Measuring Agglomeration Forces in a Financial Center

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Abstract

Basing on Scitovsky's (1954) definition of external economies and applying the method of Caballero and Lyons (1990) to macro data of Luxembourg services industry, we find significant agglomeration forces between financial intermediaries (downstream industry) on the one hand and business services and computer industry (upstream industries) on the other.

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1. Introduction

Many studies have been devoted to the empirical assessment of agglomeration effects (for a survey, see Rosenthal and Strange, 2004) and have especially identified spatially-mediated knowledge spillovers. However, to our knowledge none of these studies have been specific to banking and financial clusters.

The aim of that paper is to test for the existence of endogenous agglomeration effects within the commercial services industries of Luxembourg by using industry data. For that purpose we are interested in detecting technological spillovers as well as pecuniary externalities respectively termed as non-market and market spillovers by Scitovsky (1954). Our approach draws on Midelfart-Knarvik and Steen (1999) which is itself grounded on Caballero and Lyons (1990). This methodology is based on a standard production-function framework and is applied to (industry level) national accounts data. Using an error correction model, our results suggest significant agglomeration forces between financial intermediaries (downstream industry) on the one hand and business services and computer industry (upstream industry) on the other.

These forces are reciprocal and induce mutual self-reinforcing effects between these industries that thus constitute an endogenous cluster centered on a banking place. In particular, it seems that important pecuniary externalities channeled by input-output linkages are at work within this group of industries. These market interactions especially appeared through an impressive expansion of business service firms induced by a steadily increasing activity of downstream financial intermediaries. At the same time, rising activity in the upstream industry has supplied the downstream industry with more specialized and relatively cheaper input-services.

2. The empirical model

- *The method*

Following Caballero and Lyons (1990), we start with an industry specific production function that contains an external effect represented by an activity index (Z) of other industries that belong to the same cluster. This function is written as follows:

$$Q = F(K, L, M, Z, A), \tag{1}$$

where Q stands for output and K, L, M and A respectively represent private capital, labor, materials and technical change.

By assuming profit maximization in an imperfect competitive environment, following expression, expressed in terms of growth variables[1] may be derived (for technical details see Basu and Fernald, 1995):

$$\hat{Q} = \gamma\left(c_K \cdot \hat{K} + c_L \cdot \hat{L} + c_M \cdot \hat{M}\right) + \hat{Z} + \hat{A}, \tag{2}$$

where γ represents the degree of returns to scale and c_K, c_L , c_M are respectively the shares of capital, labor and materials in the total industry cost.

[1] $\hat{x}$ stands for $\dfrac{dx}{x}$

After simplifying expression (2) we get: $\hat{Q} = \gamma \cdot \hat{X} + \hat{Z} + \hat{A}$

where $\hat{X} = c_K \cdot \hat{K} + c_L \cdot \hat{L} + c_M \cdot \hat{M}$

The external factor $\hat{Z}$ should be measured by the growth rate of total output ($\hat{\tilde{Q}}$) produced by all the other industries belonging to the cluster. In order to mitigate endogeneity problems, Bartelsman, Caballero and Lyons (1994) suggest to proxy these externalities by the growth rate of aggregate inputs ($\hat{\tilde{X}}$) used by the other industries of the same agglomeration. Finally we obtain:

$$\hat{Q} = \gamma \hat{X} + \beta \hat{\tilde{X}} + \eta \hat{A} \tag{4}$$

- *The choice of the regressand :*

Scitovsky (1954) interestingly pointed to the fact that the scope of a production function in measuring external economies is merely limited to technological spillovers and leaves pecuniary externalities out of account. Since both concepts are however important in prospecting for the existence of endogenous agglomeration forces, Scitovsky (1954) proposed to use a profit function[2] in order to measure market and non-market externalities. Following this suggestion, Midelfart-Knarvik and Steen (1999) have chosen to replace the LHS variable in (4) by added value that is a broader concept of profitability (Bruno, 1978).

3. Results

Growth rates contained in equation (4) can be roughly expressed as logarithmic differences. By integrating this expression while assuming constancy of the coefficients, we get:

$$\ln Q_i = \gamma \ln X_i + \beta \ln \tilde{X} + \eta \ln A + u\,, \tag{5}$$

where u is an integration intercept.

