Measuring Technological Spillovers in a Financial Center by using "Feder" Model

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Abstract

The aim of this paper is to measure technological spillovers between banking activities and non financial activities and in particular market services related to finance. The econometric estimations are realized within a dynamic framework due to Feder (1982). For that purpose, we use data for Luxembourg. Due to its very small-size and to the importance of its international banking center, this country suits well for analyzing spatially-mediated externalities. The empirical estimations show significant technological externalities from the financial services industry to non-financial market services and in particular to Computer Activities and Business Services.

1. Introduction

Many studies are dealing with the empirical assessment of agglomeration effects (for a survey, see Rosenthal and Strange, 2004) and in particular with the measure of spatially-mediated spillovers. To our knowledge however, none of these studies have focused on banking and financial centers.

In this paper we intend to identify externalities between banking activities and non financial activities and in particular market services related to finance. This study refers to the case of Luxembourg. Indeed, this economy offers a convenient framework for this kind of study since it is a very small-sized country where a great share of non-financial activities is more or less localized (and related to) around an international banking center.

We shall limit ourselves to the estimation of technological spillovers within a dynamic framework due to Feder (1982). This methodology, which is based on sectoral production functions has been adapted by M.O. Odedokum (1996), and E. Wang (2000) to evaluate the impact of financial development on economic growth. Ododokum (1996) tested this relation for 71 developing countries (LDCs) and Wang (2000) applied this method to the case of Taïwan.

By contrast to Wang (2000), we don't limit the focus on the relation between the financial sector and the manufacturing industry but we extend it to activities that are apparently more closely related to finance and banking. For that purpose, we distinguish several groups of non financial industries and in particular the business services.

The empirical estimations show significant, but unilateral, technological externalities from the financial services industry to market services. It also appears that Computer Services and "Other Business Activities" are the most affected by technological spillovers. These activities include in particular legal, business and management consultancy, accounting, auditing, labor recruitment and provision of personnel.

2. A method for estimating the effect of concentrated banking industry on other nearby located industries.

The method developed by Feder (1982) consists in dividing a considered economy into two separate sectors and introducing an output indicator of one sector's output into the production function of the other sector. One can then deduce a dynamic equation that links the growth rate of total output to a set of determinants including the spillover effect we want to measure. We define a production function for the financial sector (indexed by F) and for the non-financial sector (indexed by NF).

$$Y_t^F = F^F(L_t^F, K_t^F) \quad \text{and} \quad Y_t^M = F^{NF}(L_t^{NF}, K_t^{NF}, Y_t^F) \tag{1}$$

Labor and capital used by each sector are respectively denoted by L_t^F and K_t^F for the financial sector, L_t^{NF} and K_t^{NF} for the non-financial sector. Capital and labor are distributed among the sectors F and M according to following equations:

$$K_t = K_t^{NF} + K_t^{F} \; ; \; L_t = L_t^{NF} + L_t^{F} \text{ and } Y_t = Y_t^{NF} + Y_t^{F} \tag{2}$$

The spillover effect originating from the financial sector is taken into account by introducing the variable Y_t^{F} into the non-financial sector's production function. In order to distinguish labor and capital (marginal) productivity between both sectors we introduce a constant coefficient δ. The sign and magnitude of this parameter will be established by econometric estimations. After some algebraic manipulations following dynamic growth equation may be deduced:

$$\frac{dY_t}{Y_t} = a \cdot \frac{dK_t}{Y_t} + b \cdot \frac{dL_t}{L_t^{NF}} + \left(\frac{\delta}{1-\delta} - \theta \right) g_{Y^F} \cdot \frac{Y_t^{F}}{Y_t} + \theta \cdot g_{Y^F} \tag{3}$$

with: $\quad a = \frac{\partial Y_t^{NF}}{\partial K_t^{NF}} \;, \quad b = \frac{\partial Y_t^{NF}}{\partial L_t^{NF}} \cdot \frac{L_t^{NF}}{Y_t} \;, \quad g_{Y^F} = \frac{dY_t^{F}}{Y_t^{F}}$

Coefficient θ represents the elasticity of non-financial output with respect to financial output. ($\theta = \frac{\partial Y_t^{NF}}{\partial Y_t^{F}} \cdot \frac{Y_t^{F}}{Y_t^{NF}}$). It measures the spillover effect from the financial sector to the rest of the economy.

