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RETHINKING THE MONTI-KLEIN MODEL OF BANKING INDUSTRY: NEW INSIGHTS ABOUT THE SEPARABILITY OF LOANS AND DEPOSITS DECISIONS

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Rethinking the Monti-Klein model of banking industry: New insights about the separability of loans and deposits decisions

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Abstract

In this paper I analyze three alternative modifications of the oligopoly form of the Monti-Klein model of banking competition. I show that, under some plausible assumptions about the industry structure, the decisions about loans and deposits are interdependent in these models (even under the assumptions of separable costs). Thus, I reverse the standard result of the Monti-Klein model in which the two decisions are independent. The three models are: 1) incumbent/entrant game with barriers to mobility and quantity competition, 2) incumbent/entrant game with barriers to mobility and differentiated price competition and 3) incumbent/entrant game with price competition and endogenously chosen level of differentiation. Although each of the models explains different phenomena, they are closely linked together by their sequential game theoretical nature.

Abstrakt

V tomto článku analyzuji tři alternativní modifikace oligopolní verze Monti-Kleinova modelu bankovního odvětví. Jedná se o modely: 1) incumbent/entrant game s bariérami mobility a množstevní konkurencí, 2) incumbent/entrant game s bariérami mobility a cenovou konkurencí a 3) incumbent/entrant game s bariérami mobility, cenovou konkurencí a endogenně zvoleným stupněm produktové diferenciace. Argumentuji, že za určitých realistických předpokladů o struktuře odvětví jsou rozhodnutí bank o optimální úrovni úvěrů a deposit vzájemně závislá (i za předpokladu separabilních nákladů). Tento výsledek tak kontrastuje s výsledkem tradičního Monti-Kleinova modelu, v němž jsou rozhodnutí o úvěrech a depositech nezávislá.

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1. Introduction

Banking industry has always attracted lots of interest of industrial organization economists. The question of what is the appropriate regulation of the banking industry has always been one of the most controversial topics which fuelled many heated policy debates about the future of the industry. The unprecedented wave of banking mergers and acquisitions starting in the late eighties has made the banking industry even more interesting to the industrial organization field. Although there are many other well-performing models, the most popular industrial organization model of the banking industry is the Monti-Klein model in its oligopoly form. The popularity of the Monti-Klein model can arguably be attributed to its simplicity but also to its relative power in modeling the effects of most frequently discussed issues about the conduct and performance of the banking industry[1]. However, even the well accepted Monti-Klein model is not free of controversies. One of the most important ones is the question of the separability of the decisions about loans and deposits in the banks' optimization problem.

The question of the separability has strong links to banking regulation. If the decisions about loans and deposits are interdependent then (many experts say) it might happen that the severe competition in deposits will lead to excessively high interest rates on loans. This has led many governments to impose what has become known as the regulation Q – i.e. the ceiling on deposit rates. However, if the decisions about loans and deposits are independent then such a regulation has no sense and, moreover, it can only be expected to decrease total welfare due to the

[1] Other interesting and widely used industrial organization model of the banking industry is the application of the Salop's circular city model to banking (see Freixas, Rochet, 1997 for a review); however, Monti-Klein model has arguably much wider range of applicability then the banking version of the Salop's model and thus it can be applied to the study of a great number of diverse problems.

inefficiencies inherent to any governmental regulation. The standard result of the basic Monti-Klein model is that (under the assumptions to be discussed below) the two decision problems are indeed independent. In what follows, I want to show that under some very plausible assumptions about the industry structure, the well known separability of (independence of) the decisions about the optimal level of loans and deposits in the Monti-Klein model breaks down.

There have been many efforts to show that the loans and deposits decisions are interdependent. One approach has been to introduce risk-aversion – Pyle (1971) is the representative model of this type. In the Pyle's model, the bank chooses between three securities – one risk-less security and two securities with uncertain returns – loans with interest rate r_1 and deposits with interest rate r_2. Pyle shows that in his model the loans and deposits decisions are indeed interdependent if r_1 and r_2 are not independent. Another approach has been to introduce risk of default into the model. Most notably, Dermine (1986) shows that the loans and deposits decisions are interdependent if the bank faces a positive probability of default (the link between the two decisions is facilitated through the limited liability of the bank)[2]. In my paper, I am able to show that it is possible to make the loans and deposits decisions interdependent by much less drastic changes of the standard Monti-Klein model – it is enough to slightly modify the assumptions about the industry structure.

