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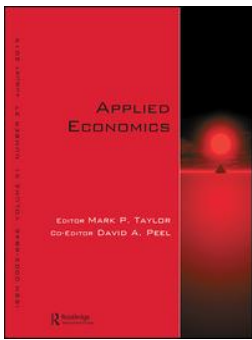
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# Cross-border workers in the Greater Region of Luxembourg and financial instability: a non-linear approach

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## ABSTRACT

This article aims to study the interactions between cross-border workers from the Greater Region of Luxembourg (compared to resident workers) and financial instability. Luxembourg, located in the heart of the Greater Region, is a major international financial centre, one of the most significant aspects of which is the phenomenon of cross-border or commuting work. Interrelationships between financial fluctuations, the real economy and employment seem to operate especially in times of crisis or post-crisis, and to affect more particularly cross-border workers, whose recruitment is facilitated by service and financial intermediation companies. We propose to evaluate these interrelationships with an asymmetric non-linear ARDL (Auto Regressive Distributive Lags) staggered delay autoregressive model, which validates the predictive power of financial indicators to explain fluctuations in cross-border and resident workers.

## KEYWORDS

Cross border workers; financial shocks; non linear approach; Luxembourg

## JEL CLASSIFICATION

G0; J61; L16

## (1) INTRODUCTION

The Greater Region is an area that transcends national borders within the European Union. With its own institutions and mechanisms for internal cooperation, the Greater Region (see map of the Greater Region in the appendix) is a human and economic entity in its own right, characterized by intense interrelationships (INSEE 2008). In line with the political and economic developments in Europe, this territory has become an area of cross-border cooperation between local and regional authorities, which is reflected in particular in support for border work.

Luxembourg is an important financial centre with an employment relations model that deserves more scientific attention (Kirov and Thill 2018). Luxembourg's financial sector began to grow in the 1920s, when the Grand Duchy decided to engage in this specialization (for more details, Trausch (2014)). Sohn and Walther (2008) show that economic development has resulted in a concentration of activities in knowledge-intensive services and research-intensive industries for the benefit of large cities or urban centres which, like Luxembourg, have managed to compensate for their small demographic size by

a strong specialization. Over the last century, the country's activities have developed in three main sectors: investment funds, insurance and banking. Luxembourg is now a leading international financial centre.

Consequently, the dynamism of the Luxembourg economy is closely linked to the evolution of demand for financial services from financial institutions operating in the country. Levels of production and employment and growth rates have historically depended on the performance and dynamism of this sector (European Commission 2014). A financial business activity is surrounded by a multitude of very diverse service providers, some of which are directly or indirectly related to financial services (IT service providers, audit and consulting firms, investment fund administration companies, clearing and settlement organizations, trustees, business lawyers and notaries, real estate companies, construction, industries, etc.). The infrastructure function of the financial sector is a pillar of the economy and determines the profitability of many companies.

Fuelled by the needs of a growing financial sector, financial services and intermediation companies have encouraged the recruitment of cross-border workers to meet their labour demand. Border or

commuting work allows Luxembourg's economic growth, which is highly dependent on the financial sector, to be based on the active population available in neighbouring areas. This concentration has made it possible to develop real know-how, strengthening Luxembourg's attractiveness to banks, audit firms, specialized companies, promoters, etc.

The cross-border mobility of workers<sup>1</sup> is particularly important within the Greater Region. In 2015, Luxembourg was the most common destination for cross-border commuters in the EU (in relative terms),<sup>2</sup> with 181,000 incoming cross-border commuters. In absolute terms, 97,000 people commuted to Luxembourg from France, more than double the number of people commuting from Germany (44,000) or Belgium (39,000). Its labour market has attracted a large number of commuters from neighbouring countries, amounting to about 42% of the workforce (Eurostat, 2016). With regard to cross-border workers from the 27 Member States of the European Union, one fifth of the total number of these employees belong to the Greater Region, which has the highest number of cross-border workers after Switzerland. Border work has become a structural component of the various regional labour markets.

Luxembourg, due to its size and geographical position, has been able to access this very particular form of economic migration, which allows it to benefit from a highly skilled workforce from the Greater Region. Due to different institutional and regulatory environments, discontinuities arise at these international borders, leading to arbitrage possibilities and thus cross-border economic activity, be it cross-border trade or shopping, commuting or migration or all of them combined (Mathä, Porpiglia, and Ziegelmeyer 2017). In Luxembourg, 'commuting' workers comply with European regulations. These are therefore individuals who work in Luxembourg but reside in another country and who, consequently, have to cross the border on a daily basis or at least once a week. When the place of residence is fixed and the place of work is not, only a commuting problem arises, and by definition there is no migration (Termote 1980).

Globalization has also played a decisive role in the development of economic migration on the Luxembourg labour market (Damette and Fromentin 2013 for more details). The financial centre has had to become highly specialized in order to compete with other financial centres while maintaining and developing its business volume. To sustain its competitive advantage, Luxembourg needs highly qualified personnel that the country has so far found in the Greater Region.

In Luxembourg, the demographic problem has ultimately been controlled thanks to the high level of intra-European mobility. However, with the financial and economic crisis and the ensuing new world order, the competitive disadvantage of Luxembourg and its companies risks compromising any voluntary strategy aimed at maintaining a high rate of economic growth both quantitatively and qualitatively compared to neighbouring countries (Chamber of Commerce 2009). Moreover, the financial crisis of 2008 exposed a volatile sector subject to corporate restructuring decisions by foreign banks and changes in business strategies (Kirov and Thill 2018).

This structural component of the Luxembourg labour market is clearly affected by financial fluctuations and financial instability. The interrelationships between financial fluctuations, the real economy and employment seem to work, especially in times of crisis or post-crisis. However, this research topic, which encompasses all three dimensions, has not been significantly studied. It deserves to be further developed, because of the resulting societal, economic and political aspects. This is all the more true for analyses that focus on financial centres with particular characteristics, such as Luxembourg, since interrelationships may differ in terms of significance and amplitude, particularly for cross-border workers. As Belo et al. (2017) points out, references to the relationship between human capital and asset returns go back as far as Mayers (1972) and Fama and Schwert (1977). Moreover, the link between the evolution of stock market indices and that of economic activity appears particularly marked in the case of

<sup>1</sup>For more details on this subject, see the recent article by Eriksson, Hane-Weijman, and Henning (2018) on the sectoral and geographical mobility of workers.

<sup>2</sup>The outlier Luxembourg has the highest share of EU-28/EFTA cross-border workers in its total number of employed people, namely 42%. Following far behind is Switzerland, with 8% of cross-border workers, then Austria with 4%, Belgium with 2% and the Netherlands, Denmark, Germany, Ireland and Finland with 1% each (Fries-Tersch, Tugran, and Bradley 2018).

Luxembourg. The fluctuations of the European markets would have lagged repercussions on Luxembourg's GDP in real terms (and undoubtedly, concomitantly, on employment). The fluctuations of the stock markets can be an important economic signal vis-à-vis the expected short-term economic results (Larue 2016). As shown by Benhabib, Liu, and Wang (2016), there are at least two channels through which the financial sector can influence the aggregate real economy: the financing of capital and the production of information on investment opportunities (see, e.g., Levine 2005).

Feldmann (2011) shows that there are four channels for the effect of stock market activity on employment or unemployment. First, as stock markets facilitate investment in long-term projects, they stimulate overall savings and investment, and allow the exploitation of economies of scale and scope. This improves the efficiency of resource allocation, including the allocation of labour. Second, stock markets help fund business formation – through initial public offerings but also indirectly by stimulating the growth of the venture capital industry – which motivates job creation in all sectors. Third, stock markets help identify the most promising investment opportunities and provide them with finance. This financial activity improves resource allocation and fosters economic development, reducing unemployment. Fourth, liquid stock markets help monitor firms after providing finance and provide relevant information. So, labour will be allocated efficiently and savers will be more willing to finance investment and innovation.

This article therefore aims to study the interrelationships between Luxembourg's financial activity (and financial instability) and cross-border workers (compared to residents in particular) during a period marked by economic and financial crises, and regulatory changes. Our research hypothesis is based on the existence of differentiated responses between cross-border workers and residents (see Fromentin and Tadjeddine 2020) for more details) in a period of rising and falling financial activity.

Several research hypotheses, with socio-economic and political implications, deserve to be addressed: How do resident and cross-border workers in Luxembourg react to fluctuations in financial activity and to uncertainty? Are they impacted in the same way in periods of rising and falling financial activity?