In a quite symmetric manner it is possible to estimate a spillover effect from the non-financial sector on the financial output. By introducing the non-financial output variable into the financial sector's production function we obtain following expression:

$$\frac{dY_t}{Y_t} = c \cdot \frac{dK_t}{Y_t} + d \cdot \frac{dL_t}{L_t^{F}} + \left(\frac{\delta}{1+\delta} - \eta \right) \cdot g_{Y^{NF}} \cdot \frac{Y_t^{NF}}{Y_t} + \eta \cdot g_{Y^{NF}} \tag{4}$$

The elasticity parameter η represents now the external effect from the non financial industry on financial activity. In the following we assume that θ and η are constant.

3. Empirical Analysis: Testing spillovers for Luxembourg

- *The financial center in the Luxembourg economy*

The rapid expansion of Luxembourg as a banking and financial centre arose from the development of Euromarkets (syndicated loans and Eurobonds) during the sixties and seventies. Ever since then Luxembourg financial center has evolved and developed its scope of activities. By the end of 2006, 154 banks are established in Luxembourg (city). The overwhelming majority of them are subsidiaries or branches of top ranking banking institutions from over 25 different countries. The financial sector (banking and insurance industries) accounts for 32 % of Luxembourg GDP and provides jobs for more than 11% of domestic working population. The center's current core businesses concentrate on private banking, fund industry and corporate

finance (financial engineering). By the beginning of the 80s there was an important shift to private banking and asset management. Banking secrecy and tax advantages are crucial for this specialization. But these causes were however reinforced by the availability of professional expertise within a multilingual context and Luxembourg's central-located position. In terms of asset management, Luxembourg reached a top-ranking position, and the Luxembourg market has become the second most important centre worldwide (after New York) for the administration of collective investment funds. Fund industry developed very rapidly in the eighties when Luxembourg created a first complete legal framework for investment funds. Luxembourg financial center developed competences especially in creating new investment vehicles (like umbrella funds) and in back-office activities. Moreover, the legal and regulatory framework appears to be crucial for the development of the general financial engineering and constitute the backbone of the holdings sector, SOPARFI (Luxembourg Investment Companies), reinsurance companies, securitization, and capital investment companies.

Besides banking industry there was also a relevant development in non-financial activities. An impressive expansion of business service firms was induced by a steadily increasing activity of upstream and downstream financial intermediaries. During the two last decades a set of new services mostly intended for companies emerged (accountancy, tax consultancy and auditing services computer related services, market research…). During 1985-2004, after the take-off period of the financial center, the number of business services firms (NACE 72-74) has grown by about 10 % per year (this number has been multiplied by 6 during the same period), and the added value (in constant prices) of these industries by 7,8% per year. This increase was stronger than that of the financial sector (5.8%).

The impressive expansion of services related to banking and the spatial closeness of manufacturing activities to an international financial center provide justification for assessing spillovers induced by the Luxembourg financial industry.

▪ *Data*

The data used in our study are taken from Luxembourg national accounts (ESA 95) provided by STATEC (the Luxembourg statistical office). Beside manufacturing and financial industries, we consider a group of seven market service industries (sections G to K of the NACE code, except Real Estate activities (70): for more precisions, see Appendix).

The relevant variables corresponding to the non-financial industries (manufacturing and non-financial service industries) are indexed by (NF) while the index (F) applies to financial activities (banking and insurance). Variables corresponding to the sum of both sectors are free of index.

Employment (number of employees) is denoted by L, gross capital stock at constant prices by K and value-added at constant prices by Y. $\dfrac{dK_t}{Y_t}$ is the ratio of capital formation to GDP and

$\dfrac{dL_t}{L_t^{NF}}$: the ratio of overall labor increase to employment in the non-financial sector.

For the sake of robustness, we use beside value-added (Y^{F1}) alternative indicators of banking activity that are taken from financial balance sheets (source: Central Bank of Luxembourg). These indicators which are generally used in studies focusing on financial development, are given as follows:

Y^{F2}: Aggregate balance sheet of financial intermediaries (at constant prices)

Y^{F3}: Aggregate banks' deposit liabilities (at constant prices).