Before discussing my extensions and modifications, I first briefly review the standard oligopoly version of the Monti-Klein model and its basic results in part 2 of the paper. In part 3, I move to the first modification of the model which is inspired by the standard incumbent/entrant game in the spirit of the Bain-Sylos-Labini-Modigliani

[2] For a more detailed disscussion of the Pyle's model as well as of other similar models see for example Baltensperger (1995) or Santomero (1994).

framework (BSM framework)[3]. In other words, I introduce the barriers to mobility into the standard Monti-Klein model. Specifically, in part 3, I present a two-stage game with quantity as the strategic variable in the second (duopoly) stage of the two-stage game. In part 3, I present a similar model but now I assume that prices instead of quantities play the role of the strategic variable and there is partial product differentiation so that we can avoid the Bertrand paradox. In part 4, I move to another two-stage oligopoly game with endogenously chosen level of differentiation. In all the three models, I am able to show that the banks' decisions about loans and deposits are interdependent – thus I reverse the basic result of the standard Monti-Klein model of the banking industry.

2. Review of the standard Monti-Klein model

I review here the standard oligopoly version of the Monti-Klein model[4] because I need to have a benchmark model for my later analysis. More precisely, I concentrate on the duopoly case here for the sake of simplicity and clarity (the generalization to the n-banks case is trivial).

Let's assume a downward sloping demand for loans $L(r_L)$, an upward sloping supply of deposits $D(r_D)$ and the respective inverse functions $r_L(L)$ and $r_D(D)$. Let's also assume that the demand for loans and the supply of deposits are independent. Bank i takes the amount of loans and deposits chosen by the other banks as given and maximizes its profit by the choice of the amount of loans L_i it offers and the amount of deposits D_i it demands (i is 1 or 2 in duopoly). The profit function of bank i takes the form

[3] For a review of the BSM framework see Tirole (2003).
[4] For a detailed discussion of the Monti-Klein model see for example Freixas, Rochet 1997.

$$\pi_i = \{(r_L(L_1 + L_2) - r)L_i + (r(1-\alpha) - r_D(D_1 + D_2))D_i - C(L_i, D_i)\},$$

where $C(L_i, D_i)$ is the bank's cost function which is assumed to be the same for all banks and which is usually interpreted as the administrative cost associated with the provision and management of loans L_i and deposits D_i. The first order conditions $\frac{\partial \pi_i}{\partial L_i} = 0$ and $\frac{\partial \pi_i}{\partial D_i} = 0$ lead to $r'_L(L^*)\frac{L^*}{2} + r_L(L^*) - r - \frac{\partial C(L_1, D_1)}{\partial L_i} = 0$

and $-r'_D(D^*)\frac{D^*}{2} + r(1-\alpha) - r_D(D^*) - \frac{\partial C(L_1, D_1)}{\partial D_i} = 0$.

If we combine these first order conditions, we obtain the standard result from the traditional industrial organization analysis of oligopoly, namely we obtain the pricing rule $L = \frac{1}{2\varepsilon}$, where L stands for Lerner index (which is equal to $\frac{price - marginal\ costs}{marginal\ costs}$) and ε stands for demand elasticity. In our case, this rule takes the form

$$\frac{r_L^* - (r + \frac{\partial C(L_1, D_1)}{\partial L_i})}{r_L^*} = \frac{1}{2\varepsilon_L(r_L^*)}$$

and $\frac{r(1-\alpha) - \frac{\partial C(L_1, D_1)}{\partial D_i})}{r_D^*} = \frac{1}{2\varepsilon_D(r_D^*)}$.

It is clear from these optimality conditions that the interdependence of the loans and deposits decisions depends only on the form of the terms $\frac{\partial C(L_1, D_1)}{\partial L_i}$ and $\frac{\partial C(L_1, D_1)}{\partial D_i}$. It is commonly assumed that $C(L_i, D_i)$ takes an additively separable form $C(L_i, D_i) = \gamma_L L_i + \gamma_D D_i$. In such a case, we obtain full independence of the loans and deposits decisions and the optimal amounts of loans and deposits are determined as

$L_i^* = L_i^*(r, \gamma_L, L_{-i})$

and $D_i^* = D_i^*(r, \alpha, \gamma_D, D_{-i})$,

where the index –i stands for "other than i".