It is possible that resident workers may be less affected than workers from the Greater Region, and that responses to downward financial shocks may be more pronounced (compared to an upward phase of financial activity). Indeed, like Caggiano, Castelnuovo, and Nodari (2017), we use a nonlinear framework which allows us to capture potentially different macroeconomic responses to an uncertainty shock occurring in different phases of the financial and business cycle.<sup>3</sup>

To assess these interrelationships, it seems appropriate to use an econometric model, without necessarily developing or using a theoretical framework. In an attempt to answer these questions, it seems suitable to employ an econometric approach, taking into account the dynamics of non-linear or asymmetric responses. In relation to our research hypotheses, an asymmetric non-linear ARDL (Auto Regressive Distributive Lags) staggered delay autoregressive model was thus estimated. The results obtained make it possible to validate the predictive power of financial indicators (Euro Stoxx and Volatility index) to explain fluctuations in cross-border and resident workers. Moreover, the impact of financial instability on cross-border and residents is clearly different, in terms of symmetry or asymmetry and response to short-term and long-term shocks.

The motivations of the article are therefore diverse: the study of a differentiated reaction (reaction time, asymmetric nature, etc.) between cross-border workers and residents; evaluation of the predictive nature of financial and stock market variables; the importance of providing additional information on the topic of frontier workers in Europe. Cross-border mobility has developed as one of the motors of European social integration that involves 'ordinary citizens' as movers within

<sup>3</sup>By referring to many scientific articles, Caggiano, Castelnuovo, and Nodari (2017) show that most macroeconomic aggregates display an asymmetric behaviour over the business cycle and that uncertainty features different dynamics in good and bad times. For example, Caldara et al. (2016) provide empirical evidence in favour of larger real effects of uncertainty shocks in periods of high financial stress.

the common market (Recchi and Favell 2009), even if economic crises erect new barriers to mobility.

The rest of the article is organized as follows. The second section refers to elements of the literature and the resulting research questions. The third section presents the data and some stylized facts. The fourth section is dedicated to the presentation of the methodology adopted. The fifth part presents the results obtained. The last section concludes and discusses the results.

## (1) LITERATURE REVIEW AND RESEARCH QUESTIONS

Several scientific publications focus on the Luxembourg labour market, as well as on the issue of cross-border workers, while highlighting the influence of financial activity.

Luxembourg has always followed a proactive European immigration policy and has never announced a halt to economic immigration, even after the 1970s slowdown in the metal industry. It is the EU Member State with the lowest rate of non-EU immigration and the highest European immigration level (86% EU immigrants and 7.2% other Europeans (THILL-DITSCH 2010)). Luxembourg has become a leading financial centre and has tried to attract highly skilled immigrants. Currently, this group represents a greater, more qualified percentage than nationals.

Zanardelli and Brosius (2009) showed that nationals and residents were slightly less skilled than cross-border workers and that among some groups of resident foreigners (Belgian and German), educational levels were higher than for Luxembourg nationals. Portuguese nationals were at the lower end of the scale. Amétépé and Hartmann-Hirsch (2011) presented another categorization by showing that nationals from the northern hemisphere (Japan, Canada, United States, Scandinavia, United Kingdom, etc.) resident in Luxembourg had the highest levels of education and remuneration. They thus had a higher level of education than highly qualified Luxembourgers.

Fehlen and Pigeron-Piroth (2009) present the transnationalisation of the national labour market in the light of the influx of foreign managers, representing about three-quarters of the country's business leaders. Various studies show that the

competitive sector is controlled by foreigners and that the excellent results of this transnational economy are due in large part to the contribution of foreigners and border residents.

Guarda (2000) complements preliminary studies on the substitutability/complementarity of cross-border workers with workers resident in Luxembourg. Elasticities seem to change over time, in line with the fundamental transformation of the Luxembourg economy over the past thirty years. Point estimates suggest that resident and cross-border workers are complementary in industry and services, but that they substitute each other in the construction sector. This means that the significant growth in the number of cross-border workers in industry and services has accelerated the growth in the number of resident employees. However, the estimated level of these elasticities decreases over the period considered, and particularly dramatically in the services sector.

Recently, Marchiori and Pierrard (2017) employed a dynamic general equilibrium model to study the transmission of a change in global demand for financial services on the internal growth of an international financial centre. Using this model, they highlight the interrelationships between financial activity and cross-border worker flows. It is generally accepted that the financial sector is the main driver of growth in the Luxembourg economy and that the influx of cross-border workers is an important feature of the Luxembourg economy. The influx of cross-border workers and activity in the financial sector are closely linked. This may be explained by endogenous reasons, such as the dynamism of the Luxembourg economy or its low taxation, which develop the links between cross-border labour flows and financial sector activity. One of the scenarios in their analysis concludes that the share of cross-border commuters will increase from 42% in 2015 to 52% in 2060 and that the share of added value in the financial sector will increase from 27% in 2015 to 33% in 2060.

Pigeron-Piroth and Belkacem (2020) propose a study of the socio-professional profiles of cross-border commuters at the different French borders, and provide a better understanding of cross-border mobility using 2013 INSEE population census data. They show that cross-border work concerns men



more than women, and people with a higher education; cross-border commuters are generally younger than those working full-time in France; immigrant populations among cross-border commuters are over-represented; these workers work mainly in the industrial (mostly in the Luxembourgish canton of Esch-sur-Alzette), trade, transport and services sectors, and in the 'new service sectors' linked to the international status of Luxembourg.

In connection with the mobility<sup>4</sup> of cross-border workers, Wiesböck et al. (2016) provide a comprehensive picture of the potential relation between the economic crisis and mobility processes from the Czech Republic, Hungary and Slovakia to Austria during the period before and after the economic crisis of 2008/2009. They highlight an increase in cross-border commuting after 2008, but on average, most commuters share the demographic characteristics of the workers who have been shown to be most vulnerable during the crisis (relative youth, lower and intermediate levels of education, employment in certain branches of the service industry).

Similarly, Borio (2014) shows that it is not serious to understand corporate fluctuations and political challenges without understanding the financial cycle. Næs, Skjeltorp, and Ødegaard (2011) point out that changes in the liquidity of the US stock market have generally coincided with changes in the real economy, at least since the Second World War. Stock market liquidity seems to be a very good 'indicator' of the real economy. The current financial crisis has shown that high systemic risk and funding liquidity problems in the financial sector can spread to the real economy. They also show that a link between asset prices (interest rates, forward spreads, stock market returns and exchange rates) and the real economy can be established on the basis of a consumption-smoothing argument. If investors are willing to pay more for a profitable asset when you think the economy is in a *bad state* than for a profitable asset when you think the economy is in a *good*

*state*, then current asset prices should contain information on investors' expectations about the future real economy.<sup>5</sup> Rouabah and Theal (2015) assess the macro-financial link between the banking system and the Luxembourg economy. They conclude on the importance of considering macro-financial linkages in macro-prudential policy decisions, as these linkages can provide information on the interactions between financial variables and the economy in general.

Through an institutionalist and territorial approach to financial systems, Crevoisier, Theurillat, and Araujo (2011) show that 'the central framework of the financial industry is based on the institutionalized distinction between the real economy on the one hand, with concrete problems relating to technology, labour markets, resources, environmental and political constraints, etc. and on the other hand the financial sphere, whose function is to permanently reconstitute securities portfolios characterized exclusively by risk and probable return properties'. They also demonstrate that, assuming that they have entered a phase of experimentation and modification of financial circuits and practices, a systematic observation of innovations in the financial field would probably make it possible to identify new ways of articulating capital, labour and their social and environmental contexts.

Similarly, the effect of financial fluctuations on labour markets has attracted attention in recent literature, especially since unemployment has become a major concern for policy makers in the wake of the global financial crisis. Several empirical studies, mainly in the United States, estimate the impact of financial conditions on employment by comparing labour market conditions before and after changes in financial regulation or before and after a major financial shock (Mian and Sufi 2014, Chodorow-Reich, 2014; Haltenhof, Lee, and Stebunovs 2014; Berton et al. 2018).

Mian and Sufi (2014) outline the importance of the housing net worth shock. They conclude that housing net worth losses lead to significant

<sup>4</sup>Mobility is related to EU citizenship practices that allow EU citizens to travel, settle, study or work in other member states indiscriminately of their country of origin (Olsen 2015; Trenz and Triandafyllidou 2017). There are also overlaps between the notion of cross-border workers/commuters and concepts such as circular migration, long-term commuting, posting of workers, and frontier and seasonal work (Fries-Tersch, Tugran, and Bradley 2018).

