment.

Most of the secondary grammar school students, 58.5% have a minimal knowledge, 20.5% a moderate knowledge and only 1% a good knowledge in the field. The students going to other secondary schools are the least informed since their majority, 72.8% do not have any knowledge of this banking product, 25.6% of them regard their knowledge as minimal and only 1.6% as moderate.

The differences according to school types are very well illustrated by the chart below (Figure 2).

By taking a closer look at the differences between sexes, it can be stated that more girls regard their knowledge moderate and good than the other sex. 42% of the boys have a minimal knowledge, and 38.3% have no knowledge of investment securities. While according to the literature boys reach better results than girls, this rate turns in the present survey. It might be explained by the fact that 65% of the respondents from economic high schools are girls,

Knowledge of investment securities							
			I do not have any knowledge of that	I have a minimal knowledge	I have a moderate knowledge	I have a good knowledge	Total
school type visited by respondent	1.Secondary grammar school	No. of respondents	39	114	40	2	195
		Distribution according to knowledge	20.3%	48.5%	38.4%	9.5%	35.3%
		Distribution according to school type	20.0%	58.5%	20.5%	1.0%	100.0%
	2.Economic high school	No. of respondents	19	74	61	19	173
		Distribution according to knowledge	9.9%	31.5%	58.7%	90.5%	31.3%
		Distribution according to school type	11.0%	42.7%	35.3%	11.0%	100.0%
	3.Other secondary school	No. of respondents	134	47	3	0	184
		Distribution according to knowledge	69.8%	20.0%	2.9%	0.0%	33.3%
		Distribution according to school type	72.8%	25.6%	1.6%	0.0%	100.0%
Total	No. of respondents	192	135	104	21	552	
	Distribution according to school type	34.8%	42.6%	18.8%	3.8%	100.0%	

Table 1.: Cross table between knowledge of investment securities and school types; Source: on the basis of my own research (2012)

and the students attending vocational education reached a better result than the students from the two other school types where the rate of girls are lower. I am of the opinion that it provides good evidence that the differences between the knowledge of sexes can by all means decreased by financial education.

Similarly to other surveys on the financial knowledge of the youth, I also experience that the financial knowledge of the secondary school students aged between 15 -19 is rather incomplete. However, I think that it is by all means a positive result that more and more students find financial knowledge acquisition important and essential in everyday life. But one must add that development of the interest inevitable for financial knowledge acquisition shows signs of shortcomings yet.

What the knowledge test concerns, the respondents interested in financial news, the students from economic high schools and the students with family

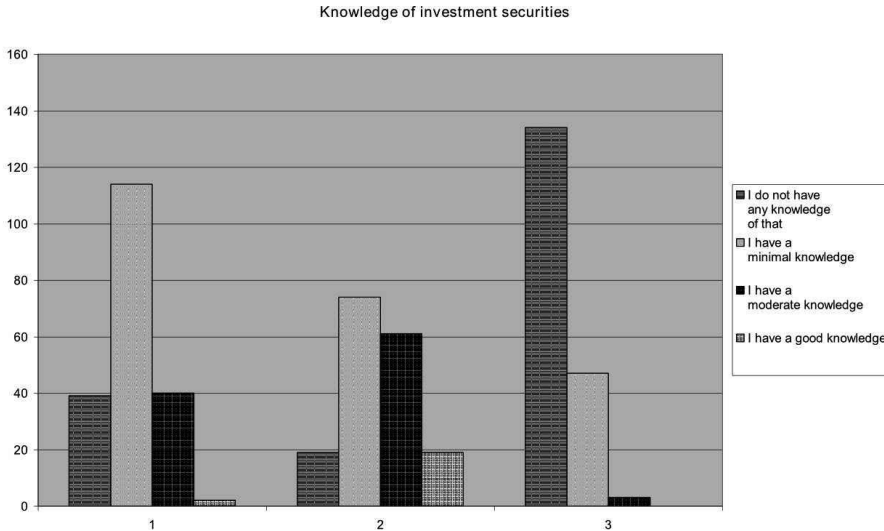


Figure 2.: Distribution of students' knowledge of investment securities according to school types; Source: on the basis of my own research (2012)

members with background in economic education reached a significantly better result.

7 Discussion

During my research, I tried to examine whether moral questions play a role in the decision-making process of the financial institutions. I am of the opinion that the majority of the banks attempt to take moral aspects into consideration somewhat more and to a certain extent therefore, for instance, several self-regulatory codes of ethics have been created. However, it is not enough to lay down these norms and standards, they have to be used and applied in right way on the spot. Unfortunately, concrete examples prove that the Hungarian financial institutions still have a lot to do to improve in the field of ethical mentality. The negative social attitude toward banks is accompanied by poor financial literacy in Hungary, therefore financial institutions have an extremely lot to do to gain confidence of the youth. If decisions of banks are not determined by momentary economic interests any more, they plan ahead for the long term instead, the competitive edges from moral image will pay off for them.

If the financial institution does not proceed ethically against his client then

it will be necessary beside the negative oral advertisement to withdraw the financial consumer protection. Contrarily the satisfied client has increasingly bigger confidence in the financial service providers, so thanks to this the all financial sectors profitability goes through a significant improvement. These clients are going to buy more and more products with better condition what furthers the opportunity of the financial markets increase. So verifiable, that the ethical banking behaviour apart from the repossession of the confidence can be key with the increase of the banks profitability. It can be an object for additional research to concretizing the efficiency survey or rather to determine and satisfy the consumer groups information claim and the different bank products. The knowledge levels of the students from different type of schools necessitate the use of various marketing device, what can be based on the results of exclusively preliminary empirical examination.

Finally, I would like to quote the words of Amitai Etzioni (Török 2000): “As soon as someone completely recognises the limits of human knowledge and the vital role of emotions and values, his attitude to the world and particularly to decision-making will significantly change. Most of the time, we lack the knowledge inevitable for making sensible decisions. Therefore we have to advance carefully, being prepared to change direction modestly - in one word.” I am of the opinion that taking moral norms and standards might be the first step on the road leading to careful progress.

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Monte Carlo Simulation in Random Coefficient Logit Models Involving Large Sums

Zsolt Sándor

Sapientia Hungarian University of Transylvania
Faculty of Economic and Human Sciences,
Miercurea Ciuc
email: sandorzsolt@sapientia.siculorum.ro

Abstract. We study Monte Carlo simulation in some recent versions of random coefficient logit models that contain large sums of expressions involving multivariate integrals. Such large sums occur in the random coefficient logit with demographic characteristics, the random coefficient logit with limited consumer information and the design of choice experiments for the panel mixed logit. We show that certain quasi-Monte Carlo methods, that is, so-called (t, m, s) -nets, provide improved performance over pseudo-Monte Carlo methods in terms of bias, standard deviation and root mean squared error.

1 Introduction

Random coefficient logit models have become the main tools in the study of demand for differentiated products and related problems. Its popularity comes from the flexible modelling of heterogeneous consumer preferences, which has been shown to facilitate the estimation of realistic patterns of substitution between different products (Berry et al. 1995, Nevo 2001).

The model that is at the basis of these studies can only be estimated with a large data set, which requires a large computational effort in the estimation algorithm. One of the sources of difficulty is the presence of the random coefficients, which compared to the logit model without random coefficients has

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fewer degrees of freedom due to the standard deviation parameters, while it is estimated based on the same observations. In addition, the random coefficient logit has analytically intractable market share expressions in the form of multivariate integrals. Since within an estimation algorithm these need to be approximated at each iteration, this further increases the computational burden of the estimation.