The loans and deposits decision problems might obviously become interdependent once we relax our assumptions about the separability of the cost function. However, based on the empirical evidence, it is often argued that the administrative costs are not very important relative to other aspects of the banking business and thus, the issue of the independence of the decision problems should not hinge only on the form of the cost function[5].

Another possibility how to introduce interdependence among the loans and deposits decisions is to relax the assumption of the independence of the demand for loans and the supply of deposits. However, similar argument can be applied here as in the previous case. It is difficult to come up with an argument in favor of the direct dependence of the demand for loans on the deposit interest rate, as well as the dependence of the supply of deposits on the loans interest rate. On the other hand, it is possible to think about some indirect interdependence between the demand for loans and the supply of deposits – that is exactly the approach which I take in part 4 of this paper. Specifically, I build a model in which the demand for loans and the supply of deposits are linked together by another factor in the model – the endogenously chosen level of differentiation. Under some arguably plausible assumptions, I am able to show that this modification leads to the interdependence between the loans and deposits decision problems.

[5] See for example Sinkey (2002).

3. Barriers to mobility in the Monti-Klein model – the case of quantity competition

The first modification of the Monti-Klein model is inspired by the standard incumbent-entrant game in the traditional BSM framework[6]. Compared to the traditional BSM framework, the presence of simultaneous competition in loans and deposits leads to a more complex model with interesting new results. Compared to the standard Monti-Klein model, the main distinguishing feature of the new model is the fact that the model is set up as a two-stage game (rather than the one-stage game in the traditional Monti-Klein framework) and that the position of the competing banks is asymmetric – in the duopoly case, one bank plays the role of the incumbent and the other assumes the role of the entrant. Another crucial assumption is that there are fixed setup costs which have to be incurred by any bank which plans to enter the banking industry. Otherwise the setup of the new model follows the setup of the standard Monti-Klein framework. Specifically, I assume here that the cost function takes the additively separable form specified above – I concentrate only on the fundamental reasons for independence of the loans and deposits decision problems (see my arguments above).

In the first stage of the game, the incumbent bank can pre-commit itself to the amount of deposits and loans which it desires to have in the second stage. The entrant can observe these choices of the incumbent and, depending on this information, decides whether or not to enter into the industry. In the second stage of the game, the incumbent is assumed to fulfill its commitments from the first stage and the entrant (if in the industry) reacts optimally to the choices of the incumbent. The

[6] Tirole (2003) discusses the BSM framework in its general form. The novelty of my model is in the incorporation of the simultaneous competition in inputs (deposits) and outputs (loans) and also in the inclusion of the Monti-Klein type of perfectly elastic outside clearing (represented by the bank-lending rate r).

second stage of the game can actually be identified with the classical Stackelberg type competition with quantity as a strategic variable. However, compared to the standard Stackelberg game, the incumbent can potentially deter entry due to the presence of fixed setup costs. In other words, accommodation in the second (Stackelberg) stage is not automatic in this modified model – it might be optimal for the incumbent to pre-commit to such amounts of loans and deposits that the entrant cannot cover its fixed costs and thus optimally chooses not to enter.

It is instructive to begin with the standard Stackelberg model without fixed costs. In such a model, the entrant (let's call it 2) maximizes the profit function

$$\pi_2 = \{(r_L(L_1 + L_2) - r)L_2 + (r(1-\alpha) - r_D(D_1 + D_2))D_2 - \gamma_L L_2 + \gamma_D D_2\},$$

which leads to (analogously to the standard case from part 2) the optimal choices (reaction functions)

$$L_2^* = L_2^*(r, \gamma_L, L_1)$$

and $D_2^* = D_2^*(r, \alpha, \gamma_D, D_1)$.