<sup>5</sup>The authors also show that before economic recessions, it is possible to observe a flight to quality, where some investors completely leave the stock market and others move their equity portfolios to larger, more liquid stocks; or a shift in liquidity supply to low-margin securities.

non-tradable sector job losses in the cross-section. This result is not driven by supply-side, industry-specific shocks or credit supply conditions. In addition, the authors do not find strong evidence of labour market adjustment through wages, labour mobility, or expansion in tradable employment in harder hit counties.

Chodorow-Reich (2014) has shown that banking relationships matter. This paper links the health of a firm's lenders to its employment outcomes. The relationship appears economically important both at the level of the firm and for aggregate fluctuations. At the level of the firm, the predicted change in employment varies by as much as four percentage points depending on the health of its lenders. In the aggregate, these frictions can account for between one-third and half of the decline in employment at small and medium firms in the year following the collapse of Lehman Brothers.

Haltenhof, Lee, and Stebunovs (2014) study how a bank credit crunch translates into job losses in US manufacturing industries. They find that, for employment, household access to bank loans matters more than firm access to bank loans. During the recent financial crisis, tightening access to commercial and industrial loans and, in particular, consumer instalment loans, may have contributed significantly to the drop in employment in the manufacturing sector.

Berton et al. (2018) show that the effects of the global financial crisis on the labour market have triggered a renewed interest in the relationship between finance and employment (Pagano and Pica 2012) and, specifically, a renewed interest in the effect that credit supply shocks have on firms' employment decisions. Financially constrained firms reduced employment: the point estimate indicates that the average elasticity of employment to a credit supply shock is 0.36. This result is due to an adjustment at the intensive margin, and to a higher probability of firm closure in response to a reduction in the supply of credit. The credit crunch has mainly affected women, foreign, and less educated workers with temporary contracts.

Ochoa (2013) show that firms' exposure to aggregate volatility is closely related to its reliance on skilled labour through the following economic mechanism. An increase in aggregate uncertainty slows a firm's labour demand reaction to changes

in economic conditions, reducing its ability to smooth cash flows.

From the perspective of economic theory, the transmission channel from uncertainty shocks to the labour market is highlighted in the works of Bloom (2009), Basu and Bundick (2014), Leduc and Liu (2016) and Netšunajev and Glass (2017).

Leduc and Liu (2016) study the macroeconomic effects of uncertainty shocks and show robust evidence that an uncertainty shock leads to a rise in unemployment and declines in inflation and the nominal interest rate.

Netšunajev and Glass (2017) extend the literature on economic policy uncertainty and study the cross effects of uncertainty shocks in two big economic regions, the US and the euro area. With a non-linear framework, they show that US shocks have an effect on both local and foreign labour markets, while euro-area shocks are much less influential; the US labour market tends to react and absorb shocks more quickly than the labour market in the euro area does.

In the same non-linearity context, Caggiano, Castelnuovo, and Nodari (2017) estimate a smooth transition vector autoregressive model and underline the asymmetric effects of uncertainty shocks over the business cycle. Industrial production and employment are more sensitive in recessions, as the drop, rebound and overshoot effects are greater than in expansions, when the influences are gradual and without any medium-term overshoot. They use the same macroeconomic data as Bloom (2009) and proxy uncertainty by the VIX index.

This literature review, which sheds light on the characteristics of the Luxembourg labour market (with a predominance of cross-border workers), and on the links between financial activity (and the instability of the financial system) and the real economy, highlights the absence of studies on the interrelationships between fluctuations in financial activity and workers (cross-border workers and residents).

## (1) STYLIZED DATA AND FACTS

It is a European grouping of territorial cooperation, located at the centre of the European 'backbone', and is one of Europe's main border regions,



incorporating parts of Germany, France, Belgium and Luxembourg. This region has a total area of 65,401 km<sup>2</sup> and a population of 11.2 million inhabitants (3% of the total population of the EU15), with a concentration of large cities, industries and companies and a high density of population, networks and flows.

Luxembourg, located in the heart of the Greater Region, is a major international financial centre due to a combination of external and internal factors that have made the country a breeding ground for the development of cross-border work (as of 31 March 2020, total domestic employment stood at 474,294 including 205,031 cross-border workers (43.23%) (Source: EURES)), i.e. restrictive financial measures in other countries, the internationalization of financial markets, the development of securitization, attractive legislative provisions in Luxembourg, political stability in the country, a significant business climate, the Schengen agreement,<sup>6</sup> etc.

In the investment fund sector, Luxembourg is now the second largest financial centre in the world for assets managed by collective investment undertakings. The Luxembourg financial centre's specialities are asset management and financial engineering activities (holding companies, domiciliation, reinsurance, securitization, etc.). The sector is, by volume of assets, the largest in the euro area when expressed as a percentage of GDP. The financial sector is thus the main driver of the Luxembourg economy, fuelling employment growth not only in the sector itself, but also in related business services activities. The activity of the financial sector thus contributes directly and indirectly to the economic growth of Luxembourg and the surrounding territories.

The European Commission (2020) shows that after the economic crisis of 2008, employment declined in the EU for two consecutive years. However, in Luxembourg, only cross-border employment fell marginally. Consequently, cross-border employment appears to be more sensitive to

economic developments than resident employment and it has often acted as a buffer or an 'adjustment variable' for resident workers and the economy. The main sectors of employment (where the share of cross-border workers exceeds 50%) are the manufacturing industry, trade, administrative and support services, construction, mining and quarrying, communication and scientific activities (with a focus on legal and accounting activities). The share of cross-border workers in the financial sector is 48.8%. The main sectors of cross-border employment largely coincide with the sectors reporting most labour shortages.

The analysis is based on monthly data from January 1996 to September 2017 (261 observations). Data on the flows of cross-border workers (with STATEC's definition as 'Non-resident borderers') and residents (National wage-earners) in Luxembourg (expressed as an annual variation to take into account the seasonal nature of the labour market) are collected from STATEC. The Euro Stoxx index and the Volatility Index (VIX) (expressed in logarithm) are collected from Yahoo Finance.<sup>7</sup> The volatility of the stock market is often used as a measure of uncertainty because when a data series becomes more volatile it is harder to forecast (Bloom 2014). The VIX index is traded on the Chicago Board Options Exchange. This index is clearly countercyclical.

With regard to Figure 1 (the blue, red and green curves represent respectively the variations in Non-resident borderers, National wage-earners and Euro Stoxx), employment variation in Luxembourg seems to have been stronger among cross-border commuters than among residents, especially during periods of economic growth, for example over the periods 1996–2001 and 2003–2008. On the other hand, in phases of gloomy economic conditions (or periods of crisis, for example, in the years 2000–2002 or 2008–2009), the reduction in employment is more pronounced among cross-border commuters than among resident employees.

<sup>6</sup>It allows cross-border commuters to cross the border to get to work and back home again without controls and other formalities. During the coronavirus crisis, the European Commission adopted guidelines on the exercise of free movement of workers, taking into account their particular situation. Note that Parenti and Tealdi (2019) estimate that the individual probability of cross-border commuting to Switzerland in response to this policy has increased among inter-regional commuters by between 3 and 6 percentage points.

<sup>7</sup>As in Bloom (2009) and Ochoa (2013), we consider implied volatility computed from the old Volatility Index (VIX) and realized volatility computed using Euro Stoxx (as proxies for aggregate volatility). It should also be noted that stock-market volatility has been previously used as a proxy for uncertainty at the firm level (Bloom, Bond, and Van Reenen (2007) for example).

The gap in employment growth rates between cross-border commuters and residents closes in times of economic slowdown or crisis. If we compare the curves for cross-border workers and residents, we see that the two curves seem to follow an almost common dynamic and merge from 2008–2009, the period after the subprime crisis. This could reflect a possible ‘regime change’ in the employment of cross-border workers, who would be more affected by economic fluctuations during and after the crises (which could reflect a non-linear or asymmetric dynamic).

There could then be a link between financial activity and the dynamics of cross-border employment. This probable correlation between cross-border workers and financial instability merits further analysis through an econometric approach.

### (1) ADOPTED METHODOLOGY

In order to assess the interrelationships between financial activity and workers (cross-border commuters and residents) in Luxembourg, we use a cointegrated and asymmetric (non-linear) autoregressive model. An ARDL (Auto Regressive Distributive Lags) staggered delay autoregressive model is used to test the existence of a long-term relationship between variables characterized by a different integration order.