Due to their usefulness, random coefficient logit models have been extended in several directions. A straightforward extension is the one that accommodates demographic characteristics (Nevo 2001). Another extension is the model with limited consumer information (Goeree 2008). Although these two models are different, they are similar in that they imply market share expressions that are sums of intractable multivariate integrals, and typically these sums have a large number of terms.

Random coefficient logit models are also used to analyze data from choice experiments. These data are obtained from respondents who choose the best from several sets of hypothetical products. Under the assumption that the preferences of a given respondent do not change, the model yields the so-called panel mixed logit. Bliemer and Rose (2010) consider the problem of designing the hypothetical products into several choice sets for this model. In order to do so, one needs to compute a scalar transformation of the information matrix, which is a large sum of expressions that depend on intractable multivariate integrals.

In this paper we study to what extent quasi-Monte Carlo sampling improves the computational efficiency in these models. For this, first we merge the large sum of multivariate integrals into one higher-dimensional integral of a function that is discontinuous in some variables and then apply quasi-Monte Carlo sampling to estimate the integral. The implied integrand functions are still square-integrable, so asymptotically quasi-Monte Carlo sampling is expected to offer computational gains over pseudo-Monte Carlo. We also expect to get finite sample computational improvement for integrals expressed as probabilities, since intuitively quasi-random draws are designed to provide better coverage than pseudo-random draws over the density for which the expectation is defined. This improved coverage usually translates into smaller expected approximation error. When the simulated probabilities are used within non-linear expressions, the greater precision and reduced bias in the simulated probabilities translates into greater precision and reduced bias in parameter estimates.

From a computational point of view we contribute to the literature by studying the performance of quasi-Monte Carlo sampling applied to the estimation

of the expectation of some discrete random variables. In the literature there seems to be an emphasis on results that show the gains from using quasi-Monte Carlo in the case of sufficiently smooth integrand functions, but applications to cases of discontinuous integrands are rare.

Recently, in the econometric literature some new approaches have appeared for the estimation of random coefficient logit probabilities. One approach uses Laplace approximations of the integrals (Harding and Hausman 2007). Another approach uses Gaussian quadrature based on sparse grids (Heiss and Winschel 2008). These approaches produce improvements in terms of precision and/or computing time with respect to Monte Carlo estimation based on some quasi-Monte Carlo samples (namely, Halton and modified Latin hypercube by Hess et al. 2006). However, on the one hand, these methods have not yet been compared directly to the quasi-Monte Carlo we consider in this paper, and on the other hand, it is not straightforward how to apply them to estimate expectations of discrete random variables.

The next section presents the random coefficient logit with demographic characteristics and the random coefficient logit with limited consumer information. Section 3 presents the experimental design problem for the panel mixed logit. Section 4 describes briefly the quasi-Monte Carlo methods used in the paper. Section 5 presents the results, and Section 6 concludes.

2 Two demand models involving large sums

We discuss two models whose econometric analysis involves the computation of large sums. Another common feature of these models is that they are used with aggregate market-level data. In both models the market share expressions involve large sums of analytically intractable multi-dimensional integrals. Approximating precisely the market shares is crucial for the estimation of the model parameters. For both models we express the large sums as integrals on the unit hypercube of discontinuous functions, and employ Monte Carlo integration methods to estimate the market shares. Both models are computationally difficult in that they require a very high number of simulation draws, so we believe it is crucial to come up with methods that reduce the computational burden and/or improve the precision of the involved estimates.

2.1 Random coefficient logit with demographic characteristics

We define this model by the utility function. Suppose that there are J products available in the market. The utility of an individual i who chooses j out of J

products is

$$u_{ij} = x'_j (\beta_i + \Gamma d_i) + \xi_j + \varepsilon_{ij},$$

where x_j is a K -vector of observed characteristics, which may also contain endogenous characteristics like price; it also contains 1 for intercept, β_i is a random parameter whose distribution is assumed to be $N(b, \Sigma)$ with $\Sigma = \text{diag}(\sigma_1^2, \dots, \sigma_K^2)$, d_i is a D -vector of demographic characteristics, Γ is a $K \times D$ matrix of parameters, ξ_j is a product-specific error, also called the unobserved characteristic of product j , ε_{ij} is assumed to be iid type I extreme value random variable independent of the rest of the variables. The utility of consumer i who does not purchase any product is

$$u_{i0} = \varepsilon_{i0},$$

where ε_{i0} is also assumed to be type I extreme value random variable independent of the rest of the variables.

We assume that the econometrician observes the product characteristics x_j , $j = 1, \dots, J$, the market shares of all products and the distribution of the demographic characteristics. We assume that the demographic characteristics have a discrete distribution with $N_D = n_1 \times \dots \times n_D$ support points. This class of models was pioneered by Nevo (2001), who extended the seminal work by Berry et al. (1995) by including demographic characteristics in the demand in an application on measuring market power in the ready-to-eat cereals market.

The market share of product j predicted by the model, that is, the probability that j is chosen, conditional on x_j and ξ_j , $j = 1, \dots, J$, as well as the unknown parameters, is

$$s_j = \int \frac{\exp \left(x'_j (\beta + \Gamma d) + \xi_j \right)}{1 + \sum_{r=1}^J \exp \left(x'_r (\beta + \Gamma d) + \xi_r \right)} dF(\beta) dG(d),$$

where $F(\beta)$ denotes the cumulative distribution function of $\beta \sim N(b, \Sigma)$ and $G(d)$ denotes the cumulative distribution function of the discrete random variable d . The demographic characteristics need to be integrated out because we assume that individual choices are not observed.

Writing out the expectation with respect to the discrete distribution of demographic characteristics, we obtain

$$s_j = \sum_{k=1}^{N_D} p_k \int_{\mathbb{R}^K} \frac{\exp \left(x'_j (\beta + \Gamma d_k) + \xi_j \right)}{1 + \sum_{r=1}^J \exp \left(x'_r (\beta + \Gamma d_k) + \xi_r \right)} dF(\beta), \quad (1)$$

where d_k and p_k are the values of d and their probabilities, respectively. In order to evaluate the market share (1) we need to compute N_D integrals for each j . It is well known that these types of integrals are analytically intractable, so they need to be approximated numerically. This implies a non-negligible computational effort, which in the case of the market share (1) is multiplied by the number of terms N_D in the sum. Typically, one of the demographic characteristics is income, and for this the number of support points is rather large making the number of terms N_D also large. In this case the computational burden for obtaining a sufficiently precise approximation of the market share becomes substantial.

As we outlined at the beginning of this section, we replace the sum by integral. At this point we assume that the components of the demographic characteristic vector are independent.¹ Then the market share (1) can be rewritten as

$$s_j = \int_{\mathbb{R}^K \times [0,1]^D} \frac{\exp\left(x'_j(\beta + \Gamma\varphi(\mathbf{u})) + \xi_j\right)}{1 + \sum_{r=1}^J \exp\left(x'_r(\beta + \Gamma\varphi(\mathbf{u})) + \xi_r\right)} dF(\beta) d\mathbf{u}, \quad (2)$$

where $\varphi(\mathbf{u}) = (\varphi_1(u_1), \dots, \varphi_D(u_D))'$ with the components $\varphi_h(u_h)$, $h = 1, \dots, D$, defined as follows. Let $v_{h,1}, \dots, v_{h,n_h}$ and $p_{h,1}, \dots, p_{h,n_h}$ be the possible values and the corresponding probabilities, respectively, of component h of the demographic characteristic vector d ; let $q_{h,i} = \sum_{\alpha=1}^i p_{h,\alpha}$ for $i = 1, \dots, n_h$ and $q_{h,0} = 0$. Then define $\varphi_h(u_h) = v_{h,i}$ if and only if $q_{h,i-1} \leq u_h < q_{h,i}$. We note that each component φ_h of φ is a step function and hence the integrand function in the above market share expression is square-integrable in \mathbf{u} .² Therefore, estimation of the integral by the Monte Carlo method is valid. We

¹Although this assumption seems to be restrictive at first sight, there are at least two reasons for which it is not unplausible. First, in many cases the econometrician is forced to assume that the demographic characteristics are independent because from the data set in many cases only the marginal distributions of the demographic characteristics can be inferred. Second, if from the data set one can infer the joint distribution of demographic characteristics, then this can be treated as a one-dimensional demographic characteristic that can take N_D values. Therefore, this situation appears as a special case of our treatment. We devote one simulation study to this case.