The incumbent's optimization problem is then to maximize the following profit function

$$\pi_1 = \{(r_L(L_1 + L_2^*(L_1)) - r)L_1 + (r(1-\alpha) - r_D(D_1 + D_2^*(D_1)))D_1 - \gamma_L L_1 - \gamma_D D_1\},$$

where $L_2^*(L_1)$ and $D_2^*(D_1)$ stand for the reaction functions from the entrant's problem. The first order conditions imply

$$r_L(L_1 + L_2^*(L_1)) - r + r_L^{'}(L_1 + L_2^*(L_1))(1 + L_2^{*'}(L_1))L_1 - \gamma_L = 0$$

and $r(1-\alpha) - r_D(D_1 + D_2^*(D_1)) - D_1(r_D^{'}(D_1 + D_2^*(D_1))(1 + D_2^{*'}(D_1)) - \gamma_D = 0$

Now it is clear that the incumbent's optimal choices of loans and deposits are still independent. Precisely, we obtain the following general results

$$L_1^* = L_1^*(r, \gamma_L)$$

and $D_1^* = D_1^*(r, \alpha, \gamma_D)$.

Thus, the sole market leadership is not enough to break the independence of the loans and deposits decision problems in the Monti-Klein model.

Now, let's move to the more interesting case with the presence of the fixed setup costs. The entrant's profit function now changes to

$$\pi_2 = \{(r_L(L_1 + L_2) - r)L_2 + (r(1-\alpha) - r_D(D_1 + D_2))D_2 - \gamma_L L_2 - \gamma_D D_2 - F\},$$

where F stands for the fixed setup costs which have to be incurred on entry. If the entrant has to face positive fixed setup costs then the incumbent has to compare the profitability of accommodation and entry deterrence. In other words, it has to compare whether it is more profitable to let the entrant enter and make positive profit or whether it is more profitable to choose such levels of loans and deposits that the entrant would make non-positive profit and thus would not enter.

Let's look at the incumbent's problem in a slightly more formal way. The profit from accommodation is computed in the same way as in the standard case of Stackelberg competition discussed above. Precisely, the profit is given by

$$\pi_1^A = \{(r_L(L_1^A + L_2^*(L_1^A)) - r)L_1^A + (r(1-\alpha) - r_D(D_1^A + D_2^*(D_1^A)))D_1^A - \gamma_L L_1^A - \gamma_D D_1^A\},$$

where the index A stands for accommodation and L_1^A and D_1^A are the optimal choices of the Stackelberg leader from above.

The profit from entry deterrence is computed in a slightly more complex way. As the first step, the incumbent has to compute its own amounts of loans and deposits which induce the entrant's profit to be non-positive. Precisely, the incumbent chooses such amounts of loans L_1 and deposits D_1 that the following equation holds

$$\pi_2 = \{(r_L(L_1 + L_2^*(L_1)) - r)L_2^*(L_1) + (r(1-\alpha) - r_D(D_1 + D_2^*(D_1)))D_2^*(D_1) - \gamma_L L_2^*(L_1) - \gamma_D D_2^*(D_1) - F\} \leq 0.$$

Note that I have obtained this equation by plugging the entrant's reaction functions into the entrant's profit function and by comparing the resulting term to 0. Thus, the entry-deterrence equation implicitly defines the combinations of the incumbent's

loans and deposits for which the entrant's profit is non-positive. Precisely, these combinations can be expressed as

$L_1^{**} = L_1^{**}(D_1^{**})$ or $D_1^{**} = D_1^{**}(L_1^{**})$, where the index ** means that the respective variable belongs to the solutions of the implicit equation given above. In the second step, the incumbent maximizes its monopoly profit function (entry is deterred) subject to the entry-deterrence equation given above. Thus, the problem is to maximize

$$\pi_1 = \left\{\left(r_L\left(L_1^{**}\right) - r\right)L_1^{**} + \left(r(1-\alpha) - r_D\left(D_1^{**}\right)\right)D_1^{**} - \gamma_L L_1^{**} - \gamma_D D_1^{**}\right\}$$

subject to the entry deterrence condition

$$L_1^{**} = L_1^{**}(D_1^{**}).$$

It is obvious that the optimal loans and deposits decisions are interdependent now – the interdependence naturally comes from the entry-deterrence condition. The incumbent's optimization problem is then completed by the comparison of the accommodation profit π_1^A with the implied entry deterrence profit $\pi_1^D = \pi_1^D(L_1^{***}, D_1^{***})$, where the index *** means that the respective variable is the solution of the incumbent's profit maximization problem in the case of entry deterrence. However, the main result of interest for us is the presence of the interdependence between the deposits and loans decisions in the entry deterrence part of the whole problem.