The implementation of a version of the staggered delay autoregressive model proposed by Pesaran

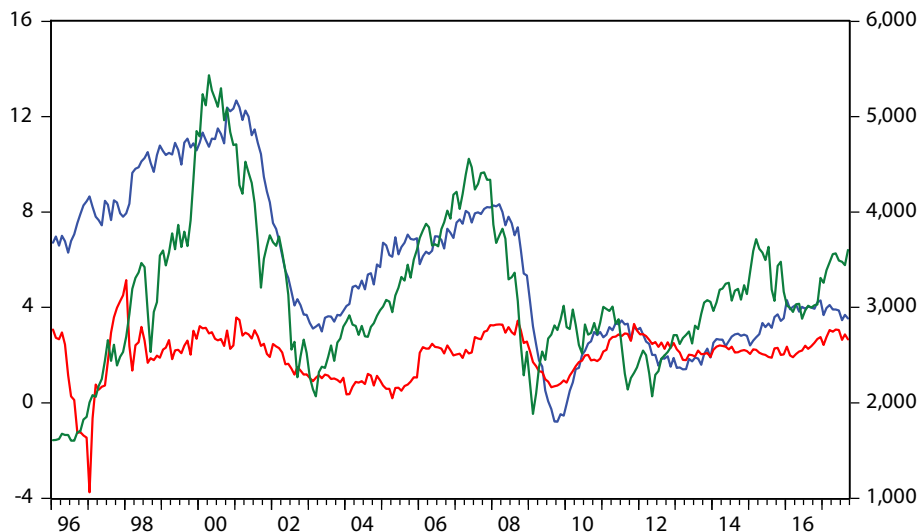
and Shin (1998) allows us to estimate a long-term relationship and jointly characterize the impact of this relationship on the short-term dynamics of a variable of interest. We can then deal with long-term dynamics and short-term adjustments. In addition, the ARDL representation allows us to mix variables  $I(0)$  and  $I(1)$  (but not  $I(2)$ ) and directly test whether there is a long-term cointegration relationship using the ‘bounds test to cointegration’ methodology (Pesaran, Shin, and Smith 2001).

The ARDL model takes the following form:

$$\Delta y_t = \mu + \sum_p^{j=1} \varphi_j \Delta y_{t-j} + \sum_q^{j=0} \pi_j \Delta X_{t-j} + \rho y_{t-1} + \theta X_{t-1} + \varepsilon_t \quad (1)$$

With  $\varphi_i$  and  $\pi_i$  representing the short-term dynamics of the model and  $\rho$  and  $\theta$  representing the long-term relationship.  $\varepsilon_t$  is the error term.  $\Delta y_t$  may represent cross-border or resident workers and  $\Delta X_{t-i}$  includes financial variables and possible control variables. We can deduce the long-term coefficient or the lasting impact of a variation in stock market activity on workers:  $\beta = -\theta/\theta\rho$ .

This model was supplemented by Shin, Yu, and Greenwood-Nimmo (2014) by incorporating long-term and short-term asymmetric effects (we can refer to a recent application of this methodology: Tiryaki, Ceylan, and Erdogan (2019)). The asymmetric cointegration relationship will take the following form:



**Graph 1:** Variations of Euro Stoxx, cross-border workers and residents in Luxembourg. Source: Author’s calculations with data from STATEC and Yahoo Finance.

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + v_t \quad (2)$$

Where  $\beta^+$  and  $\beta^-$  are the long-term coefficients and  $x_t$  represents a decomposed vector (Schorderet 2003) as follows:

$$x_t = x_0 + x_t^+ + x_t^- \quad (3)$$

Where  $x_t^+$  and  $x_t^-$  represent the partial sums of positive and negative changes in  $x_t$ . In our case, the idea may be to see whether cross-border workers and residents react with the same degree to increases and decreases in financial activity. We might expect that asymmetries could result from labour market rigidities and workers' intrinsic characteristics.<sup>8</sup>

Shin, Yu, and Greenwood-Nimmo (2014) show, in the following equation, that the potential asymmetric effects of stock market activity increases and decreases on workers can be estimated in a non-linear ARDL model; the model becomes:

$$\begin{aligned} \Delta y_t = & \mu + \sum_p^{j=1} \varphi_j \Delta y_{t-j} + \sum_q^{j=0} \pi_j \Delta X_{t-j} + \rho y_{t-1} \\ & + \theta X_{t-1} + \varepsilon_t X_{t-1} + \theta X_{t-1} + \varepsilon_t \end{aligned}$$

In this case,  $\beta^+ = -\theta^+/\rho$  and  $\beta^- = -\theta^-/\rho$  represent long-term coefficients. The first part of the equation retains the lags of the asymmetric terms of the stock market variable as the first difference. The second part represents the long-term relationship. In the short term, workers adjust differently to an assessment ( $\pi_j^+$ ) rather than depreciation ( $\pi_j^-$ ) if the sum of each of the dynamic coefficients associated with '+' is different from that associated with '-'. This specification allows three possibilities to be tested: asymmetries present in both the short and long term; only in the long term; and only in the short term (see Shin, Yu, and Greenwood-Nimmo (2014)).

Finally, this model makes it possible to calculate the dynamic multipliers and study the effect of a variation in  $x_t^+$  and  $x_t^-$  on workers. The dynamic multipliers are calculated as follows:

$$m_h^+ = \sum_{j=0}^h \frac{\partial y_{t+j}}{\partial x_t^+} \quad \text{and} \quad m_h^- = \sum_{j=0}^h \frac{\partial y_{t+j}}{\partial x_t^-}$$

Logically, when  $m_h^+ \rightarrow \beta^+$  and  $m_h^- \rightarrow \beta^-$ . Therefore,

These dynamic multipliers make it possible to observe the adjustment from an initial equilibrium to the new equilibrium following a shock on  $x_t^+$  or  $x_t^-$ . We can observe asymmetric adjustment trajectories and/or the duration of the imbalance by adding information on short- and long-term forms of asymmetry.

This asymmetric non-linear ARDL approach is interesting for several reasons:

- The model can be estimated using the ordinary least squares (OLS) method.
- It allows us to distinguish different types of cointegration: linear cointegration, asymmetric cointegration or no cointegration. The existence of an asymmetric cointegration relationship is detectable by applying the test developed by Banerjee, Dolado, and Mestre (1998) referred to as  $t_{bdm}$  and the test developed by Pesaran, Shin, and Smith (2001) referred to as  $tF_{pss}$ .
- It examines whether the associated long-term coefficients and dynamic short-term adjustment are asymmetric, with respect to a Wald test. Therefore, asymmetries may be present in both the short and long term, or only in the long term, or only in the short term.

Finally, this approach allows us to estimate the OLD ARDL model by taking into account a possible linear or asymmetric cointegration, while testing the real rigidities in the short and/or long term, without imposing restrictive symmetry assumptions, with stationary variables in level and/or difference. This approach is thus 'positively' different from very similar approaches, since the threshold cointegration framework developed by Enders and Siklos (2001) only takes into account long-term asymmetry, and Hamilton's Markov vector error correction model (MS-VECM) (Hamilton 1989) and Krolzig (1997) do not allow the existence of long-term asymmetry to be detected.

This approach therefore requires testing stationarity (while allowing for a difference in order). We thus use unit root tests with unknown breaks, i.e. unit root tests by Zivot and Andrews (1992),

<sup>8</sup>Like Huang and Chang (2005), it can be assumed that the meaning of asymmetry varies according to the time horizon considered.

**Table 1.** ADF, Zivot and Andrews and Perron tests.

	Cross-border workers	Resident workers	Euro Stoxx	VIX
ADF	-3.46**	-4.45***	-2.69*	-4.56***
Zivot and Andrews (critical value at 10%)	-4.76 (-4.82)	-5.30** (-4.82)	-3.26 (-4.82)	-5.67*** (-4.82)
Perron (critical value at 10%)	-4.25 (-4.60)	-6.58*** (-4.60)	-3.36 (-4.60)	-6.72*** (-4.60)

\*\*\*, \*\* and \* indicate the rejection of the null hypothesis at the respective thresholds of 1%, 5% and 10%. The null hypothesis of the Zivot and Andrews test is the unit root series with drift.

Perron (1997a, 1997b) and Lee and Strazicich (2004). Zivot and Andrews (1992) propose a unit root test with an endogenous rupture. The null hypothesis assumes that the series has a unit root but without any breakage. The alternative hypothesis assumes that the series is stationary with only one break at an unknown date. Perron (1997a, 1997b) completes this test by distinguishing between an instantaneous effect (Additive Outlier (AO)) and an effect with transition (Innovational Outlier (IO)). The AO model allows a sudden change in the mean while the IO model allows a more gradual evolution. These sequential tests can finally be considered as an extension of the Dicky-Fuller tests that allow structural changes in level or trend to be taken into account via dummy variables. They introduce into the Dicky-Fuller regression an indicator variable specifying the existence of a break. The break date is chosen when the *t*-statistic of the Dicky-Fuller unit root test is at its minimum.

