Technological Spillovers of Financial Centers on a Regional Economy: A Macroeconomic Approach Applied to Luxembourg[i]

Patrice Pieretti and Arnaud Bourgain

Introduction

Recent research has emphasized the role of innovation in economic growth. Innovation does not only result from intentional profit maximizing behaviour within the boundary of individual firms. It also takes its source in a broader structure induced by dense spatial locations where ideas circulate informally between people and firms. These knowledge spillovers may lead to the emergence of new products and new methods of producing existing goods. In this context, it appears that banking and financial centers may be considered as a spatial and institutional context favouring the emergence of innovation in terms of new products and improvements in productivity.

Economists have identified two types of knowledge spillovers: «Marshall-Arrow-Romer » MAR spillovers and Jacobs spillovers. «Marshall-Arrow-Romer » MAR spillovers are induced by the concentration of activities within the same industry. Alfred Marshall is the famous British economist who developed a theory of knowledge spillovers in 1890. John Kenneth Arrow and Paul Romer extended this theory to economic growth recently. Jacob's spillovers are named after Jane Jacobs who developed in 1969 the argument that knowledge spillovers result from interaction between different industries. The underlying argument is that exchange of ideas is easier between people having different backgrounds and qualifications. According to J. Jacobs and J. Jackson (McDonald 1997) the development of car industry in Detroit was not independent of the pre-existence of Detroit's shipbuilding.

In this paper we try to measure if Luxembourg financial development improved the performance of the rest of the economy. We shall limit ourselves to the sole study

of technological spillovers by using production function theory.

The spillovers thus analyzed are of the Jacobs variety since we only focus on interactions between different industries. Luxembourg 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 around the international financial and banking place.

The methodology we use is due to Feder (1983). In this framework, external effects are represented by a parameter entering the production function of the sector where the spillover is destined.

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

This method that is inspired by Feder (1983) 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. After that we can deduce a dynamic equation linking the growth rate of total output to a set of determinants among which there is the spillover effect we want to measure. This relation is then estimated with OLS (ordinary least squares) by using time series coming from Luxembourg national accounting.

Feder's approach (1983), was recently adapted by M.O. Odedokum (1996), and E. Wang (2000) for the analysis of the relation between the financial sector and the rest of the economy.

Let's define a production function for the financial sector (noted by the index F) and for the non-financial sector (noted by the index M).

(1) $Y_t^F = F^F (L_t^F , K_t^F)$ and $Y_t^M = F^M (L_t^M , K_t^M , Y_t^F)$

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

(2) $\qquad K_t = K_t^M + K_t^F \; , \; L_t = L_t^M + L_t^F \; \text{and} \; Y_t = Y_t^M + Y_t^F$

The original feature is the introduction of the financial sector's output 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, which sign and magnitude will be established by econometric estimation. It can be shown (Bourgain and Pieretti, 2002) that the algebraic manipulations of the two sectoral production functions lead to following dynamic growth equation:

$$(3) \qquad \frac{dY_t}{Y_t} = cste + a \cdot \frac{dK_t}{Y_t} + b \cdot \frac{dL_t}{L_t^M} + c \cdot g_{Y^F} \cdot \frac{Y_t^F}{Y_t} + \theta \cdot g_{Y^F} + \varepsilon_t$$

$$\text{with :} \quad a = \frac{\partial Y_t^M}{\partial K_t^M} \quad , \quad b = \frac{\partial Y_t^M}{\partial L_t^M} \cdot \frac{L_t^M}{Y_t}, \quad g_{Y^F} = \frac{dY_t^F}{Y_t^F} \quad \text{and} \quad c = \left(\frac{\delta}{1+\delta} - \theta \right)$$

The coefficient θ represents the elasticity of non-financial output with respect to financial output. It measures the spillover effect moving from the financial sector to the rest of the economy.

In a quite symmetric manner it is possible to estimate the spillover effect from the non-financial sector on the financial output. For that purpose the non-financial output indicator must be introduced into the financial sector's production function.

Testing spillovers for Luxembourg

A brief description of Luxembourg financial center

By the end of June 2002, 184 different banks are located in Luxembourg (city). In 1971 there were only 43 banks. The overwhelming majority of them are subsidiaries or branches of top ranking banking institutions from over 25 different countries. Associated with banking activity a wide range of intermediaries (investment advisors, auditors, lawyers, brokers,) has emerged. The financial sector (banking and insurance industries) accounts for 30% of Luxembourg GDP and provides jobs for more than 11% of domestic working population.

Luxembourg's financial center was born by the end of the 60s. Its development was mainly achieved by successive inflows of foreign bank subsidiaries and by the enormous growth of their activities. The very beginning of international financial activity was triggered by the arrival of German banks wishing to operate in the Euro markets free of legal requirements (mainly reserve requirements) practiced in Germany. Euro market deposit and lending activities developed rapidly in Luxembourg as a consequence of regulatory limitations, and the absence of minimum reserve requirements existing there. In its early days the financial center was mainly specialized in wholesale activities on the Euro markets (syndicated loans and Eurobonds).