The Luxembourg economy, due to its very small size and to its high integration into the European Space, is very exposed to the international economic environment. The detection of inter industrial externalities within Luxembourg may thus be biased by significant external effects. So it is important to disentangle external and internal financial spillovers to the domestic services industries. For that purpose we control in our regression for the influence of the international banking activity. A significant control variable we introduce is aggregate added value (at constant prices) of the banking activity in the three principal economic partners (Germany, Belgium and France) of Luxembourg. (Source: Eurostat and database Klems). This variable is denoted by $Y^{F.eur3}$.

- ***Estimation results***

In a first step, Eq. (3) is estimated according OLS by using annual macro-industrial data from Luxembourg national accounts for 1970-2004. To test for possible cross-relations between the financial and non-financial sectors we estimated Eqs. (3) and (4) simultaneously by the standard SUR (Seemingly Unrelated Regression) technique.

The estimation of Eq. (3) (table 1) generally yields statistically significant coefficients. Introducing dummies into regressions 1 and 2 did substantially improve the estimation results. These dummies were necessary to take account of external economic circumstances that occurred during 1973-1975 and 1981. The absence of residual autocorrelation has been assessed by the Durbin-Watson and Breusch-Godfrey LM tests. The Jarque-Bera test did not reject the normality of errors.

Eq. (3) has been tested in different ways to take successively into account various groups of industries. The elasticity-coefficient θ, (indicated in bold in tables 1 and 2), measures the spillover effect from the financial sector to the non financial industry specified at the top of each column of tables 1 and 2.

Table 1: Estimation results of dynamic equations (OLS)

Dependent variable:	dY_t/Y_t	dY_t/Y_t	dY_t/Y_t	dY_t/Y_t
Target activities:	Manufacturing + Non-Financial Market Services	Non-Financial Market Services	Business Services (72-73-74)	Manufacturing
Regressions:	(1)	(2)	(3)	(4)
Period:	(1971-2004)	(1972-2004)	(1972-2004)	(1971-2004)
Constant	0.02	0.01	0.01	0.01
	(4.08)***	(2.89)***	(3.93)***	(1.71)*
dK_t/Y_t	-0.08	0.02	-0.08	0.03
	(-1.40)	(0.37)	(-1.97)*	(0.43)
dL_t/L_t^{NF}	0.34	0.19	0.03	-0.01
	(2.75)***	(2.17)**	(1.21)	(-0.07)
$\left(dY_t^{F1}/Y_t^{F1}\right)\cdot\left(Y_t^{F1}/Y_t\right)$	0.89	0.69	0.68	0.91
	(3.35)***	(2.53)**	(4.43)***	(4.42)***
dY_t^{F1}/Y_t^{F1}	**0.10**	**0.11**	**0.19**	0.04
	(2.56)**	(2.11)**	(3.08)***	(0.52)
$dY_t^{Feuro3}/Y_t^{Feuro3}$	0.17	0.24	0.02	0.12
	(1.99)**	(2.81)***	(0.33)	(0.92)
D75	-0.09			-0.17
	(-6.65)***			(-7.84)***
D81	-0.03			-0.05
	(-2.84)***			(-2.55)**
D73			-0.06	
			(-3.26)***	
R^2	0.90	0.90	0.93	0.88
DW	2.04	1.54	2.26	1.98
Breusch-Godfrey LM Test (2)				
F	0.27	0.62	0.42	1.20
Probability	0.77	0.55	0.66	0.32

Regression 1 evaluates the impact of financial activities on the whole non-financial sector (including the manufacturing industry). The resulting estimation of the elasticity-parameter θ is equal to 0.10. This coefficient equals 0.11 in regression 2, which tests for spillovers on non-financial market services. In regression 3, the target industries are limited to the Other Business and Computer Activities (72-73-74). The corresponding estimation of coefficient θ is now larger since it is equal to 0.19. Finally, there is no significant spillover effect on the manufacturing industry (see regression 4). This result is not surprising since manufacturing firms are generally less closely located to financial activities than market services are.