The analysis is then supplemented by Lee and Strazicich (2004) test based on Lagrange's maximum. This allows the existence of possible structural breaks (one or two) to be taken into account endogenously under both the null hypothesis of unit root and the alternative hypothesis. The Zivot and Andrews and Perron tests omit the possibility of breaks under the null hypothesis of unit root and sometimes lead to rejection biases in unit root tests (Nunes, Newbold, and Kuan 1997). Lee and Strazicich (2003) show that these unit root tests

with endogenous rupture can conclude that the variable in question is stationary in trend, whereas in fact the series is non-stationary with rupture.<sup>9</sup>

In addition,<sup>10</sup> we apply another unit root test in the presence of two regime changes. We use the test developed by Clemente, Montañes, and Reyes (1998), which is a generalization of the Perron and Vogelsang (1992) that allows only a single regime change (with endogenous break-up dates).

## (1) RESULTS OBTAINED

Before reporting the results of the NARDL model: we test the stationarity of the series.

The values between () denote the critical values at the 5% threshold tabulated by Clemente, Montañes and Reyes on the one hand and by Perron-Vogelsang on the other. The null hypothesis of the presence of a unit root is rejected if the *t*-statistic is lower than the critical value.

Based on the results of the unit root tests in Table 1, the null hypothesis of unit root is rejected (in level) only with the ADF test (except for residents). On the other hand, the Lee and Strazicich test (with model C, which combines a change in level and slope) leads to less clear results (see Table 2). In most cases, it rejects the null hypothesis of a unit root without a structural break and accepts the alternative hypothesis, i.e. the series presents a stationary trend with breaks (except for cross-border workers with two breaks).

**Table 2.** Lee and Strazicich test.

	CB workers		Resident workers		Euro Stoxx		VIX	
Break(s)	1	2	1	2	1	2	1	2
Min. LM test	-4.37**	-4.46	-5.59***	-6.70***	-4.34**	-4.34**	-3.76**	-4.72***
k	6	6	6	6	0	0	1	1

\*\*\*, \*\* and \* indicate the rejection of the null hypothesis (unit root series with two level breaks) at the respective thresholds of 1%, 5% and 10%. *k* is the number of delays included to correct the serial autocorrelation and represents the order of delay in the regression. The critical values in model C depend on the location of the failure ( $\lambda = t_B/T$ ) and are symmetrical around  $\lambda$  and  $(1-\lambda)$ .

<sup>9</sup>For more details, please refer to Bassil (2012) or Fromentin (2015).

<sup>10</sup>Due to uncertainty about the stationarity at the level of the 'cross-border workers' variable.

For cross-border workers, it is therefore preferable to carry out an additional test, i.e. that developed by Clemente, Montañés, and Reyes (1998). The IO procedure shows that the series is stationary in level with regime changes in August 2001 and August 2008. However, the AO procedure, which is used to capture sudden changes in the series, does not present significant statistics (see Table 3).

We are now able to estimate an ARDL model (linear) and a cointegrated and asymmetric NARDL model (due to the potentially asymmetric nature of job creation and job losses).

In the linear ARDL, the presence of a cointegrating relationship is assessed using the test coined by Banerjee, Dolado, and Mestre (1998) referred to as  $t_{bdm}$  and by Pesaran, Shin, and Smith (2001) referred to as  $tF_{pss}$ . In the ARDL (5,3) estimate, with regard to the AIC criteria, for cross-border workers, the null hypothesis of a lack of cointegration relationship is not rejected since:  $t_{bdm} = -2.06$  (10% threshold =  $-2.57$ ) and  $tF_{pss} = 2.60$  (10% threshold =  $4.04$ ). In the light of the statistics of the  $t_{bdm}$  and the  $tF_{pss}$  it is not possible to reject the null hypothesis of no cointegration. In addition, other cointegration tests (Johansen 1991; Engle and Granger 1987; Phillips and Ouliaris 1990; Gregory and Hansen 1996, which allow for structural breaks in the cointegration relationship) do not provide evidence that the null hypothesis is rejected.

The long-term coefficient, i.e. the lasting impact of a change in the stock market variable on cross-border workers ( $\beta^1 = 0.181$ ) is not significant. The error correction parameter  $\rho_y$  is negative and significant (up to 5%).

For residents: the null hypothesis of no cointegration relationship is rejected ( $tF_{pss} = 13.78$ ); the long-term coefficient ( $\beta^1 = 0.061$ ) is significant at 1%;  $\rho_y$  is negative and significant. It can therefore be assumed that the symmetric model is sufficient

**Table 3.** Clémente-Montañés-Reyes test.

	Cross-border workers	
Break(s)	IO	AO
Statistics	-6.207	-3.689
(critical value at 5%)	(-5.49)	(-5.49)
Breakdown dates	August 2001 August 2008	February 2002 December 2008

to explain the relationship between stock market fluctuations and resident workers.

As pointed out by Schorderet (2001) and Shin et al. (2014), the absence of cointegrating relationships between two variables can be masked by the presence of asymmetric dynamics. It therefore seems appropriate to estimate a cointegrated and asymmetric NARDL model (especially in the case of cross-border workers).

In Table 4, concerning cross-border workers, the NARDL(5,3), selected according to the AIC criteria, reveals the existence of a cointegrating relationship according to the statistics  $t_{bdm} = -4.65$  and  $tF_{pss} = 7.23$  (these tests can also be used to calculate long-term multipliers). The asymmetric structure allows us to highlight a cointegrating relationship (unlike the linear framework).

The error correction parameter is negative and significant. Long-term coefficients ( $\beta^+ = 0.138$  and  $\beta^- = -0.174$ ) are significant at 1%. We can therefore deduce that a 10% increase in the stock market variable leads to a 1.38% increase in cross-border workers and a 10% decrease in the Eurostoxx leads to a 1.74% reduction in cross-border workers. Over the period studied, the long-term coefficients diverge. It would appear that (downward) financial shocks have a greater impact on the long-term relationship.

For resident workers, the results are almost identical. However, it is important to note that the value of long-term coefficients is lower than for cross-border workers, while at the same time showing a proximity between  $\beta^+$  and  $\beta^-$  (related to the results of the linear model). This suggests that residents appear to be less sensitive to both upward and

**Table 4.** Estimates of NARDL models with Euro Stoxx.

	Cross-border workers	Resident workers
Asymmetry of LT	72.05***	4.363**
CT asymmetry	1.46	2.768*
$t_{bdm}$	-4.65	-5.57
$tF_{pss}$	7.23	11.27
	-0.08***	-0.194***
$\beta^+$	0.138***	0.067***
$\beta^-$	-0.174***	-0.063***
$\chi^2_{SC}$	0.066	0.001
$\chi^2_{NORM}$	27.03***	1053***

Note: Long-term asymmetry refers to the Wald test for the zero of long-term symmetry defined by  $-\frac{\theta^+}{\rho} = -\frac{\theta^-}{\rho}$ . Short-term asymmetry refers to the Wald test for the nullity of the short-term additive symmetry condition.  $\beta^+$  and the  $\beta^-$  are the associated positive or negative long-term coefficients of the stock market indicator.  $\rho_y$  is the error correction parameter.  $\chi^2_{SC}$  represents the Breusch-Godfrey LM test and  $\chi^2_{NORM}$  is the test of normality. The best model (with or without LT and CT symmetry) is defined from the AIC and SIC values.



downward changes in the market variable. A 10% decrease (increase) in the Eurostoxx causes a 0.63% (0.67%) reduction (increase) in worker flows. In line with Berton et al. (2018), it would appear that resident employment is less affected by financial ‘shocks’.

Concerning the results with VIX<sup>11</sup> (in Table 5), we obviously find counter-cyclical results. It seems that a 10% increase in the VIX variable leads to a 2.07% decrease in cross-border workers and that a 10% decrease in the volatility index leads to a 1.91% increase in cross-border workers. The error correction parameter is negative and significant. The coefficients for Luxembourg workers are not significant.

The estimation combining the variables Euro Stoxx and VIX (in particular in a logic of robustness) results in very similar results (see Table 6). We find a more asymmetrical effect for the variable Euro Stoxx, compare to VIX. The error correction parameter is also negative and significant.