²For an integral $\int_{[0,1]^D} g(\mathbf{u}) d\mathbf{u}$ the integrand function g is square-integrable if $\int_{[0,1]^D} g^2(\mathbf{u}) d\mathbf{u} < \infty$. This property allows the computation of the variance of the Monte Carlo estimator $\sum_{i=1}^N g(\mathbf{u}_i) / N$.

form the (quasi-)Monte Carlo estimator by using joint draws $\Delta_N = (\beta_i, \mathbf{u}_i)_{i=1}^N$:

$$\tilde{s}_j(\xi, \theta, \Delta_N) = \frac{1}{N} \sum_{i=1}^N \frac{\exp\left(x_j'(\beta_i + \Gamma\varphi(\mathbf{u}_i)) + \xi_j\right)}{1 + \sum_{r=1}^J \exp\left(x_r'(\beta_i + \Gamma\varphi(\mathbf{u}_i)) + \xi_r\right)}, \quad (3)$$

where β_i is a draw from F and \mathbf{u}_i is a draw from the uniform distribution on $[0, 1]^D$.

2.2 Random coefficient logit with limited consumer information

In this subsection we discuss a discrete choice model in which a consumer can potentially choose (at most one out) of J products, but she only observes a subset of the J products. Let

$$P_S(\gamma_i) = \prod_{k \in S} \phi_k(\gamma_i) \prod_{h \notin S} (1 - \phi_h(\gamma_i))$$

be the probability that consumer i observes subset S of the products, where γ_i is a consumer-specific L -vector of parameters affecting this probability; we will refer to S as the choice set of consumer i . The choice set probability $P_S(\gamma_i)$ also depends on product characteristics t_j (suppressed in the notation) that affect the observability of the products through the factor $\phi_j(\gamma_i)$, $j = 1, \dots, J$. The probability that product j is chosen, conditional on x_j , ξ_j , t_j , $j = 1, \dots, J$, and the unknown parameters, is

$$s_j = \int_{\mathbb{R}^{K+L}} \sum_{S \in \mathcal{S}_j} P_S(\gamma) \frac{\exp\left(x_j'\beta + \xi_j\right)}{1 + \sum_{r \in S} \exp\left(x_r'\beta + \xi_r\right)} dF(\beta, \gamma), \quad (4)$$

where \mathcal{S}_j denotes the set of subsets of $\{1, 2, \dots, J\}$ containing j ; x_j , β , ξ_j are as in the model from the previous subsection, and $F(\beta, \gamma)$ denotes the joint cumulative distribution function of (β, γ) . It will be convenient to assume that the random parameters can be parameterized so that $\beta \equiv \beta(\theta_1, v_1)$ and $\gamma \equiv \gamma(\theta_2, v_2)$ where θ_1 and θ_2 are unknown parameter vectors and v_1 and v_2 are standard normal random vectors of dimension K and L , respectively. In what follows, instead of $\phi_k(\gamma(\theta_2, v_2))$ we use $\phi_k(\theta_2, v_2)$. With this notation the market share of product j is

$$s_j = \int_{\mathbb{R}^{K+L}} \sum_{S \in \mathcal{S}_j} P_S(\theta_2, v_2) \frac{\exp\left(x_j'\beta(\theta_1, v_1) + \xi_j\right)}{1 + \sum_{r \in S} \exp\left(x_r'\beta(\theta_1, v_1) + \xi_r\right)} d\Phi(\mathbf{v}), \quad (5)$$

where $\Phi(\mathbf{v})$ denotes the standard normal cumulative distribution function of $\mathbf{v} = (v_1, v_2)$.

A similar model is used by Goeree (2008), where the choice sets are determined by the amount of advertising of the products. The number of terms in the above sum is equal to 2^{J-1} , which is the number of subsets of $\{1, 2, \dots, J\}$ containing some product j . In many markets the number of products J is large, so the sum in the market share expression (4) will have very many terms. This will cause a substantial computational burden, if one wants to compute the market shares directly.

We follow the literature (e.g., Goeree 2008) in that we approximate the market shares by Monte Carlo integration. Let (v_{1i}, v_{2i}) , $i = 1, \dots, N$, be a random sample from the standard normal distribution and

$$\frac{1}{N} \sum_{i=1}^N \sum_{S \in \mathcal{S}_j} P_S(\theta_2, v_{2i}) \frac{\exp(x'_j \beta_i + \xi_j)}{1 + \sum_{r \in S} \exp(x'_r \beta_i + \xi_r)}$$

the corresponding Monte Carlo estimator of (5), where $\beta_i = \beta(\theta_1, v_{1i})$. For each i we can write the sum with respect to $S \in \mathcal{S}_j$ as the expected value of a discrete random variable. In this regard, for given i , note that

$$\begin{aligned} & \sum_{S \in \mathcal{S}_j} P_S(\theta_2, v_{2i}) \frac{\exp(x'_j \beta_i + \xi_j)}{1 + \sum_{r \in S} \exp(x'_r \beta_i + \xi_r)} \\ &= \phi_j(\theta_2, v_{2i}) \sum_{S \in \mathcal{N}_j} P_S(\theta_2, v_{2i}) \frac{\exp(x'_j \beta_i + \xi_j)}{1 + \exp(x'_j \beta_i + \xi_j) + \sum_{r \in S} \exp(x'_r \beta_i + \xi_r)} \end{aligned} \tag{6}$$

where \mathcal{N}_j is the set of subsets of $\{1, 2, \dots, J\}$ that do not contain j . Since $\sum_{S \in \mathcal{N}_j} P_S(\theta_2, v_{2i}) = 1$, the sum in (6) can be interpreted as the expected value of a discrete random variable with values

$$P_{j|S}(\theta_1, v_{1i}) = \frac{\exp(x'_j \beta_i + \xi_j)}{1 + \exp(x'_j \beta_i + \xi_j) + \sum_{r \in S} \exp(x'_r \beta_i + \xi_r)}, \quad S \in \mathcal{N}_j$$

and probabilities $P_S(\theta_2, v_{2i})$. This can be used to obtain the Monte Carlo estimator of the sum. For this we need to draw a sample of size N from this discrete distribution. This can be done by drawing N uniform random vectors $\mathbf{u}_1, \dots, \mathbf{u}_N \in [0, 1]^J$ and then, based on these, constructing the choice

sets S_1, \dots, S_N by $S_i = \{k \in \{1, \dots, J\} \setminus \{j\} : u_{ik} \leq \phi_k(\theta_2, v_{2i})\}$ for $i = 1, \dots, N$, where u_{ik} is the k -th component of \mathbf{u}_i . The obtained Monte Carlo estimator of the sum in (6) is

$$\frac{1}{N} \sum_{i=1}^N P_{j|S_i}(\theta_1, v_{1i}).$$

(Note that we do not use the j -th component of the u_i 's.)