4. Barriers to mobility in the Monti-Klein model – the case of differentiated price competition

The second modification of the Monti-Klein model is very similar to the model discussed in the previous part. The main difference is that now the two banks are assumed to be choosing prices (the interest on loans and deposits) instead of quantities (the amounts of loans and deposits) – in the jargon of game theory, we

have different strategic variables here. If we had homogenous product in a model with prices as strategic variables, we would get the standard undercutting problem which is known as the Bertrand paradox. Thus, in order to avoid undercutting and the implied (and unrealistic) absolute price competition, I assume here that the bank's product (loans and deposits) is not perfectly homogenous. In other words, I assume that the loans and deposits are partially differentiated. For the sake of simplicity of the notation, I neglect the reserve requirements represented by the parameter α (I set it equal to zero arbitrarily). Otherwise, the setup of the model is the same as in the case with quantity competition.

The logic of the solution of the model is very similar to the logic of the previous model and thus I will proceed in a slightly faster pace this time. The incumbent bank is again comparing its profit in the accommodation and the entry deterrence cases. For both these cases, it first needs to know the entrant's reaction function which can be computed by maximizing the entrant's profit with respect to the entrant's interest on loans r_{L2} and the entrant's interest on deposits r_{D2}. The entrant's profit function looks as follows

$$\pi_2 = \{(r_{L2} - r)L_2(r_{L1}, r_{L2}) + (r - r_{D2})D_2(r_{D1}, r_{D2}) - C(L_2(r_{L1}, r_{L2}), D_2(r_{D1}, r_{D2})) - F\},$$

where it is assumed that $\frac{\partial L_2}{\partial r_{L2}}, \frac{\partial D_2}{\partial r_{D1}} \leq 0$ and $\frac{\partial L_2}{\partial r_{L1}}, \frac{\partial D_2}{\partial r_{D2}} \geq 0$ due to the assumption of partial differentiation of the loans and deposits. The first order conditions imply

$$L_2(r_{L1}, r_{L2}) + (r_{L2} - r)\frac{\partial L_2(r_{L1}, r_{L2})}{\partial r_{L2}} - \frac{\partial C(L_2(r_{L1}, r_{L2}), D_2(r_{D1}, r_{D2}))}{\partial L_2}\frac{\partial L_2(r_{L1}, r_{L2})}{\partial r_{L2}} = 0$$

and $-D_2(r_{D1}, r_{D2}) + (r - r_{D2})\frac{\partial D_2(r_{D1}, r_{D2})}{\partial r_{D2}} - \frac{\partial C(L_2(r_{L1}, r_{L2}), D_2(r_{D1}, r_{D2}))}{\partial D_2}\frac{\partial D_2(r_{D1}, r_{D2})}{\partial r_{D2}} = 0$.

We can immediately see that the cost function term is the first potential source of the interdependence between the decisions about loans and deposits. However, as in

the previous model, I am interested in a more fundamental source of the interdependence and thus, from now on, I will neglect the cost term completely[7]. It is then obvious that the entrant's reaction functions take the form $r_{L2}^{*} = r_{L2}^{*}(r, r_{L1})$ and $r_{D2}^{*} = r_{D2}^{*}(r, r_{D1})$.