**Table 5.** Estimates of NARDL models with VIX.

	Cross-border workers	Resident workers
Asymmetry of LT	15.11***	1.751
CT asymmetry	0.18	0.281
	-3.10	-3.70
$tF_{pss}$	5.77	4.69
$\rho_y$	-3.11***	-0.111***
$\beta^+$	-0.207**	0.012
$\beta^-$	0.191**	-0.01
$\chi^2_{SC}$	0.035	38.5***
$\chi^2_{NORM}$	26.72***	1389***

Note: Same comments as for Table 4.

**Table 6.** Estimates of NARDL models with Euro Stoxx and VIX.

	Cross-border workers
Asymmetry of LT Euro Stoxx	12.27***
CT asymmetry Euro Stoxx	0.06
Asymmetry of LT VIX	4.47**
CT asymmetry VIX	0.92
$t_{bdm}$	-3.97
$tF_{pss}$	5.74
$\rho_y$	-0.08***
$\beta^+_{EuroStoxx}$	0.118***
$\beta^-_{EuroStoxx}$	-0.225***
$\beta^+_{VIX}$	-0.078**
$\beta^-_{VIX}$	0.098***
$\chi^2_{SC}$	4.607
$\chi^2_{NORM}$	4.67*

Note: Same comments as for Table 4. The results for resident workers are not presented so as not to interfere with the presentation and interpretation of the results. However, they can be sent following a request to the author.

By studying dynamic multipliers and analysing the short-term dynamic effects between the variables involved, we can monitor price developments following a financial shock and provide a ‘living’ picture of the dynamic process. Asymmetric multipliers are capable of capturing the characteristics of a large or persistent transmission following a shock. Charts 5 and 6 represent the variation in the dynamic multipliers obtained with the NARDL model estimate. These multipliers show workers’ asymmetric adjustments to its new long-term equilibrium following a negative (red curve) or positive (green curve) unit change in the stock market variable, with a 40-month forecast horizon. The asymmetry curve (in blue), on the other hand, represents the linear combination of dynamic multipliers associated with positive and negative variations.

In terms of the graphs, cross-border workers and residents present truly different short-term reactions. With Euro Stoxx, in both cases, an increase (decrease) in the financial indicator leads to an increase (decrease) in the flow of workers, but cross-border workers seem to be more sensitive to a decrease, while residents are more sensitive to an increase. Cross-border workers react more quickly and strongly to a decrease, rather than an increase, in the stock market variable. The asymmetry curve (blue line), which is the linear combination of dynamic multipliers associated with positive and negative shocks (plotted with its bands below and above the 95% confidence interval), returns to a lower balance for cross-border workers. In addition, dynamic multipliers take about 12 months and 20 months to converge on long-term multipliers, respectively for residents and border residents. For residents, in the long term, both depreciation and assessments are reflected in flows to a similar extent.<sup>12</sup> Like Fromentin and Tadjeddine (2020), who use spectral analysis, we find a differential impact of shocks in the short term and long term on cross-border and residents workers.

With the VIX, we find substantially the same conclusions, i.e. cross-border workers react more

<sup>11</sup>Ochoa (2013) also uses a volatility indicator to analyse its effect on employment, and finds a positive and statistically significant cross-sectional relation between the reliance on skilled labour and expected returns.

<sup>12</sup>It should be noted that the inclusion of additional variables in the estimation of the ARDL and NARDL models (such as the economic climate indicator or the volume production index) only marginally modifies the results obtained, which seems to justify a certain robustness of the results.



quickly and strongly to an increase (which reflects stronger financial instability) than to a decrease (compared to resident workers).

The results show that interrelationships exist between financial activity and workers (cross-border commuters and residents) in Luxembourg (Rouabah and Theal 2015), and that stock market variables and financial instability are good predictors of employment (Næs, Skjeltop, and Ødegaard 2011; Pagano and Pica 2012; Haltenhof, Lee, and Stebunovs 2014), particularly for cross-border workers (Damette, Fromentin, and Salesina 2020).

As the 2007–2008 crisis clearly illustrated, the instability of financial centres has an effect on employment, particularly in countries where the financial sector is strong (Escudero 2009). It is likely that financial variables influence the number of workers, despite a certain time lag. Indeed, one way to link macroeconomic variables and stock returns is through arbitrage pricing theory (Ross 1976), whereby a change in a given macroeconomic variable is considered to reflect a change in an underlying systematic risk factor influencing future returns. In addition, the price of inventory assets must correspond to the present value of the firm's future payments. These payments then reflect the actual activity of the company and, by extension and aggregation, that of a sector or even a country. Moreover, cross-border workers, whose labour market status is probably less stable than that of local workers, can be expected to act as a buffer (or shock absorber) and are therefore among those most affected by financial fluctuations.

The fact of using a non-linear framework, for cross-border workers, allows a more detailed appreciation of the sensitivity of the job to financial fluctuations. Finally, it is important to note that our results are in line with the literature mentioned above, notably concerning the asymmetric effects on employment of uncertainty shocks over the business cycle (Bloom 2009; Basu and Bundick, 2014; Caggiano, Castelnovo, and Nodari 2017; Leduc and Liu 2016, and Pan, 2018).

### (1) ROBUSTNESS

We test the robustness of our results on two different proxies. The addition of control variables, such as share price indices and credit spreads,

demonstrates that the results obtained are robust (see tables 7, tables 8 and tables 9). Share price indices (source: OECD) are calculated from the prices of common company shares traded on national or foreign stock exchanges. The credit spread is expressed as the monthly US corporate credit spread of Baa-rated bonds minus AAA-rated bonds (see for example Gilchrist and Zakrajšek (2012) for more details). In addition, we estimate models that incorporate both indicators.

The results lead to similar conclusions, i.e. a stronger reaction and asymmetry for cross-

**Table 7.** Estimates of NARDL models with share price indices.

	Cross-border workers	Resident workers
Asymmetry of LT	84.08***	0.056
CT asymmetry	6.03	0.237
$t_{bdm}$	-3.81	-4.906
$tF_{pss}$	5.26	8.859
$\rho_y$	-0.07***	-0.159***
$\beta^+$	0.175***	0.069***
$\beta^-$	-0.228***	-0.068***
$\chi^2_{SC}$	0.005	4.24**
$\chi^2_{NORM}$	9.211***	1262***

Note: Same comments as for Table 4.

**Table 8.** Estimates of NARDL models with credit spread.

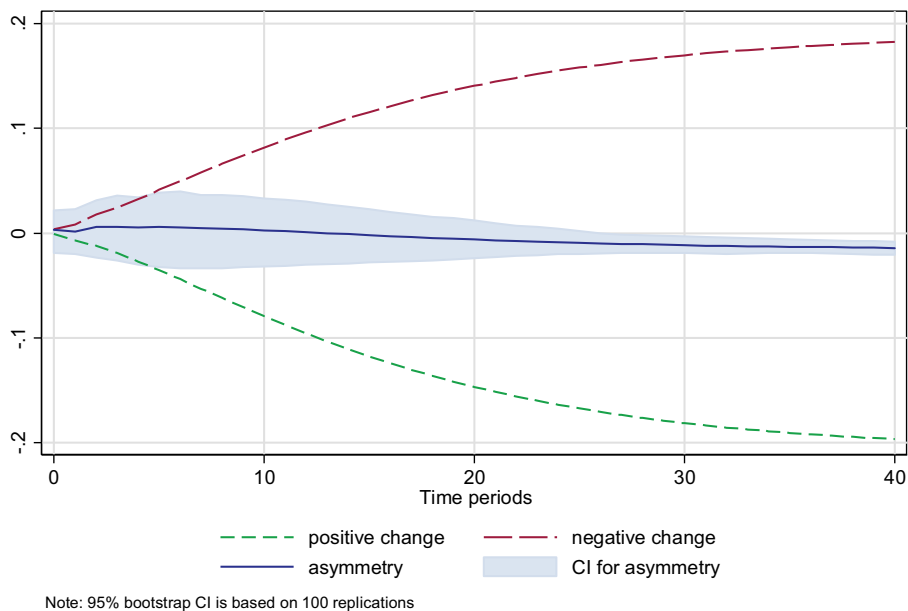
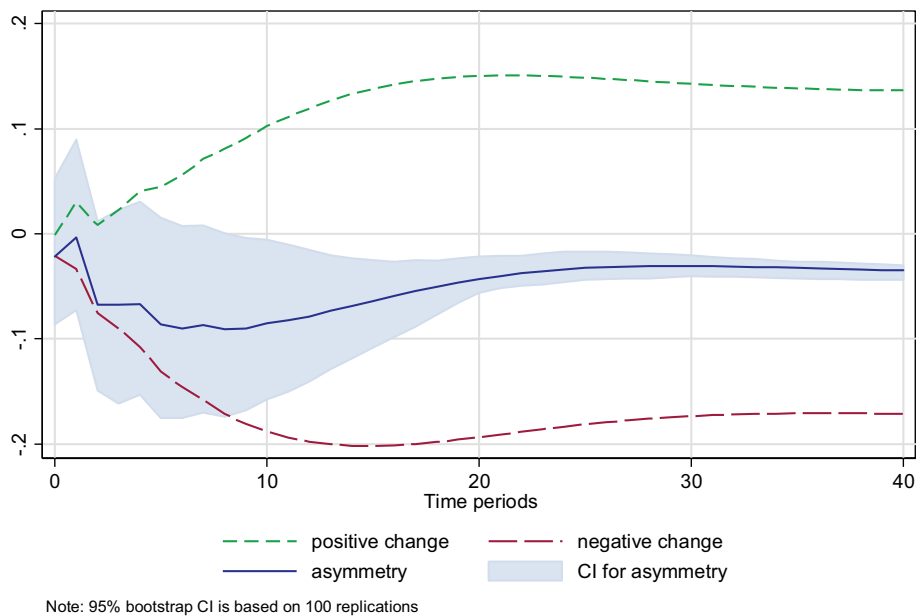
	Cross-border workers	Resident workers
Asymmetry of LT	3.14*	1.752
CT asymmetry	2.88*	0.001
$t_{bdm}$	-3.09	-3.75
$tF_{pss}$	8.60	5.26
$\rho_y$	-0.036***	-0.110***
$\beta^+$	-0.103***	0.010
$\beta^-$	0.099***	0.012***
$\chi^2_{SC}$	1.206	81.85***
$\chi^2_{NORM}$	14.1***	1697***