However, this Monte Carlo estimator is not continuous in the unknown parameters in general, because, for a given sample $\mathbf{u}_1, \dots, \mathbf{u}_N \in [0, 1]^J$, the choice sets S_1, \dots, S_N may change when θ_2 changes, and this modifies the structure of $P_{j|S_i}(\theta_1, v_{1i})$. A solution to this problem is via importance sampling, as suggested by Goeree (2008). Let θ_{20} be a fixed value of the parameter θ_2 and define the importance sampling probabilities $P_S(\theta_{20}, v_{2i})$. Using these, we can rewrite the sum in (6) as

$$\sum_{S \in \mathcal{N}_j} P_S(\theta_{20}, v_{2i}) \frac{P_S(\theta_2, v_{2i})}{P_S(\theta_{20}, v_{2i})} P_{j|S}(\theta_1, v_{1i}).$$

Now, this can be written as the integral

$$\int_{[0,1]^J} \frac{P_j(\theta_2, v_{2i}, \mathbf{u})}{P_j(\theta_{20}, v_{2i}, \mathbf{u})} \frac{\exp(x'_j \beta_i + \xi_j)}{1 + \exp(x'_j \beta_i + \xi_j) + \sum_{\substack{r=1 \\ r \neq j}}^J 1(u_r \leq \phi_r(\theta_{20}, v_{2i})) \exp(x'_r \beta_i + \xi_r)} d\mathbf{u},$$

where for $\mathbf{u} = (u_1, \dots, u_J)$

$$P_j(\theta_2, v_2, \mathbf{u}) = \prod_{\substack{k=1, \\ k \neq j}}^J \phi_k(\theta_2, v_2)^{1(u_k \leq \phi_k(\theta_2, v_2))} (1 - \phi_k(\theta_2, v_2))^{1(u_k > \phi_k(\theta_2, v_2))}$$

and $1(A)$ is the indicator of the event A . Note that $P_j(\theta_2, v_2, \mathbf{u}) = P_S(\theta_2, v_2)$ if $S = \{k \in \{1, \dots, J\} \setminus \{j\} : u_k \leq \phi_k(\theta_2, v_2)\}$. Consequently, we obtain that the market share of product j is³

$$s_j = \int_{\mathbb{R}^{K+L}} \int_{[0,1]^J} \phi_j(\theta_2, v_2) \frac{P_j(\theta_2, v_2, \mathbf{u})}{P_j(\theta_{20}, v_2, \mathbf{u})} \times \frac{\exp(x'_j \beta(\theta_1, v_1) + \xi_j)}{1 + \exp(x'_j \beta(\theta_1, v_1) + \xi_j) + \sum_{\substack{r=1 \\ r \neq j}}^J 1(u_r \leq \phi_r(\theta_{20}, v_2)) \exp(x'_r \beta(\theta_1, v_1) + \xi_r)} d\mathbf{u} d\Phi(\mathbf{v}). \quad (7)$$

³In order to keep the notation simple we use the whole vector \mathbf{u} in the integrand function above, although it does not depend on u_j . However, this does not change the results.

The integrand function in this integral is square-integrable for the probabilities ϕ_k that we consider (see Section 5.2), so we approximate the integral by (quasi-) Monte Carlo estimation using joint draws $\Delta_N = (\mathbf{u}_i, \mathbf{v}_i)_{i=1}^N$. The estimator is

$$\begin{aligned} \tilde{s}_j(\xi, \theta, \Delta_N) &= \frac{1}{N} \sum_{i=1}^N \phi_j(\theta_2, v_{2i}) \frac{P_j(\theta_2, v_{2i}, \mathbf{u}_i)}{P_j(\theta_{20}, v_{2i}, \mathbf{u}_i)} \times \\ &\times \frac{\exp(x'_j \beta(\theta_1, v_{1i}) + \xi_j)}{1 + \exp(x'_j \beta(\theta_1, v_{1i}) + \xi_j) + \sum_{\substack{r=1 \\ r \neq j}}^J 1(u_{ir} \leq \phi_r(\theta_{20}, v_{2i})) \exp(x'_r \beta(\theta_1, v_{1i}) + \xi_r)}, \end{aligned} \tag{8}$$

where $\xi = (\xi_1, \dots, \xi_J)$ and $\theta = (\theta_1, \theta_2)'$; from the the arguments of \tilde{s}_j we omit the rest of the variables.

2.3 Estimation of the model parameters

In this subsection we discuss the essentials on estimation of the model parameters needed for understanding the simulation results from Section 5. In both models the market share of a product j can be expressed as a function of the model ingredients (see equations (1) and (4)). In both models the system of market shares can be inverted, as shown by Berry (1994), to obtain the variables ξ_1, \dots, ξ_J as a function of the market shares and the other ingredients of the models. In practice we need to solve in ξ_1, \dots, ξ_J the nonlinear systems made up of (3) and (8) for $j = 1, \dots, J$. In order to get the solution we appeal to Berry et al. (1995), who have introduced the operator $T(\cdot, \mathbf{s}^0, \theta, \Delta_N) : \mathbb{R}^J \rightarrow \mathbb{R}^J$ such that its component j is defined by

$$T_j(\xi, \mathbf{s}^0, \theta, \Delta_N) = \xi_j + \ln s_j^0 - \ln \tilde{s}_j(\xi, \theta, \Delta_N),$$

and whose fixed point is the solution of our nonlinear system, where \mathbf{s}^0 is the vector of observed market shares. These authors have established that in the random coefficient logit model $T(\cdot, \mathbf{s}^0, \theta, \Delta_N)$ is a contraction for any feasible $(\mathbf{s}^0, \theta, \Delta_N)$. Goeree (2008) has extended this result to the random coefficient logit with limited consumer information.

Let the solution be denoted by $\xi(\mathbf{s}^0, \theta, \Delta_N)$. The identification of the unknown parameters is based on the moment condition that

$$E[\xi(\mathbf{s}^0, \theta, \Delta_N)] = 0 \text{ implies } \theta = \theta^0,$$

where θ^0 is the true value of the parameter vector. The method for estimating θ is nonlinear least squares by

$$\min_{\theta} \xi(\mathbf{s}^0, \theta, \Delta_N)' \xi(\mathbf{s}^0, \theta, \Delta_N).$$

Clearly, the obtained estimator depends on the simulation draws Δ_N used for estimating the market shares.⁴ In the simulation study (Section 5) we evaluate the performance of different samples Δ_N by comparing the mean squared error of the estimator of the objective function evaluated at the true parameter value and normalized by the number of observations, that is, $\xi(\mathbf{s}^0, \theta^0, \Delta_N)' \xi(\mathbf{s}^0, \theta^0, \Delta_N) / J$.

3 Experimental design for the panel mixed logit

Suppose that each consumer $i = 1, \dots, n$ chooses one alternative from the same S choice sets. Each choice sets has J alternatives. Let $y_{j_s}^i \in \{0, 1\}$ denote the choice of consumer i in choice set s in the sense that $y_{j_s}^i = 1$ iff alternative j is chosen. Suppose that the utility of i corresponding to alternative j in s is

$$u_{ijs} = x_{js}(\beta + V_i\sigma) + \varepsilon_{ijs},$$

where x_{js} is the vector of attributes of alternative j in choice set s , $\beta + V_i\sigma$ is the random coefficient with V_i being a diagonal matrix having standard normal random variables v_i on its main diagonal, and ε_{ijs} is an extreme value distributed error term.