Equation (5) can be expressed in a dynamic form with an error correction mechanism[3]. We can thus distinguish between a short and a long run term. This approach allows testing for possible externalities by clearing the coefficient β from short term disturbances.

[2] Scitovsky (1954, p 146): *It seems that external economies are invoked whenever the profits of one producer are affected by the actions of other producers.[…] This definition of external economies obviously includes direct or nonmarket interdependence among producers as defined by Meade. It is much broader, however, than his definition, because, in addition to direct interdependence among producers, it is also includes interdependence among producers through the market mechanism. This latter type of interdependence may be called "pecuniary external economies"*

[3] The analysis of the stationarity of the variables on which we regress consists in testing (Augmented Dickey-Fuller test) the null hypothesis of the existence of a unit root against the alternative hypothesis of a stationary process. The tests show that all our variables are non-stationary in level. In first difference, on the other hand we can reject the hypothesis of non-stationarity, leading to test the existence of a relation of cointegration. The ADF test rejects the non-stationarity hypothesis of the static equation residuals. The hypothesis of a long-run cointegration relationship among the explanatory variables is therefore justified. In this case, the coefficients of a model in error correction form can be estimated by ordinary least squares.

The dependent variable (Q_i) represents industry profitability that is proxied by added value. This implies that the inter-industry externalities we intend to measure include pecuniary effects in addition to technological spillovers. Since the Luxembourg banking centre is mainly characterized by offshore business activities, external effects are principally conveyed through input-output relations between financial intermediaries and local upstream industries.

In the following, we assume that the financial industry of Luxembourg is the driving force of a group of seven (commercial) service industries (sections G to K of the NACE code, except Real estate activities (70): for more precisions, see Appendix 1). Within that set, we want to identify a possible endogenous sub-cluster centered on financial services. Therefore, we run 14 regressions to test for external effects from financial services (J) to all the other industries taken as a whole and to each industry individually and inversely, we test for dependency of the added value of financial industry (J)[4] on the output of the other service industries (individually and as a whole).

Complete results from our estimations are presented in Appendix 2. The absence of residual autocorrelation has been assessed by the Breusch-Godfrey LM test (see Appendix 2). Since inputs fluctuate less than output (see notably Mankiw 1989), the estimation of β could be biased by common chocks hitting the whole set of industries. This problem is mitigated by the fact that we use total factor productivity (TFP) as an indicator for technical progress. As a matter of fact this variable takes into account common external chocks due to its pro-cyclical nature (Basu and Fernald 2000).

Table 1 indicates the long term value of coefficient β that measures spillovers emanating from one defined industry and that affect one or more industries. Only the statistical significant coefficients are shown.

Regressions have first been run in such a way to measure external effects that flow from financial service activities (Financial intermediation "J" according to NACE) to other industries. The most significant coefficient β is obtained for the industry providing business activities (Industries "73-74" include Research and development (73), and "Other business activities" (74) according to NACE[5]): $\beta = 0.28$. A significant effect but lower in intensity ($\beta = 0.16$) is obtained for the whole set of commercial services without financial services. The remaining relations that have been tested with financial intermediaries taken as source industry don't show significant effects.

After having run regressions in the opposite way by considering financial intermediaries as experiencing external effects, we obtain significant spillovers from other business activities ($\beta = 0.18$) and from computer and related activities ($\beta = 0.23$).

These results underline the importance of input-output linkages that exist between the core activity of the banking place of Luxembourg and the up-stream industry that is made up of business providers. More precisely, it seems that important pecuniary externalities are channeled by upstream/downstream relations. These market interactions especially appeared through an impressive expansion of business service firms induced by a steadily increasing activity of downstream financial intermediaries. During 1985-2002, the

[4] We have also tested for interactions between each business service industry (except financial industry) and the others (except financial industry), but we did not find any significant effect.
[5] The industries 73 and 74 are merged in our data. The share of R&D in this total is very low.

number of service providing firms has grown by about 11% (this number has been multiplied by 6 during the same period). At the same time, expanding activity in the upstream industry has supplied the downstream industry with more specialized and relatively cheaper input-services. In Appendix 3 we illustrate that input prices tended to fall relative to financial output prices during the major part of the considered period.