The incumbent's optimization problem in the case of accommodation is to maximize the following profit function

$$\pi_1^A = \{(r_{L1} - r)L_1(r_{L1}, r_{L2}^{*}(r_{L1})) + (r - r_{D1})D_1(r_{D1}, r_{D2}^{*}(r_{D1})) - C(L_1(r_{L1}, r_{L2}^{*}(r_{L1})), D_1(r_{D1}, r_{D2}^{*}(r_{D1})))\},$$

where $r_{L2}^{*}(r_{L1})$ and $r_{D2}^{*}(r_{D1})$ stand for the reaction functions from the entrant's problem. The first order conditions imply (neglecting the cost term)

$$(r_{L1} - r)\left(\frac{\partial L_1(r_{L1}, r_{L2}^{*}(r_{L1}))}{\partial r_{L1}} + \frac{\partial L_1(r_{L1}, r_{L2}^{*}(r_{L1}))}{\partial r_{L2}}\frac{\partial r_{L2}(r_{L1})}{\partial r_{L1}}\right) + L_1(r_{L1}, r_{L2}^{*}(r_{L1})) = 0$$

and $(r - r_{D1})\left(\frac{\partial D_1(r_{D1}, r_{D2}^{*}(r_{D1}))}{\partial r_{D1}} + \frac{\partial D_1(r_{D1}, r_{D2}^{*}(r_{D1}))}{\partial r_{D2}}\frac{\partial r_{D2}(r_{D1})}{\partial r_{D1}}\right) - D_1(r_{D1}, r_{D2}^{*}(r_{D1})) = 0$.

It is again clear that the incumbent's optimal choices of loans and deposits are still independent in the case of accommodation.

The profit from entry deterrence is computed in the following way. Firstly, the incumbent has to compute its own interest on loans and deposits which induce the entrant's profit to be non-positive. Thus, the incumbent chooses such levels of r_{L1} and r_{D1} that the following equation holds[8]

$$\pi_2 = \{(r_{L2}^{*}(r_{L1}) - r)L_2(r_{L1}, r_{L2}^{*}(r_{L1})) + (r - r_{D2}^{*}(r_{D1}))D_2(r_{D1}, r_{D2}^{*}(r_{D1})) - F\} \leq 0 .$$

This entry-deterrence condition implicitly defines the combinations of the incumbent's interest on loans and deposits for which the entrant's profit is non-positive. These combinations can be expressed as $r_{L1}^{**} = r_{L1}^{**}(r, r_{L2})$ or $r_{D1}^{**} = r_{D1}^{**}(r, r_{D2})$, where the index

[7] Concerning the relative unimportance of the administrative costs, see the argumentation provided in part 3.
[8] Note that I ignore the cost term here – see the discussion above.

** means that the respective variable belongs to the solutions of the implicit equation given above. In the second step, the incumbent maximizes its monopoly profit function (entry is deterred) subject to the entry-deterrence equation given above. Thus, the problem is to maximize

$$\pi_1 = \left\{(r_{L1}^{**} - r)L(r_{L1}^{**}) + (r - r_{D1}^{**})D(r_{D1}^{**})\right\}$$

subject to the entry deterrence condition

$$r_{L1}^{**} = r_{L1}^{**}(r, r_{L2}).$$

It is obvious that the optimal decisions about the interests on loans and deposits are now interdependent – the interdependence again comes from the entry-deterrence equation.

4. Endogenously chosen level of differentiation in the Monti-Klein model

The models developed in parts 3 and 4 were both variants of the BSM model which is fundamentally based on the Stackelberg type of competition. In any Stackelberg model it is implicitly assumed that the incumbent fulfills its commitments from the first stage of the game. The problem with this assumption is that the fulfillment of the commitment is not part of Nash equilibrium in the second stage of the incumbent/entrant game. Thus, in order for the equilibrium from parts 3 and 4 to be stable, the incumbent's commitment must be binding. However, it is not very likely that the commitment is binding in many real world contexts.

In the third modification of the Monti-Klein model, I introduce endogenous choice of the differentiation of the product (loans and deposits) and at the same time, I eliminate the commitment problem. The main logic of the model is very similar to that of the Dixit's (1980) model of investment into capacity. Alternatively, my model

can be seen as an application of the ideas contained in the advertising model developed by Tirole and Fudenberg (1984).