Note: Same comments as for Table 4.

**Table 9.** Estimates of NARDL models with share price indices and credit spread.

	Cross-border workers
Asymmetry of LT <i>share price indices</i>	4.01**
CT asymmetry <i>share price indices</i>	1.49
Asymmetry of LT <i>Credit spread</i>	-0.028*
CT asymmetry <i>Credit spread</i>	2.01
$t_{bdm}$	-4.10
$tF_{pss}$	6.01
$\rho_y$	-0.08***
$\beta^+_{Sharepriceindices}$	0.133***
$\beta^-_{Sharepriceindices}$	-0.204***
$\beta^+_{Creditspread}$	-0.028*
$\beta^-_{Creditspread}$	0.034**
$\chi^2_{SC}$	1.465
$\chi^2_{NORM}$	9.57***

Note: Same comments as for Table 4. The results for resident workers are not presented so as not to interfere with the presentation and interpretation of the results. However, they can be sent following a request to the author.



**Graph 5:** Dynamic multipliers for cross-border workers (Euro Stoxx and VIX respectively).

border workers, especially for variable share price indices.

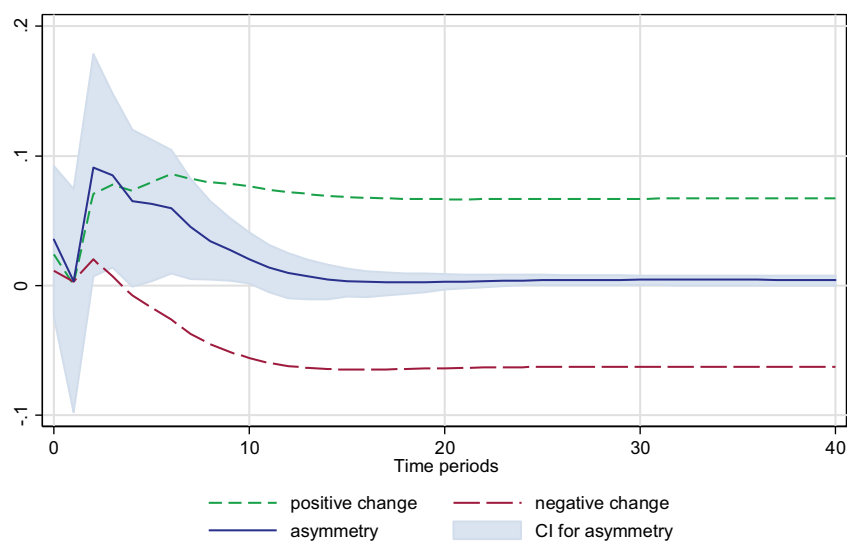
### (1) DISCUSSION

Several lessons, drawn from empirical analysis, can be advanced in order to provide answers on a rarely studied research theme that nevertheless encompasses important economic, political and societal issues.

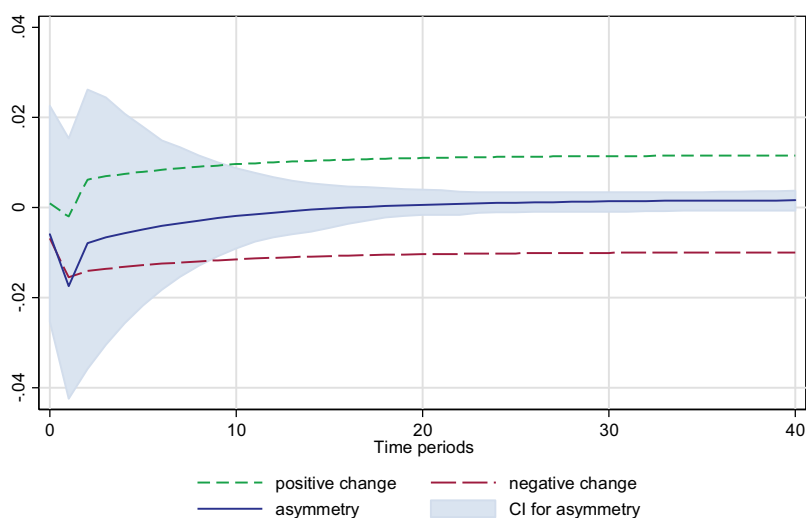
The predictive power of financial indicators (Euro Stoxx) to explain fluctuations in numbers of cross-border and resident workers seems to be validated against the results of the ARDL and NARDL models. In addition, the impact of financial instability on border residents and residents is clearly different, in terms of symmetry or asymmetry and response to short-term and long-term shocks (for the ARDL and NARDL models).

<sup>13</sup>Lang and De Peretti (2009) also propose a theoretical model explaining this phenomenon.

<sup>14</sup>Luxembourg, being a 'small' country, relatively to Switzerland for example, presents a particular character, since the 'border region' aspect has less relevance.



Note: 95% bootstrap CI is based on 100 replications



Note: 95% bootstrap CI is based on 100 replications

**Graph 6:** Dynamic multipliers for resident workers (Euro Stoxx and VIX respectively).

Several explanatory elements, at the crossroads of disciplines (economics, management, finance, etc.), can be put forward to shed light on and contribute to the explanation of this ‘phenomenon’ inherent to the Greater Region.

Our conclusions could be compared to the studies by Palley (1993) and Lee (2000) (who test Okun’s law by taking into account the asymmetry of this relationship), which show that labour market transformations in the United

<sup>15</sup>It is important to note that cross-border workers, who account for more than 40% of total domestic employment, were particularly affected by the crisis, probably due to the sectoral distribution of cross-border workers, who are over-represented in temporary contracts or internationally oriented sectors (e.g. industry, finance and business services).

States, including the gradual entry of female workers, have gradually reduced the cushioning role of labour supply (refer for example to Stephan (2014)). In our case, the behaviour of cross-border and resident workers could differ during recessions.

During recessions, resident workers tend to remain in the labour force, unlike cross-border workers. The cushioning role of labour supply, materialized by the existence of asymmetry, could be better ensured by cross-border workers in Luxembourg.