We thus assume that there exist self-reinforcing effects between financial activities (J) on the one hand and upstream business services (73-74) and computer activities[6] (72) on the other. These industries may be considered as an endogenous cluster centered on a banking place. However, external effects don't significantly appear between financial services and the four remaining industries (G, H, I, 71).

Table 1 : Measures of elasticity β

Origin industries j	**Target industries i**	**Elasticity β (long term)**
Financial Services (J)	Business Services except Fin. Serv.	0.16***
Fin. Serv. (J)	Comput. (72)	n.s.
Fin. Serv. (J)	Business Serv. (73-74)	0.28**
Fin. Serv. (J)	Trade (G)	n.s.
Fin. Serv. (J)	Hotels-Restau. (H)	n.s.
Fin. Serv. (J)	Transp. and Com (I)	n.s.
Fin. Serv. (J)	Renting (71)	n.s.
Serv. except Fin. Serv.	Fin. Serv. (J)	n.s.
Comput. (72)	Fin. Serv. (J)	0.23*
Business Serv. (73-74)	Fin. Serv. (J)	0.18**
Trade (G)	Fin. Serv. (J)	n.s.
Hotels-Restau. (H)	Fin. Serv. (J)	n.s.
Transp. and Com (I)	Fin. Serv. (J)	n.s.
Renting (71)	Fin. Serv. (J)	n.s.

*** denotes significance at the 1% level , **: 5%, *: 10% and n.s.: not significant

Now we try to measure inter-industry technological spillovers by replacing added value with real output in the LHS of equation (5).

We first test for technological spillovers from all commercial service industries except financial activities (J) to financial intermediaries (J). Estimations (Appendix 2, table A2) show the existence of significant spillovers from "other business activities (73-74)" (β = 0.17) and "computer and related activities (72)" (β = 0.19) to financial intermediaries. However, output of the financial industry (J) does not depend significantly on the output of the other industries (G, H, I, 71).

[6] Notice that between this industry and financial activities there is only a one-way link, by contrast to a two-way link existing between industries (J) and (73-74).

Finally we test for spillovers from financial intermediaries (J) to other commercial service industries (all except J). Among the tested relations, we only find a significant effect, though weak in intensity (β = 0.08), from financial services (J) to the other commercial service industries taken as a whole.

4. Conclusion

Basing on Scitovsky's (1954) definition of external economies and applying the method of Caballero and Lyons (1990) to macro data (at the industry level) of Luxembourg services industry, we find significant agglomeration forces between financial intermediaries (downstream industry) on the one hand and business services and computer industry (upstream industries) on the other.

The emergence of Luxembourg financial center has largely been triggered by exogenous causes like favorable legal and tax regimes. However, our results suggest that there are some endogenous forces at work that contribute to perpetuate Luxembourg banking place.

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Appendix 1: Data

The data are obtained from National Accounts (STATEC, Statistical Institute of Luxembourg), and from EUROSTAT during 1985-2002. Data about financial and business services that are consistent with SNA 95 are available only during the period under review.

The business service industries considered in this paper are given as follows: Financial intermediation (J), Wholesale and retail trade… (G), Hotels and Restaurants (H), Transport, Storage and Communication (I), Renting of Machinery and Equipment (71), Computer and Related Activities (72), Research an Development and Other Business Activities (73-74). The industries "73-74" include : Research and development, Legal, accounting, book-keeping and auditing activities; Tax consultancy; Market research and public opinion polling; Business and management consultancy; Holdings; Architectural and engineering activities and Related technical consultancy; Technical testing and analysis; Advertising; Labor recruitment and provision of personnel; Investigation and security activities; Industrial cleaning; Miscellaneous business activities.

Indications in parentheses correspond to NACE codes of national accounting. When all the industries are gathered in a group except the target industry i, we write "All services except i".

- Q_i: Production (according to national accounting) of industry i or added value of the same industry if we test for pecuniary externalities.
- X_i : Aggregate input index of industry i.
- $\tilde{X}$: Aggregate input index of an industry (or industries) different than i. Industries are weighted according to their share in total annual production of the group they belong to.
- Aggregate input index is computed as follows : $\Delta X = c_L \, \Delta L + c_K \, \Delta K + c_M \, \Delta M$,

  Where c_L, c_K and c_M represent each factor's share in total cost, such as:

  $$c_L = \frac{W\,L}{w\,L + P_K\,K + P_M\,M}$$

  WL: Wage bill (W : wage rate ; L : number of employees)

  $P_K(r+\delta)\,K$: Approximation of capital services, where r is a long-term interest rate; δ is the depreciation rate of fixed capital and P_K designates the market price of new fixed capital.