The model is again based on a two-stage game framework similar to the one from the part 4 above. In the first stage, the incumbent bank chooses its level of differentiation from the potential entrant. Think of this as an investment into (directed) advertising which differentiates the incumbent bank from the others. The potential entrant is not in the industry yet – thus it is realistic to assume that it cannot advertise (at least not comparably to the incumbent). The crucial simplifying assumption in this model is that the incumbent is able to differentiate only in one dimension – i.e. it can set the differentiation of the whole bank, not of the loans or deposits separately. Specifically, let there be some differentiation variable called Dif. Then the incumbent influences its own and its competitor's demand for loans and supply of deposits by the choice of Dif. The higher is Dif the more is the incumbent differentiated from the entrant. For the sake of simplicity, I assume here that the supply and demand take the following linear form

$$L_i = a - b_1(Dif)r_{Li} + b_2(Dif)r_{L(-i)}$$

and $D_i = c + d_1(Dif)r_{Di} - d_2(Dif)r_{D(-i)}$,

where the index i is 1 or 2 for the incumbent or the entrant respectively and the index (-i) is the other value of i. I assume that people (banks' clients) like differentiated loans (loans which are better tailored to their specific needs) but do not like differentiated deposits. The rationale for the second part of this assumption is the following. For example, people may feel that the probability of provoking a self-fulfilling prophecy and a subsequent run on banks is lower if banks choose to attract only standard (almost) homogenous deposits. This is because the stability of the

perfectly elastic bank-lending market assumed in the Monti-Klein model is arguably higher in the case of the more homogenous deposits.

Based on the remarks made above, I assume that the investment into differentiation by the incumbent bank has the following influence on the demand for loans and the supply of deposits

$b_1^{'}(Dif) \leq 0,\ \ b_2^{'}(Dif) \geq 0,\ \ d_1^{'}(Dif) \leq 0,\ \ d_2^{'}(Dif) \geq 0$.

The entrant's decision in stage one is again whether or not to enter into the industry. Obviously, the entrant enters only if its profit is positive. In the second stage of the game, I look for the standard Nash equilibrium instead of the Stackelberg one. Thus, the banks choose the prices of their loans and deposits according to the pricing rules obtained from the intersection of their reaction functions. The resulting equilibrium is then more stable than in the case of Stackelberg competition because the commitment problem is eliminated.

In order to solve the model, I use backward induction and thus I first compute the second stage (Nash) equilibrium. The profit functions of the incumbent and entrant look as follows

$$\pi_1 = \{(r_{L1} - r)(a - b_1(Dif)r_{L1} + b_2(Dif)r_{L2}) - (r - r_{D1})(c + d_1(Dif)(c + d_1(Dif)r_{D1} - d_2(Dif)r_{D2})\}$$
$$\pi_2 = \{(r_{L2} - r)(a - b_1(Dif)r_{L2} + b_2(Dif)r_{L1}) - (r - r_{D2})(c + d_1(Dif)(c + d_1(Dif)r_{D2} - d_2(Dif)r_{D1}) - F\}.$$

Assume for simplicity that the fixed setup costs F are equal to 0 – I have already shown in parts 3 and 4 that the presence of the setup costs implies the interdependence between the decisions about loans and deposits. In this model, I am able to show that the two decision problems are connected even in the absence of the fixed setup costs (the extension to the case with positive setup costs would be analogous to the strategy undertaken in the models of parts 3 and 4). The first order

conditions (differentiate the profits with respect to r_{Li} and r_{Di}) imply the following expressions for the reaction functions

$$r_{Li} = \frac{a + b_1(Dif)r + b_2(Dif)r_{L(-i)}}{2b_1(Dif)}$$

and $r_{Di} = \dfrac{-c + d_1(Dif)r + d_2(Dif)r_{D(-i)}}{2d_1(Dif)}$.

The Nash equilibrium for a given level of differentiation Dif is then given by the intersection of the reaction functions of the incumbent (i=1) and the entrant (i=2). Precisely, the second-stage equilibrium is given by

$$r_{L1}^* = r_{L2}^* = \frac{a + b_1(Dif)r}{2b_1(Dif) - b_2(Dif)}$$

and $r_{D1}^* = r_{D2}^* = \dfrac{c - d_1(Dif)r}{d_2(Dif) - 2d_1(Dif)}$.