Table 2: Estimation results of dynamic equations with various indicators of financial activities (OLS)

Dependent variable:	dY_t/Y_t		dY_t/Y_t		dY_t/Y_t	
Target activities:	Manufacturing + Non-Financial Market Services		Non-Financial Market Services		Business Services (72-73-74)	
Regressions:	(5)	(6)	(7)	(8)	(9)	(10)
Period:	(1972-2004)	(1972-2004)	(1972-2004)	(1972-2004)	(1972-2004)	(1972-2004)
Constant	0.02 (3.64)***	0.02 (3.61)***	0.02 (2.91)***	0.02 (2.95)***	0.02 (2.07)**	0.02 (2.07)**
dK_t/Y_t	0.06 (0.75)	0.06 (0.71)	0.05 (0.69)	0.05 (0.73)	-0.05 (-0.59)	-0.04 (-0.51)
dL_t/L_t^{NF}	0.34 (1.77)*	0.36 (1.89)*	0.38 (3.04)***	0.39 (3.17)***	0.12 (2.12)**	0.12 (2.16)**
$\left(dY_t^{F2}/Y_t^{F2}\right)\cdot\left(Y_t^{F2}/Y_t\right)$	-0.06 (-0.11)		-0.49 (-0.92)		-0.18 (-0.77)	
$\left(dY_t^{F3}/Y_t^{F3}\right)\cdot\left(Y_t^{F3}/Y_t\right)$		-0.24 (-0.33)		-0.64 (-1.09)		-0.19 (-0.72)
dY_t^{F2}/Y_t^{F2}	**0.06** (3.11)***		**0.09** (4.06)***		**0.09** (2.68)**	
dY_t^{F3}/Y_t^{F3}		**0.07** (3.22)***		**0.09** (4.22)***		**0.09** (2.57)**
$dY_t^{Feuro3}/Y_t^{Feuro3}$	0.31 (2.61)**	0.30 (2.50)**	0.28 (2.29)**	0.26 (2.21)**	0.45 (2.79)***	0.43 (2.72)***
D75					0.12 (3.96)***	0.11 (3.92)***
D01	-0.04 (-1.87)*	-0.04 (-1.83)*	-0.05 (-2.49)**	-0.05 (-2.54)***		
R^2	0.80	0.79	0.82	0.83	0.70	0.70
DW	2.08	2.10	2.11	2.16	2.26	2.26
Breusch-Godfrey LM Test (2)						
F	0.23	0.24	0.37	0.45	0.61	0.60
Probability	0.80	0.78	0.70	0.65	0.55	0.55

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

Regressions were run by using the above indicators Y^{F2} and Y^{F3}, which stand for alternative measures of aggregate financial activity. The results are shown in Table 2. The coefficient θ is particularly significant when we consider spillovers from the financial industry to Manufacturing and Market Services considered together (estimated coefficient: 0.06-0.07) and to Market Services taken alone (estimated coefficient: 0.09).

Until now, we only were interested in the existence of spillovers emanating from banking activities. In order to test for reciprocal effects between financial and non-financial industries, we jointly estimated Eqs. (3) and (4) by the SUR (Seemingly Unrelated Regression) technique. The regression**s** were run by using the same macro-sectoral data as above. The coefficient

indicating the possible spillover effect from the non-financial to the financial industry was not statistically significant[1].

4. Conclusion

In this paper we studied the effect of the banking and financial place of Luxembourg on the non-financial activities by estimating technological spillovers within a dynamic framework based on sectoral production functions. Since Luxembourg is very small sized, we could use macrosectoral data to assess the existence of possible technological spillovers induced by an international banking center. The results obtained show a significant impact of financial output growth on the non-financial market services sector and in particular on the Computer Activities and Business Services.

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[1] Results are available on request.

Appendix: Data

The data are obtained from National Accounts (STATEC, Statistical Institute of Luxembourg) during 1970-2004. Data taken from different databases have been merged.

The industries that are considered in this paper are described as follows:

Manufacturing industries (D): Consumer manufacturing, Intermediate manufacturing, Investment goods.

The Market Service industries: 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 and Development and Other Business Activities (73-74).

The Other Business Activities (73-74): 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 between brackets correspond to NACE codes of national accounting.