  $P_M.M$: Consumption of intermediates (according to national accounting)

  A: Technical progress indicator for the whole set of industries. This factor is approximated by total factor productivity computed according to the traditional growth accounting framework.

Appendix 2

Table A1 :

Estimations of dynamic equations (Indicator of profitability: VA), Period: 1985-2002, OLS

Dependent variable: $\Delta\ln(VA_i)$ of the target industry i	$\Delta\ln(VA_{S\ except\ Fin})$	$\Delta\ln(VA_{72\text{-}73\text{-}74})$	$\Delta\ln(VA_{73\text{-}74})$	$\Delta\ln(VA_{Fin})$	$\Delta\ln(VA_{Fin})$
Regression	(1)	(2)	(3)	(4)	(5)
$\Delta\ln(X_{Fin.})$		0.44 (2.51)**	0.80 (11.23)***	0.05 (0.38)	-0.26 (-1.99)*
$\Delta\ln(X_{S.except\ i})$	0.78 (4.44)***				
$\Delta\ln(X_{72})$				-0.13 (-1.18)	
$\Delta\ln(X_{73\text{-}74})$			0.60 (2.39)**		
$\Delta\ln(X_{72\text{-}73\text{-}74})$		0.84 (3.14)***			
$\Delta\ln(TFP)$	0.78 (3.76)***	-0.36 (-0.76)	-0.34 (-0.76)	1.52 (6.86)***	1.92 (8.85)***
Cst	1.86 (1.46)	6.76 (3.45)***	8.10 (4.66)***	-0.46 (-0.47)	-2.33 (-2.41)**
$\ln(VA_i)_{-1}$	-1.21 (-6.32)***	-1.18 (-5.77)***	-1.33 (-6.46)***	-0.92 (-5.63)***	-0.88 (-5.53)***
$\ln(X_i)_{-1}$	0.86 (5.56)***	0.44 (2.91)**	0.42 (-3.14)*	0.22 (1.44)	0.31 (2.85)**
$\ln(X_{Fin})_{-1}$	0.23 (2.56)**	0.33 (2.50)**	0.37 (2.86)**		
$\ln(X_{72})_{-1}$				0.20 (2.24)**	
$\ln(X_{73\text{-}74})_{-1}$					0.16 (2.46)**
$\ln(PGF)_{-1}$	0.50 (2.32)**	-0.70 (1.43)	-0.81 (-1.99)*	1.16 (4.03)***	1.45 (5.79)***
D97	-0.05 (-2.52)**				
D94			-0.06 (-1.92)*		
D93				0.08 (3.72)***	0.07 (3.12)**
R^2	0.90	0.93	0.95	0.93	0.93
DW	2.30	1.58	2.17	2.70	2.61
Breusch-Godfrey LM Test (2) F Probability	 0.54 0.60	 2.98 0.11	 0.14 0.87	 0.78 0.49	 1.31 0.32

In parentheses: t statistic. *** denotes significance at the 1% level , **: 5%, and *: 10%.

Table A2 :
Estimations of dynamic equations (Indicator of output: Q), Period: 1985-2002, OLS