Next we derive the likelihood for this model. For a consumer i the likelihood that a given $y^i = \left(y_{j_s}^i \right)_{\substack{j=1, \dots, J \\ s=1, \dots, S}}$ is chosen, given v_i , is proportional to

$$l_i(y^i | \theta, v_i) = \prod_{s=1}^S \prod_{j=1}^J p_{j_s}^{y_{j_s}^i}(\theta | v_i),$$

where $\theta = (\beta', \sigma')'$ and

$$p_{j_s}(\theta | v_i) = \frac{\exp(x_{js}(\beta + V_i\sigma))}{\sum_{h=1}^J \exp(x_{hs}(\beta + V_i\sigma))} \quad (9)$$

is the probability that alternative j is chosen in choice set s , given v_i . The unconditional likelihood for consumer i is (proportional to)

$$l_i(y^i | \theta) = \int \prod_{s=1}^S \prod_{j=1}^J p_{j_s}^{y_{j_s}^i}(\theta | v) d\Phi(v), \quad (10)$$

⁴We use this framework in our simulation study, but we note that in these classes of models in the literature typically one product characteristic considered is price, which is treated as endogenous. Due to this, the estimation method followed in the literature is the method of instrumental variables, which we wanted to avoid due to its potentially poor small sample properties.

where Φ is the cumulative distribution function of the standard normal random vector v . This yields the log-likelihood for all the n consumers

$$L(y|\theta) = \sum_{i=1}^n \ln \left(\int \prod_{s=1}^S \prod_{j=1}^J p_{j_s}^{y_{j_s}^i}(\theta|v) d\Phi(v) \right).$$

In order to make the expressions more similar to the cross-sectional mixed logit, let

$$L_i(y^i|\theta, v_i) = \ln \left(\prod_{s=1}^S \prod_{j=1}^J p_{j_s}^{y_{j_s}^i}(\theta|v) \right) = \sum_{s=1}^S \sum_{j=1}^J y_{j_s}^i \ln p_{j_s}(\theta|v_i) = (y^i)' \ln p(\theta|v_i),$$

where

$$y^i = (y_{11}^i, y_{21}^i, \dots, y_{J1}^i, y_{12}^i, \dots, y_{J2}^i, \dots, y_{1S}^i, \dots, y_{JS}^i)'$$

$$p(\theta|v) = (p_{11}(\theta|v), p_{21}(\theta|v), \dots, p_{J1}(\theta|v), p_{12}(\theta|v), \dots, p_{J2}(\theta|v), \dots, p_{1S}(\theta|v), \dots, p_{JS}(\theta|v))'$$

So

$$L(y|\theta) = \sum_{i=1}^n \ln \left(\int \exp L_i(y^i|\theta, v) d\Phi(v) \right).$$

For deriving the design criterion below we use this formula.

3.1 Design criterion

The design criterion is typically based on local D-optimality and defined as

$$D(X, \theta) = [\det I(X, \theta)]^{1/d}, \tag{12}$$

where d denotes the dimension of the information matrix $I(X, \theta)$. This criterion is called local because it depends on the true parameter value θ and "D" comes from determinant. Other criteria can also be considered; see Kessels et al. (2006).

The design criterion depends on the information matrix, so next we derive this. The information matrix is

$$I(X, \theta) = E \left[\frac{\partial L(y|\theta)}{\partial \theta} \frac{\partial L(y|\theta)}{\partial \theta'} \right] = n \cdot E \left[\frac{\partial \mathcal{L}(y^i|\theta)}{\partial \theta} \frac{\partial \mathcal{L}(y^i|\theta)}{\partial \theta'} \right]$$

because $y^i, i = 1, \dots, n$, are assumed to be iid, where

$$\mathcal{L}(y^i|\theta) = \ln \left(\int \exp L_i(y^i|\theta, v) d\Phi(v) \right)$$

is the log-likelihood corresponding to i . Therefore,

$$I(X, \theta) = n \cdot \sum_{y^i} \Pr(y^i) \left[\frac{\partial \mathcal{L}(y^i|\theta)}{\partial \theta} \frac{\partial \mathcal{L}(y^i|\theta)}{\partial \theta'} \right],$$

where the summation is according to all possible J^S values of y^i ; $\Pr(y^i)$ is the probability that the choice vector y^i occurs, that is,

$$\Pr(y^i) = \int \prod_{s=1}^S \prod_{j=1}^J p_{js}^{y_{js}^i}(\theta|v) d\Phi(v).$$

Note that this is identical to $l_i(y^i|\theta)$ from (10).

In order to derive the information matrix we need the first order derivative of the log-likelihood corresponding to i :

$$\frac{\partial \mathcal{L}(y^i|\theta)}{\partial \theta} = \frac{\partial \left(\int \exp L_i(y^i|\theta, v) d\Phi(v) \right)}{\partial \theta} = \frac{\int \frac{\partial (\exp L_i(y^i|\theta, v))}{\partial \theta} d\Phi(v)}{\int \exp L_i(y^i|\theta, v) d\Phi(v)},$$

where recall $L_i(y^i|\theta, v_i) = (y^i)' \ln p(\theta|v_i)$. Of this,

$$\frac{\partial (\exp L_i(y^i|\theta, v))}{\partial \theta} = \frac{\partial L_i(y^i|\theta, v)}{\partial \theta} \exp L_i(y^i|\theta, v) = \begin{pmatrix} \frac{\partial L_i(y^i|\theta, v)}{\partial \beta} \exp L_i(y^i|\theta, v) \\ \frac{\partial L_i(y^i|\theta, v)}{\partial \sigma} \exp L_i(y^i|\theta, v) \end{pmatrix}.$$

The first order derivatives

$$\frac{\partial L_i(y^i|\theta, v)}{\partial \theta} = \left(\frac{\partial L_i(y^i|\theta, v)}{\partial \theta'} \right)' = \left(\frac{\partial \ln p(\theta|v_i)}{\partial \theta'} \right)' y^i.$$

Split the probability vector $p(\theta|v_i)$ into the probability vectors corresponding to the choice sets, so

$$\ln p(\theta|v_i) = \begin{pmatrix} \ln p_{(1)}(\theta|v_i) \\ \vdots \\ \ln p_{(S)}(\theta|v_i) \end{pmatrix},$$

where $p_{(s)}(\theta|v_i)$, $s = 1, \dots, S$, are the probability vectors corresponding to choice set s , so

$$\frac{\partial \ln p(\theta|v_i)}{\partial \theta'} = \begin{pmatrix} \frac{\partial \ln p_{(1)}(\theta|v_i)}{\partial \theta'} \\ \vdots \\ \frac{\partial \ln p_{(S)}(\theta|v_i)}{\partial \theta'} \end{pmatrix}$$

and

$$\frac{\partial L_i(y^i|\theta, v)}{\partial \theta} = \left(\left(\frac{\partial \ln p_{(1)}(\theta|v_i)}{\partial \theta'} \right)' \quad \dots \quad \left(\frac{\partial \ln p_{(S)}(\theta|v_i)}{\partial \theta'} \right)' \right) y^i.$$