Ever since then Luxembourg financial center has evolved and developed its scope of activities. The center's current core businesses concentrate on international lending, private banking and fund industry with a focus on the two last activities.

International lending activities

Though Luxembourg's importance in international financing (that was the main business until the international (LDC) debt crisis of the 80s) has diminished, it still remains an important business nowadays. In 1998 Luxembourg ranked fourth concerning banks' deposits coming from the non-bank sector and ranked third with respect to external loans (CEPROS 1999). Owing to a recent study (CEPROS 1999), international lending activities are considered as the third pillar of Luxembourg center's future.

Private banking

By the beginning of the 80s there was an important shift to private banking and asset management. These activities that now account for a large share of Luxembourg business banking have offset decreasing traditional areas like Euro market business and international loans. The main customers come from Belgium, Germany and Switzerland. The origin of Luxembourg's success in private banking relies in first place on strict bank secrecy and the absence of withholding taxes. These causes were however reinforced by the availability of professional expertise within a multilingual context and Luxembourg's central-located position (between Belgium, Germany and France).

Fund industry

Fund industry developed very rapidly since 1988. The reason of this explosion

goes back to 1983 when Luxembourg created a first complete legal framework for investment funds. This *first mover advantage* allowed the rapid adaptation to a EU Directive concerning certain types of UCITS (Undertakings for Collective Investment in Transferable securities). Owing to this directive investment funds (UCITS) that are registered in one EU country can be marketed freely in all Community countries without prior approval from the authorities. Luxembourg financial center developed competences especially in creating new investment vehicles (like umbrella funds) and in back-office activities (accounting and administration activities). In this context note that Luxembourg legislation requires that investment funds have their central administration in Luxembourg.

Non-financial industry

Besides banking industry there was also a relevant development in non-financial activities. During the last decade a set of new services mostly intended for companies emerged (accountancy, tax consultancy and auditing services computer related services, market research,). The manufacturing industry was initially strongly dominated by the steel sector but has become diversified since the end of the sixties. Steel industry still remains efficient, but new industrial growth has been achieved in a wide range of light industries using advanced production technologies. Since the mid-seventies, foreign investors have established about one hundred and eighty new firms, which now account for over one third of Luxembourg's total industrial assets. The main non financial-activities include chemical, rubber and glass industries, air transport services (in particular, airfreight), and communications services (especially satellite communications services) sector. Note that the development of non-financial industries was encouraged by public policy instruments mainly in the form of financial support like capital grants and long-term loans at favorable conditions. *However it is very plausible that this evolution may also have been favoured by the existence of an international financial center, even if this possible link has not been seriously considered until now.*

Before trying to estimate the possible impact of financial and banking activities on growth in other branches of Luxembourg economy, we briefly describe the data used and their evolution for 1970-1999.

Data description

The data used in our study are taken from Luxembourg national accounting (ESA 95) provided by STATEC (the Luxembourg statistical office). The relevant

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

L: Employment (number of employees); K: Gross capital stock at constant prices;

Y: Value-added index at constant prices; $\dfrac{dK_t}{Y_t}$: The ratio of capital formation to GDP.

$\dfrac{dL_t}{L_t^M}$: The ratio of total employment to employment in the non-financial sector.

Let's illustrate the importance of financial sector in Luxembourg overall output growth. Figure 1 depicts the evolution of financial output share in value-added generated by the Luxembourg non public sector. The exceptional development of financial activities is well reflected in the (almost) steady growth of banking and insurance output share in total non-public value-added. This share was 5% at the beginning of the 70s, then after having attained 20 % for some years it soared to 30% by the end of 2000. Figure 1 depicts the high level of output growth in banking and insurance industries compared to the rest of the non-public economy, which nevertheless experienced satisfactory positive levels. During 1976-1999, annual value-added (at constant prices) attained an average of 7,4 % in the financial sector and 3.4 % in the (non public) non-financial sector.
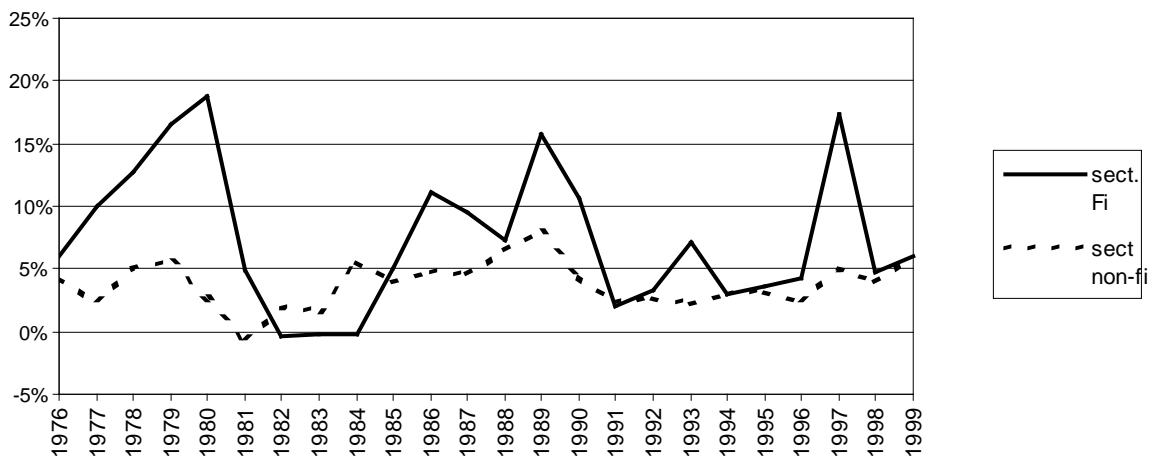