Dependent variable $\Delta\ln(Q_i)$ of the target industry	$\Delta\ln(Q_{Fin})$	$\Delta\ln(Q_{Fin})$	$\Delta\ln(Q_{Fin})$	$\Delta\ln(Q_{S\ except.\ Fin})$
Regression	(6)	(7)	(8)	(9)
$\Delta\ln(X_{Fin.})$	0.93 (11.59)***	0.82 (17.71)***	0.80 (11.23)***	
$\Delta\ln(X_{S.except\ i})$	-0.35 (-2.42)**			1.55 (10.8)***
$\Delta\ln(X_{72})$			0.02 (0.36)	
$\Delta\ln(X_{73\text{-}74})$		-0.14 (2.42)**		
$\Delta\ln(TFP)$	0.74 (3.49)**	0.86 (7.18)***	0.66 (4.90)***	0.36 (3.04)**
Cst	-1.72 (-1.23)	-1.16 (-2.14)*	0.48 (0.81)	2.36 (2.90)**
$\ln(Q_i)_{-1}$	-0.52 (-3.04)**	-0.58 (-5.00)***	-0.62 (-4.05)***	-1.55 (-5.59)***
$\ln(X_i)_{-1}$	0.42 (2.19)*	0.48 (4.30)***	0.46 (-3.00)**	1.13 (5.44)***
$\ln(X_{S.\ except\ i})_{-1}$	0.16 (1.28)			
$\ln(X_{Fin})_{-1}$				0.09 (1.98)*
$\ln(X_{72})_{-1}$			0.12 (2.39)**	
$\ln(X_{73\text{-}74})_{-1}$		0.10 (2.79)**		
$\ln(TFP)_{-1}$	0.67 (2.68)**	0.65 (0.12)***	0.35 (2.42)**	0.31 (2.19)**
D93		0.03 (3.04)**	0.03 (3.17)**	
D98	-0.04 (-2.44)*	-0.02 (-2.53)**	-0.02 (-1.79)*	
R^2	0.98	0.99	0.99	0.94
DW	2.40	2.68	2.88	2.64
Test Breusch-Godfrey (LM)(2) F Proba	 0.79 0.49	 2.47 0.17	 1.60 0.28	 1.31 0.32

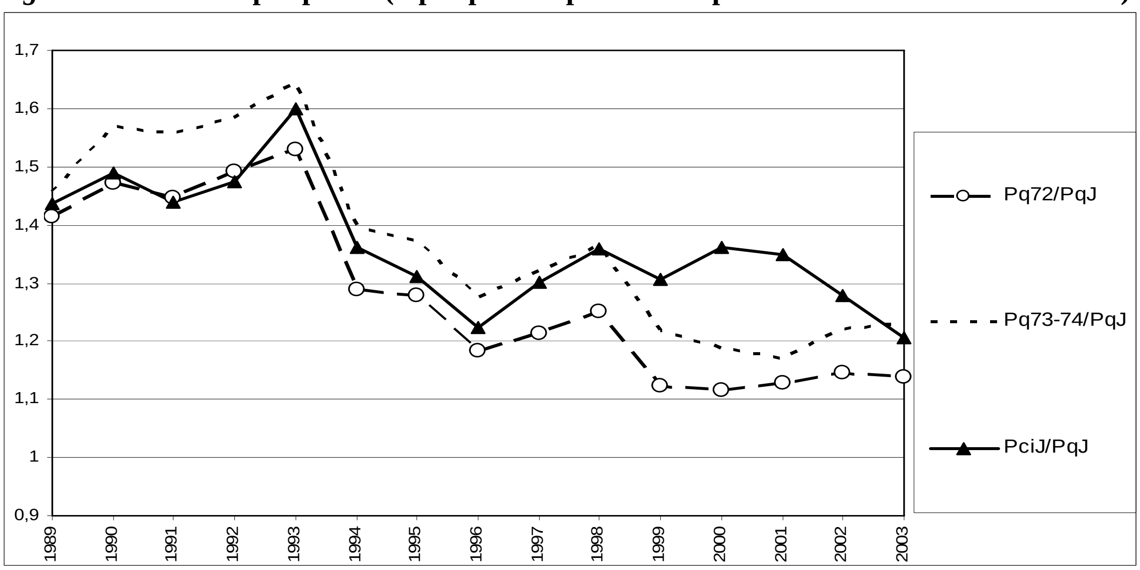
In parentheses: t statistic. *** denotes significance at the 1% level , **: 5%, and *: 10%.

Abbreviations used in tables A1 and A2:

Q: Production
VA: Value added
X: Input aggregate
TFP: Total factor productivity
D: Dummy variables
Subscript character indicates each industry
i: "Target" industry, on heading rows of the tables
Fin.: Financial services
Services except i: All services industries (7 industries) except industry i
72: Computer activities
73-74: Research and development, business activities

Appendix 3

Figure 1: **Relative input prices (input prices / production price of financial intermediaries)**



Source: Authors' calculations based on data from STATEC

Pq72/PqJ: Production prices of Computer and Related Activities (72) / Production prices of financial intermediaries.
Pq(73-74)/PqJ: Production prices of other business services / Production prices of financial intermediaries.
PciJ/PqJ: Prices of financial industry's intermediates/ Prices of financial industry's output.