By Sándor (2001, p.9)

$$\frac{\partial \ln p_{(s)}(\theta|v_i)}{\partial \theta'} = P_{(s)}^{-1} \frac{\partial p_{(s)}}{\partial \theta'},$$

where $P_{(s)}$ is the diagonal matrix of $p_{(s)}$ and for simplicity we omitted the argument $(\theta|v_i)$. Let us particularize to β . Then we obtain,

$$\frac{\partial p_{(s)}}{\partial \beta'} = \left(P_{(s)} - p_{(s)} p'_{(s)} \right) X_{(s)},$$

so

$$\frac{\partial \ln p_{(s)}(\theta|v_i)}{\partial \beta'} = P_{(s)}^{-1} \left(P_{(s)} - p_{(s)} p'_{(s)} \right) X_{(s)} = \left(I_{(s)} - \iota_{(s)} p'_{(s)} \right) X_{(s)},$$

hence

$$\left(\frac{\partial \ln p_{(s)}(\theta|v_i)}{\partial \beta'} \right)' = X'_{(s)} \left(I_{(s)} - p_{(s)} \iota'_{(s)} \right),$$

and

$$\begin{aligned} \frac{\partial L_i(y^i|\theta, v)}{\partial \beta} &= \left(X'_{(1)} \left(I_{(1)} - p_{(1)} \iota'_{(1)} \right) \quad \dots \quad X'_{(S)} \left(I_{(S)} - p_{(S)} \iota'_{(S)} \right) \right) y^i \\ &= \left(X'_{(1)} \quad \dots \quad X'_{(S)} \right) \begin{pmatrix} I_{(1)} - p_{(1)} \iota'_{(1)} & & 0 \\ & \ddots & \\ 0 & & I_{(S)} - p_{(S)} \iota'_{(S)} \end{pmatrix} y^i \\ &= X' (I - B_i) y^i, \end{aligned}$$

where

$$B_i \equiv B(\theta|v_i) = \begin{pmatrix} p_{(1)} \iota'_{(1)} & & 0 \\ & \ddots & \\ 0 & & p_{(S)} \iota'_{(S)} \end{pmatrix}.$$

In a similar way, we can derive

$$\frac{\partial L_i(y^i|\theta, v)}{\partial \sigma} = V X' (I - B_i) y^i.$$

Consequently,

$$\begin{aligned} \frac{\partial (\exp L_i (y^i | \theta, v))}{\partial \theta} &= \begin{pmatrix} X' (I - B_i) y^i \exp L_i (y^i | \theta, v) \\ V X' (I - B_i) y^i \exp L_i (y^i | \theta, v) \end{pmatrix} \\ &= \begin{pmatrix} I_V \\ V \end{pmatrix} X' (I - B (\theta | v)) y^i \exp L_i (y^i | \theta, v), \end{aligned}$$

and

$$\frac{\partial \mathcal{L} (y^i | \theta)}{\partial \theta} = \frac{\int \begin{pmatrix} I_V \\ V \end{pmatrix} X' (I - B (\theta | v)) y^i \exp L_i (y^i | \theta, v) d\Phi (v)}{\int \exp L_i (y^i | \theta, v) d\Phi (v)}. \quad (13)$$

Since this expression is in vector-matrix form, it is easier to program (in Gauss or Matlab) than the one provided by Bliemer and Rose (2010), which uses sums.

3.2 Estimation of the design criterion

The design criterion cannot be computed exactly, so it needs to be estimated/approximated. Recall that the design criterion is $D (X, \theta) = [\det I (X, \theta)]^{1/d}$, where

$$I (X, \theta) = n \cdot \sum_{y^i} \Pr (y^i) \left[\frac{\partial \mathcal{L} (y^i | \theta)}{\partial \theta} \frac{\partial \mathcal{L} (y^i | \theta)}{\partial \theta'} \right]. \quad (14)$$

Estimation of $I (X, \theta)$ involves estimation of the integrals in $\frac{\partial \mathcal{L} (y^i | \theta)}{\partial \theta}$ and the sum over all possible realizations of y^i . The number of these possible realizations is J^S , which in typical practical examples has the magnitude of several thousands (e.g., $2^{15} = 32768$ in the case of 15 choice sets with 2 alternatives or $3^{10} = 59049$ in the case of 10 choice sets with 3 alternatives).

The integrals involved in $\frac{\partial \mathcal{L} (y^i | \theta)}{\partial \theta}$ can be estimated by one of the commonly used methods (Monte Carlo, quasi-Monte Carlo or Gaussian quadrature using sparse grids). The sum over y^i typically contains excessively many terms, and therefore, we also estimate it by Monte Carlo simulations. To do this, we draw from the discrete distribution of the y^i 's. In order to accomplish this, first for each consumer i we draw v_i , the standard normally distributed random vector that determines the random coefficient of respondent i . Once we know v_i , the choices of i across the choice sets become independent; in choice set s the choice (i.e., y_{js}^i , $j = 1, \dots, J$) can be obtained as one multinomial draw with

probabilities $p_{js}(\theta|v_i)$, $j = 1, \dots, J$ defined in (9). If we denote these draws by \tilde{y}_{js}^i and let $\tilde{y}^i = \left(\tilde{y}_{js}^i\right)_{\substack{j=1, \dots, J, \\ s=1, \dots, S}}$, and obtain a sample $(\tilde{y}^{i,r})_{r=1, \dots, R}$ of such replicated draws, then a Monte Carlo estimate of $I(X, \theta)$ is

$$\tilde{I}(X, \theta) = \frac{n}{R} \sum_{r=1}^R \left[\frac{\partial \mathcal{L}(\tilde{y}^{i,r}|\theta)}{\partial \theta} \frac{\partial \mathcal{L}(\tilde{y}^{i,r}|\theta)}{\partial \theta'} \right].$$

4 Quasi-Monte Carlo sampling

We use two different types of quasi-Monte Carlo samples. The first type is a randomized (t, m, s) -net and the second type is a randomly shifted lattice. They are both samples from $[0, 1)^s$ and they are meant to replace in the Monte Carlo estimator pseudo-random draws from the uniform distribution on $[0, 1)^s$ in order to estimate integrals on $[0, 1)^s$. These samples are randomized versions of deterministic sequences. There are several quasi-Monte Carlo samples available in the literature; the reason for using exactly these is that they perform relatively well in the estimation of multivariate normal probabilities (Sándor and András 2004). We mention below only the most essential features of these; for more details we refer to Sándor and András (2004) and the references therein.

4.1 Randomized (t, m, s) -nets

A (t, m, s) -net in base b is a set of b^m points from $[0, 1)^s$ that satisfy certain equidistribution property, namely that all subintervals of $[0, 1)^s$ of a certain type contain a given number of points of the sequence. This equidistribution property ensures that the sequence approximates closely the continuous uniform distribution on $[0, 1)^s$. (t, m, s) -nets are deterministic, so we need to randomize them. We use a method that randomizes these numbers from the s -dimensional unit hypercube by permuting their digits in base b representation such that the permutation depends on the coordinate $j \in \{1, \dots, s\}$ and the order of the digits in base b representation. By this randomization one obtains vectors whose elements are from the set $\left\{0, \frac{1}{b^m}, \frac{2}{b^m}, \dots, \frac{b^m-1}{b^m}\right\}$. In order to make these coordinates uniform random on $[0, 1)$, we add to them $\frac{u_{ij}}{b^m}$, where u_{ij} is uniform random on $[0, 1)$. This way we obtain randomized (t, m, s) -nets that inherit the equidistribution property of the original nets and contain points that are uniformly distributed.

4.2 Randomized good lattice points

The simplest type of lattice points s -dimensional vectors

$$x_i = \left(\left\{ \frac{i}{n} \right\}, \left\{ \frac{iq}{n} \right\}, \dots, \left\{ \frac{iq^{s-1}}{n} \right\} \right) \text{ for } i = 0, 1, \dots, n-1, \quad (15)$$

where n is the number of lattice points, q is a positive integer relative prime with n , and the symbol $\{x\}$ means the fractional part of the number x . Lattice points are easy to generate, provided that we know q . Procedures for obtaining appropriate q values are based on minimizing the worst-case integral error. This criterion is based on the Fourier series representation of the integrand. Fourier series are helpful in expressing the integration error of lattice points because lattice points are especially suited for integrating periodic functions, or, more precisely, functions that admit a continuous periodic extension.