In the first stage, the incumbent bank chooses the level of differentiation Dif so as to maximize its profits. Thus, it maximizes the following expression

$$\pi_1^* = \left(\frac{a + b_1(Dif)r}{2b_1(Dif) - b_2(Dif)} - r\right)\left(a + [b_2(Dif) - b_1(Dif)]\frac{a + b_1(Dif)r}{2b_1(Dif) - b_2(Dif)}\right)$$
$$-\left(r - \frac{c - d_1(Dif)r}{d_2(Dif) - 2d_1(Dif)}\right)\left(c + [d_1(Dif) - d_2(Dif)]\frac{c - d_1(Dif)r}{d_2(Dif) - 2d_1(Dif)}\right).$$

For our purposes, this complicated formula can be rewritten into the following form

$$\pi_1^* = (r_{L1}(Dif) - r)(a + [b_2(Dif) - b_1(Dif)]r_{L1}(Dif)) - (r - r_{D1}(Dif))(c + [d_1(Dif) - d_2(Dif)]r_{D1}(Dif)).$$

It is easy (though technically quite cumbersome) to obtain the incumbent's first-stage optimum by computing the first order condition $\dfrac{\partial \pi_1^*}{\partial Dif} = 0$. The general form of the solution has the form $Dif^* = Dif^*(a, c, r)$. Subsequently, the equilibrium of the model has the form

$$r_{L1}^{*} = r_{L2}^{*} = \frac{a + b_1(Dif^{*}(a,c,r))r}{2b_1(Dif^{*}(a,c,r)) - b_2(Dif^{*}(a,c,r))}$$

and $r_{D1}^{*} = r_{D2}^{*} = \dfrac{c - d_1(Dif^{*}(a,c,r))r}{d_2(Dif^{*}(a,c,r)) - 2d_1(Dif^{*}(a,c,r))}$

However, the main result of our interest can already be seen from the form of the profit function which is to be maximized and thus we do not have to compute the first order conditions explicitly. It is clear that the solution must depend on both the loans and deposits parts of the profit function – there is only one first order condition linking the two parts together. Thus, the loans and deposits decision problems are again linked together. To see that clearly, imagine that there is for example some binding restriction on the deposit interest rates – think about some constant ceiling $\overline{r_{D1}}$. Then the abbreviated formula for the incumbent's profit function becomes

$$\pi_1^{*} = (r_{L1}(Dif) - r)(a + [b_2(Dif) - b_1(Dif)]r_{L1}(Dif)) - (r - \overline{r_{D1}})(c + [d_1(Dif) - d_2(Dif)]\overline{r_{D1}}),$$

and it is immediately obvious that the optimal level of Dif^{**} is different from Dif^{*} from the unconstrained case (since $\dfrac{\partial \overline{r_{D1}}}{\partial Dif} = 0$).

5. Conclusions

In this paper I have focused on the issue of the separability of the banks' decisions about loans and deposits in the family of industrial organization models derived from the Monti-Klein model. In the standard oligopoly version of the Monti-Klein model, under appropriate assumptions about the banks' cost functions, the decisions about loans and deposits are independent. In this paper, I was able to show that this independence is rather an exception to the rule because it depends on

the very simple industry structure of the banking industry assumed in the standard Monti-Klein model.

I have presented three alternative models which were derived from the standard Monti-Klein model by changing some of its crucial assumptions and I have shown that the banks' decision problems are interdependent in these models. Specifically, these models were based on: 1) the incumbent/entrant game with barriers to mobility and quantity competition, 2) the incumbent/entrant game with barriers to mobility and differentiated price competition and 3) the incumbent/entrant game with price competition and endogenously chosen level of differentiation.

The common feature of all these three models was their sequential game theoretical nature – they were all built as two-stage games. In addition (and closely linked to the sequential form of the game), the other common feature was the asymmetric position of the two competitors. I believe that this sequential and asymmetric nature of these models is an important step towards greater validity of the industrial organization models of the banking industry – empirically, we can hardly ever encounter any real world situation in which the two competitors are perfectly equally positioned and can act simultaneously.

The previous efforts to break the independence of the loans and deposits decisions in the Monti-Klein model have achieved their goal by considering relatively strong modifications of the original setup. These models are interesting but, due to their complexity, not very easy to work with in empirical work. In this paper, I have shown that it is enough to adopt more realistic assumptions about the industry structure and the independence breaks down. Thus, I have shown that it is possible to build a model which is able to explain the interdependence of the two major bank's decision problems and yet keeps relative simplicity.

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