Fig.1. Value added growth rate at constant prices

Empirical analysis

Equation (4) is estimated according OLS by using annual macro data from Luxembourg national accounts for 1970-1999. In order to use OLS estimation suppose that the coefficients a, b and c are constant. Equation (4) has been tested in two different ways. A first variant is intended to measure the effect of the financial sector on manufacturing and non-financial services industries. A second regression however estimates the impact of financial production uniquely on non-financial services industries. The dependent variable of the first regression represents output growth in manufacturing and total commercial (financial and non-financial) services industries.

In the second variant there is only growth in total commercial (financial and non-financial) services industries, which is explained by the regression.

The results derived from both regressions are reported in Table 1.
Tab. 1. Estimation of Dynamic equations. Observations: 29(1971-1999). Estimation by OLS

Regression 1		Regression 2	
Dependent variable: dY_t/Y_t (manufacturing and total commercial (financial and non-financial) services industries)		*Dependent variable*: dY_t/Y_t (financial and non- financial services industries)	
Variables			
Constant	0.02 (4.63)***	Constant	0.01 (2.15)**
dK_t / Y_t	-0.06 (-1.56)	dK_t / Y_t	-0.09 (-2.18)**
dL_t / L_t^M	0.23 (1.86)*	dL_t / L_t^M	0.28 (2.50)**
$\left(dY_t^F / Y_t^F\right)\cdot\left(Y_t^F / Y_t\right)$	0.66 (2.13)**	$\left(dY_t^F / Y_t^F\right)\cdot\left(Y_t^F / Y_t\right)$	0.62 (2.36)**
dY_t^F / Y_t^F	0.15 (3.59)***	dY_t^F / Y_t^F	0.19 (3.64)***
D75	-0.10 (-7.70)***	D75	-0.03 (-2.54)**
D81	-0.03 (-2.54)**		
R^2	0.89	R^2	0.91
DW	2.0	DW	2.01
Test Breusch-Godfrey (LM)(2) F	0.05	*Test Breusch-Godfrey (LM)(2)* F	0.28
Probability	0.95	Probability	0.76

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

The elasticity (θ), which we shall suppose constant, denotes the spillover effect moving from the financial sector to the rest of the economy. The estimations yield an elasticity θ equal to 0.15 in regression 1 (impact of financial activities on the whole private non -financial sector) and a coefficient equal to 0.19 in regression 2 (impact of financial activities on the private non-financial service sector). The coefficients have to be interpreted as follows: For given input levels (Labour and capital), a 10 % increase in financial sector's value-added induces an output growth of 1.5 % (regression 1) in manufacturing and non-financial services industries and an output growth of 1.9% (regression 2) in non-financial service industries.

Note that these effects don't represent the total impact that finance and banking have had on the rest of the economy but only technological spillovers, an aspect often neglected in this kind of studies. For that purpose we modelled spillovers as an ingredient of production functions that may positively influence real output even if factor inputs are held constant[ii].

Conclusion

The aim of this paper is to study the effect of the banking and financial place of Luxembourg on domestic growth by estimating technological spill-overs within a dynamic framework based on sectoral production functions. The results obtained show a significant impact of financial output growth on the non-financial sector. A spillover effect running from the non-financial industries to the financial sector could not be detected. This suits well with the international character of Luxembourg financial center.

The findings sum up as follows. For given input levels (Labour and capital), a 10 % increase in financial sector's value-added induces an output growth of 1.5 % (regression 1) in manufacturing and non-financial services industries and an output growth of 1.9% (regression 2) in non-financial service industries.

The top down approach like that we pursued in this paper does unfortunately not give details about the real content of spillover effects which could be significantly detected. Moreover the methodology we used does not exclude another type of externalities, which are strictly speaking different from knowledge spillovers. For instance one could think at reputation effects generated by a flourishing financial

center, which could be attractive for new financial and non-financial activities. Another fostering effect induced by a financial center could be the formation of a pool of high-qualified labour force.

All these details and transmission channels can hardly be made apparent through official statistical data. Therefore a more accurate understanding of inter firms spillovers should involve direct observation of the banking and business world by researchers. This fieldwork should be accomplished by firm and site visits, case studies and sample surveys.

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[i] This paper draws on « Finance et dynamique de croissance : « Quelques considérations théoriques et une application empirique au Luxembourg », in Cahiers Economiques N° 93 du STATEC, Luxembourg, avril 2002 by Arnaud Bourgain and Patrice Pieretti

[ii] The opposite causality running from the non-financial sector to the financial activities has been tested according the SURE (Seemingly Unrelated Regression Estimation) method. However, no growth impact running that way could be detected. For more details see Bourgain and Pieretti (2002).