Randomization of lattice points is typically done by random shifting. A randomly shifted lattice has the points

$$x_i = \left(\left\{ \frac{i}{n} + u_1 \right\}, \left\{ \frac{iq}{n} + u_1 \right\}, \dots, \left\{ \frac{iq^{s-1}}{n} + u_s \right\} \right) \text{ for } i = 0, 1, \dots, n-1, \quad (16)$$

where u_1, \dots, u_s are independent random uniform numbers on $[0, 1)$. These randomly shifted lattice points can be regarded as having been drawn from the uniform distribution if we replace i by $\pi(i)$ in (16), where π is a random uniform permutation of $0, 1, \dots, n-1$.

The lattice points perform better if they are transformed by the so-called baker's transformation $\varphi(z) = |2z - 1|$ (that is, each coordinate of each point is transformed). This in fact transforms the integrand function into a function that has a continuous periodic extension, so it is expected to improve the performance of the lattice points.⁵

5 Simulation studies

The motivation of the simulation studies, as mentioned in Section 4, is to find out if quasi-Monte Carlo sampling can improve the precision of the objective function simulator, and if so, what the gains are in terms of precision and computing time. In the simulation design we intend to come as close as possible to reality.

⁵Gauss-codes for generating the samples are available from the author.

5.1 Random coefficient logit with demographic characteristics

There are some common ingredients in the data generating processes (DGP's) that we use for the two models. In both models $K = 5$, which is the number of random coefficients, the characteristics are generated as $x_{j1} = 1, x_{j2}, \dots, x_{j5} \sim U[0, 1], \xi_j \sim N(0, 0.25)$. The true parameters are $b = (-6, -1, 1, 1, 1)'$, $\sigma_1 = \dots = \sigma_5 = 1$. The true market shares are computed by MC with 10,000 pseudo-random draws.

In all cases considered we generate randomly 11 data sets and across all the different simulation studies these are constructed by the same random number generating seeds. We compare the performance of four samples: two pseudo-random samples of size N and $r \times N$ (denoted *MC* and *MCr*), a digital $(0, m, s)$ -net (denoted *Net*) and lattice points with the bakers's transformation (found to be the best in estimating normal probabilities by Sándor and András 2004, denoted *Lat* in the tables) of size (approximately) N . In order to measure the performance we estimate the bias, standard deviation (SD) and root mean squared error (RMSE) of the objective function estimates by using 100 replications of the objective function estimates. Across all the different simulation studies we construct the samples based on the same 100 random number generating seeds. Out of the 11 cases we only present three cases for each simulation study. These correspond to the minimum, median and maximum of the ratios of $RMSE_{Net}/RMSE_{MCr}$. In all cases when we use lattice points we chose the parameter value $q = 1571$ from those given by Hickernell et al. (2000). We use this value for all sample sizes and dimension values.

For this model we consider two different data generating processes (DGP's) that differ in the dimension L and number of support points $n_h, h = 1, \dots, L$, of the demographic characteristics. In both DGP's we use $J = 100$, we assume that d_{ih} has support of n_h values generated from $N(0, 4)$, where n_h will be specified below. For the sample size we take $N = 512$.

In the first DGP we take $L = 5, n_1 = 30$ and $n_2 = \dots = n_5 = 3$. For the coefficients of the demographic characteristics we take $\Gamma = \text{diag}(1, 1, 2, 2, 2)$. The results are summarized in Table 1. In this case the sample sizes differ slightly due to the fact that there is no $(0, m, s)$ -net of size exactly 512 and dimension 10. Instead we use a $(0, 2, 10)$ -net in base 23, which is of size 529. From the results we can see that the estimates of the objective functions obtained by the samples *Lat*, *Net* and *MC6* appear to be fairly precise. In general, the estimates of the objective functions tend to be upward biased. We can also see that a smaller SD corresponds to smaller bias.

Table 1. Random coefficient logit with multiple demographic characteristic

Sample	Size	Min $\left\{ \frac{RMSE_{Net}}{RMSE_{MC6}} \right\}$			Median $\left\{ \frac{RMSE_{Net}}{RMSE_{MC6}} \right\}$			Max $\left\{ \frac{RMSE_{Net}}{RMSE_{MC6}} \right\}$		
		True value=0.2587			True value=0.3040			True value=0.2835		
		Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE
MC	529	0.3234	0.4705	0.5709	0.0509	0.0619	0.0801	0.0478	0.0511	0.0700
Lat	512	0.0152	0.0167	0.0226	0.0124	0.0121	0.0173	0.0223	0.0207	0.0304
Net	529	0.0187	0.0180	0.0260	0.0093	0.0114	0.0147	0.0261	0.0190	0.0323
MC6	3072	0.0377	0.0501	0.0627	0.0095	0.0134	0.0164	0.0186	0.0173	0.0254

Notes. (i) The minimum, median and maximum of the RMSE ratios are computed from 11 randomly generated realizations.
(ii) The $RMSE_{Net}/RMSE_{MC6}$ values are 0.41, 0.53, 0.84, 0.86, 0.87, 0.90, 0.98, 1.21, 1.22, 1.23, 1.27.
(iii) The $RMSE_{Lat}/RMSE_{MC6}$ values are 0.36, 0.75, 0.78, 0.81, 0.90, 1.06, 1.07, 1.20, 1.26, 1.42, 1.45.

Regarding the performance of the samples, *Net* has a better performance in the median case than the other samples by having both SD and RMSE the smallest. When the ratio $RMSE_{Net}/RMSE_{MC6}$ is minimal, *Lat* is the best, while when it is maximal, *MC6* is the best. In all cases presented, the other three samples clearly outperform *MC*. The overall relative performances can be assessed from the values of the ratios $RMSE_{Net}/RMSE_{MC6}$ and $RMSE_{Lat}/RMSE_{MC6}$ in the *Notes* at the bottom of the table. According to these, *Net* outperforms *MC6* seven times, so we can say that *Net* performs at least as good as *MC6* in this example. This implies that by using a (0, 2, 10)-net in base 23 instead of a pseudo-random sample of size 3072, in order to achieve the same precision of the objective function estimate, we can reduce the computing time by about 83%. According to the values of the ratios, we can also conclude that the lattice sample has a performance comparable to *MC6*.

In the second DGP we take $L = 1$, $n_1 = 2000$ and $\Gamma = 1$. Such a case, in which there is one demographic characteristic with very many possible values, covers the situation when the demographic characteristics are dependent and the researcher has information about their joint discrete distribution (as we mention in a footnote on page 89).

The results are summarized in Table 2. In this example we use a (0, 3, 6)-net in base 8, which is of size 512. We note that a sample of this type was found to be the best by Sándor and Train (2004) among several different samples. The larger pseudo-random sample has size 1536. The estimates of the objective functions appear to be more precise than in the previous example.

Table 2. Random coefficient logit with one demographic characteristic

Sample	Size	Min $\left\{ \frac{RMSE_{Net}}{RMSE_{MC3}} \right\}$			Median $\left\{ \frac{RMSE_{Net}}{RMSE_{MC3}} \right\}$			Max $\left\{ \frac{RMSE_{Net}}{RMSE_{MC3}} \right\}$		
		True value=0.2616			True value=0.2009			True value=0.3362		
		Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE
MC	512	0.0065	0.0074	0.0098	0.0073	0.0110	0.0132	0.0068	0.0113	0.0131
Lat	512	0.0024	0.0041	0.0047	0.0028	0.0061	0.0067	0.0081	0.0144	0.0165
Net	512	0.0016	0.0020	0.0026	0.0015	0.0046	0.0049	0.0023	0.0077	0.0080
MC3	1536	0.0025	0.0038	0.0045	0.0023	0.0043	0.0048	0.0026	0.0056	0.0062

Notes. (i) The minimum, median and maximum of the RMSE ratios are computed from 11 randomly generated DGP realizations.
 (ii) The $RMSE_{Net}/RMSE_{MC3}$ values are 0.57, 0.73, 0.79, 0.85, 0.89, 1.01, 1.02, 1.06, 1.15, 1.21, 1.30.
 (iii) The $RMSE_{Lat}/RMSE_{MC3}$ values are 0.46, 0.78, 0.84, 0.84, 1.04, 1.13, 1.21, 1.29, 1.38, 2.68, 3.09.

The results in Table 2 imply that *Net* has a performance much better than *MC*. In the median case its performance is very similar to that of *MC3* and better than *Lat*. Based on the $RMSE_{Net}/RMSE_{MC3}$ ratios, the two samples have rather similar performances. This implies a computing time reduction of about 66% by using a (0, 3, 6)-net in base 8 instead of a pseudo-random sample of size 1536. According to the values of the ratios $RMSE_{Lat}/RMSE_{MC3}$, we can conclude that the lattice sample has a performance just slightly poorer than *MC3*.

5.2 Random coefficient logit with limited consumer information

For this model, besides the variables specified at the beginning of this section, we take $J = 20, K = 5, L = 1$. The probability that affects whether consumer i observes product j is specified as

$$\phi_j(\gamma_i) = \frac{\exp(\gamma_i t_j)}{1 + \exp(\gamma_i t_j)},$$

where $\gamma_i \sim N(-1.5, 1)$, so $\theta_2 = (-1.5, 1)$ and t_j are generated as $U[0, 1]$, $j = 1, \dots, J$. We take $\theta_{20} = (-1, 1.5)$ for the fixed value of the parameter used for the importance sampling probabilities. We use a (0, 2, 26)-net in base 32, which has size 1024, while the larger pseudo-random sample has size 2024. The results are presented in Table 3.

Table 3. Random coefficient logit with limited information

Sample	Size	Min $\left\{ \frac{RMSE_{Net}}{RMSE_{MC2}} \right\}$			Median $\left\{ \frac{RMSE_{Net}}{RMSE_{MC2}} \right\}$			Max $\left\{ \frac{RMSE_{Net}}{RMSE_{MC2}} \right\}$		
		True value=0.1594			True value=0.3209			True value=0.2240		
		Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE
MC	1024	0.0280	0.0337	0.0438	0.0252	0.0487	0.0549	0.0116	0.0263	0.0287
Lat	1024	0.0275	0.0884	0.0926	0.0144	0.0419	0.0443	0.0203	0.1028	0.1048
Net	1024	0.0190	0.0208	0.0282	0.0164	0.0339	0.0377	0.0065	0.0248	0.0256
MC2	2048	0.0258	0.0381	0.0460	0.0222	0.0379	0.0440	0.0069	0.0105	0.0125

Notes. (i) The minimum, median and maximum of the RMSE ratios are computed from 11 randomly generated DGP realizations.
(ii) The $RMSE_{Net}/RMSE_{MC4}$ values are 0.61, 0.63, 0.72, 0.73, 0.83, 0.86, 0.97, 1.20, 1.21, 1.35, 2.04.
(iii) The $RMSE_{Lat}/RMSE_{MC4}$ values are 1.01, 1.50, 1.97, 2.01, 2.02, 2.16, 2.43, 2.57, 3.02, 5.26, 8.36.

The results in Table 3 imply that *Net* has a performance clearly better than *MC*. In the median case its performance is very similar to that of *MC2* and better than *Lat*, which has a surprisingly poor performance. In fact, according to the values of the ratios $RMSE_{Lat}/RMSE_{MC2}$, the lattice sample has a performance poorer than *MC3* in all cases. Based on the $RMSE_{Net}/RMSE_{MC2}$ ratios, *Net* outperforms *MC2* in 7 out of the the 11 cases considered. This implies a computing time reduction of at least 50% by using a (0, 2, 26)-net in base 32 instead of a pseudo-random sample of size 2024.

5.3 Design for the panel mixed logit

We consider a design of type $3^4/2/15$, that is, with $S = 15$ choice sets, $J = 2$ alternatives in each set with four attributes, each attribute having three levels: 1, 2, 3. We use effect coding that assigns $[1 \ 0]$, $[0 \ 1]$, $[-1 \ -1]$ to the levels 1, 2, 3, respectively. We assume that the true parameters are $\beta = [-1 \ 0 \ -1 \ 0 \ -1 \ 0 \ -1 \ 0]'$, $\sigma = [1 \ 0 \ 1 \ 0 \ 1 \ 0 \ 1 \ 0]'$. We construct nine such designs by the swapping (Huber and Zwerina 1996) and cycling (Sándor and Wedel 2001) algorithms using randomly generated starting designs. For each design we evaluate the design criterion (12) in the way described in Section 3.2. For the integrals (13) involved in the design criterion we use a (0, 3, s)-net in base 4. We estimate the sum from (14) by a (0, 2, s)-net in base 19, which has size 361, and pseudo-random samples of size 361 and 650. For computing the true values we used a sample of size 100,000. The results are reported in Table 4.

Table 4. Design criterion estimation for the panel mixed logit

Sample	Size	Min $\left\{ \frac{RMSE_{Net}}{RMSE_{MC2}} \right\}$			Median $\left\{ \frac{RMSE_{Net}}{RMSE_{MC2}} \right\}$			Max $\left\{ \frac{RMSE_{Net}}{RMSE_{MC2}} \right\}$		
		True value=1.497			True value=1.559			True value=1.580		
		Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE
MC	361	-0.033	0.066	0.074	-0.035	0.064	0.073	-0.039	0.060	0.072
Net	361	-0.019	0.045	0.049	-0.022	0.047	0.052	-0.028	0.047	0.055
MC2	650	-0.013	0.050	0.052	-0.019	0.049	0.053	-0.022	0.047	0.052

Notes. (i) The minimum, median and maximum of the RMSE ratios are computed from 9 randomly generated DGP realizations.
(ii) The $RMSE_{Net}/RMSE_{MC2}$ values are 0.95, 0.96, 0.97, 0.99, 0.99, 1.02, 1.02, 1.02, 1.06.

The first impression from the results is that all estimates are rather precise and have rather small downward bias. *Net* improves on the performance of *MC* only slightly; its performance is close to that of the pseudo-random sample *MC2* of size slightly less than double. The $RMSE_{Net}/RMSE_{MC2}$ ratios in the Notes below the table show the similarity of *Net* and *MC2*. We can conclude that the reduction in computing time is about 45%.

6 Conclusions

This paper presents results on how quasi-Monte Carlo methods ((t, m, s) -nets and lattice points) perform for estimating large sums. The terms of these large sums typically contain analytically intractable integrals so that computing the sums exactly is computationally unfeasible. The paper concludes that quasi-Monte Carlo methods offer significant advantages in terms of computation. Specifically, $(0, m, s)$ -nets used in this paper yield reductions in computing time relative to pseudo-random draws that range between 45-83%.

When the terms of the large sums are integrals, then it is possible to express the sum as one integral having dimension higher than the original integrals. In such cases the performance of the quasi-Monte Carlo methods compared to pseudo-Monte Carlo is better due to the joint treatment of the variables of the obtained integral (see the results reported in Sections 5.1 and 5.2. The design criterion for the panel mixed logit model is a large sum of expressions that are nonlinear in several integrals, so its estimation makes only limited use of the advantages offered by quasi-Monte Carlo samples.

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