This asymmetric response could also be explained by the existence of an unemployment hysteresis in relation to movements in financial indicators or real GDP. With regard to insiders/outsiders (or human capital models), while employers lay off a certain number of workers after a negative financial shock, they do not hire exactly the same number of workers after a positive shock (of a magnitude comparable or not to the negative shock).<sup>13</sup>

Similarly, the literature on the effects of recessions on migrant workers generally shows that migrants are more responsive to economic shocks (Dustmann et al., 2010; Findlay, Geddes, and McCollum 2010; Fromentin, Damette, and Zou 2017). However, it should be taken into consideration that ‘immigrants’ and ‘commuting workers’ do not present the same characteristics, and do not perceive financial fluctuations in the same way. Dustmann, Schönberg, and Stuhler (2017) show that commuting workers do not live and consume in the affected areas, thus reducing possible demand effects induced by immigrant consumption. Cross-border workers constitute an additional labour supply, but because they live abroad<sup>14</sup> they likely generate smaller local consumption/demand effects than other immigrants (Beerli and Peri 2017). Moreover, labour supply shocks differ, and may have been viewed as temporary by firms, making them reluctant to expand capital in response to the shock; in parallel, protection against partial wage rigidity and firing restrictions is different.

This over-reaction can also be explained by the sectoral distribution of the labour market. Sectors such as general government, education and health (less exposed to financial and economic

fluctuations) attract very few cross-border workers. Luxembourg employees can use their special skills (especially linguistic skills) that have become scarce on the market. It limits access for non-residents and non-nationals to these positions. They are thus protected from competition from the increasing number and quality of foreign and cross-border workers (Fehlen and Pigeron-Piroth 2009).

From a human resources management perspective, it is possible that our results can be explained by the pessimism of employers in the sense that bad business news appears to them with more certainty than good news (Silvapulle, Silvapulle, and Moosa 2004). In times of economic recovery, companies may be reluctant to hire staff because they doubt the sustainability of the recovery. In addition, the low regulatory constraints on hiring and firing in Luxembourg may also explain the reaction of employers in times of recession. Overall, more firms implement job cuts than wage cuts with the effect that the impact on overall wage dynamics is limited. Companies that have to reduce their workforce or change their composition do so by freezing or reducing the number of new hires, followed by individual layoffs, reduction of temporary workers, non-renewal of temporary contracts and unsubsidized reduction of working hours (Matha et al., 2016),<sup>15</sup> which has more impact on cross-border workers.

However, it is important to note that this effect is reduced due to the characteristics of the Luxembourg financial cluster, which plays the role of an attractor of key skills (Porter 1998; Damette, Fromentin, and Salesina 2018). In this perspective, core competencies are mechanisms of ‘collective learning in the organization, in particular how to coordinate various production skills and the integration of different forms of technology’ (Prahalad and Hamel, 1990). Because companies invest in staff training, when an economic or financial crisis occurs, they may be reluctant to part with staff in the short term, given the loss of human capital. Companies may wish to retain the workers that they have invested in most. Similarly, during an expansion, employers start hiring again taking into account the time required for the employee training process. It is therefore possible that entrepreneurs may adopt a ‘wait-and-see

attitude' before relaunching the hiring process, in order to validate the economic and financial recovery.

In addition, the characteristics and specific features of companies, particularly with regard to investor involvement, can also condition and increase the pressure on restructuring and redundancy plans (Guery-Stevenot and Guery 2006). The financial sphere constantly seeks to reconstitute securities portfolios by taking into account the risk/return trade-off. Investors may thus not be concerned with other dimensions of economic life. Following this logic, we could also speak of a dualization of current accumulation spaces (Crevoisier, Theurillat, and Araujo 2011): on the one hand, financial circuits take the form of networks centred on the 'global city'; on the other hand, the real economy (training, research, labour market, etc.) is still very largely organized on the traditional model of national and regional governance.

However, the interrelationships between the financial sphere and the real economy (including employment) remain and become more important in times of instability, although the cost and availability of external financing may have divergent effects on employment. On the one hand, easing financing constraints can allow firms to optimally substitute capital for labour (Garmaise 2007). On the other hand, frictions on the financial markets limit investment; conversely, a decrease in the cost of external financing will increase investment at the firm level and demand for workers may then increase. Shocks on firms' borrowing capacity, combined with some rigidities in adjusting their financial structure, play an important role in generating business cycle movements, particularly for labour (Jermann and Quadrini 2012).

The impact of financial shocks on employment may therefore depend on the flexibility with which firms can change their financial structure, i.e. the composition of debt and equity. The important and direct role of credit constraints, beyond the general impact of the overall decline in aggregate demand on businesses, is confirmed in a recent study analysing the impact of the 2008–2009 financial crisis on European labour markets (Sharma and Winkler 2018).

## (1) CONCLUSION

The goal of this study was to investigate the non-linear relationship between equity prices and a labour market in an international financial centre. The case of the Greater Region of Luxembourg is highly relevant because of its extreme specialization in banking and the finance and the significant number of cross-border workers. Interrelationships seem to operate between financial fluctuations, the real economy and employment, especially in times of crisis or post-crisis, and more particularly for cross-border workers, whose recruitment is facilitated by service and financial intermediation companies.

Estimations of these interrelationships using an asymmetric non-linear ARDL (Auto Regressive Distributive Lags) model validate the predictive power of financial indicators in explaining fluctuations in numbers of cross-border and resident workers. Our main findings confirm the differential impact of an equity shock and implied volatility on cross-border and resident workers. Residents appear to be less sensitive to both upward and downward changes in the market variable. Like Berton et al. (2018) or Fromentin and Tadjeddine (2020), we find a differential impact of shocks in the short term and long term on cross-border and resident workers. Interrelationships exist between financial activity and workers (particularly cross-border commuters) in Luxembourg, and stock market variables and financial instability are good predictors of employment (Næs, Skjeltorp, and Ødegaard 2011; Pagano and Pica 2012; Haltenhof, Lee, and Stebunovs 2014). The instability of financial centres has an effect on employment, particularly in countries where the financial sector is strong (Escudero 2009).

Several arguments can thus be put forward to explain the over-reaction to financial fluctuations (with regard to the conclusions of the NARDL model) by cross-border workers in the Greater Region (compared to Luxembourg resident workers). This asymmetric response could be explained by the existence of an unemployment hysteresis in relation to movements in financial indicators; the sectoral distribution of the labour market; the characteristics of the Luxembourg financial cluster,

which plays the role of attractor of key skills; dualization of current accumulation spaces; the changes in interrelationships between the financial sphere and the real economy during crisis periods; etc.

However, this research topic deserves much further investigation in order to better understand the effects of financial or economic instability on cross-border workers, particularly with regard to changes in the regulation of the financial system, and also in a comparative logic by integrating other financial clusters into the analysis.

The significant increase in the number of cross-border workers in recent decades has led to a reduction in the supply of skilled labour in the Greater Region, which could lead to a possible labour shortage on the national labour market. As a result, companies are forced to seek highly skilled labour not only beyond the natural borders of the Greater Region, but also in third countries, due to the flexible and dynamic needs that characterize a globalized financial centre.

Moreover, in Luxembourg, companies' responses to the 2008 financial crisis seem to vary according to the size and sector of economic activity. Future research could further address this aspect in order to better understand the response of frontier workers to financial fluctuations and to the health crisis.

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## References

- Amétépé, F., and C. Hartmann-Hirsch. 2011. "An Outstanding Positioning of Migrants and Nationals: The Case of Luxembourg." *Population Review* 50 (1)
- Banerjee, A., J. Dolado, and R. Mestre. 1998. "Error-correction Mechanism Tests for Cointegration in a Single-equation Framework." *Journal of Time Series Analysis* 19 (3): 267–283. doi:10.1111/1467-9892.00091.
- Bassil, C. 2012. "Interaction between Unit Roots and Structural Breaks." *Economic Review* 63 (1): 93–128.
- Basu, S., and B. Bundick. 2014. "Downside Risk at the Zero Lower Bound." *Boston College, NBER, and Federal Reserve Bank of Kansas City mimeo*.
- Beerli, A., and G. Peri (2017). "The Labor Market Effects of Opening the Border: Evidence from Switzerland." *KOF Working Papers*. 17–431 KOF Swiss Economic Institute, ETH Zurich.
- Belo, F., J. Li, X. Lin, and X. Zhao. 2017. "Labor-force Heterogeneity and Asset Prices: The Importance of Skilled Labor." *The Review of Financial Studies* 30 (10): 3669–3709. doi:10.1093/rfs/hhx070.
- Benhabib, J., X. Liu, and P. Wang. 2016. "Sentiments, Financial Markets, and Macroeconomic Fluctuations." *Journal of Financial Economics* 120 (2): 420–443. doi:10.1016/j.jfineco.2016.01.008.
- Berton, F., S. Mocetti, A. F. Presbitero, and M. Richiardi. 2018. "Banks, Firms, and Jobs." *The Review of Financial Studies* 31 (6): 2113–2156. doi:10.1093/rfs/hhy003.
- Bloom, N. 2009. "The Impact of Uncertainty Shocks." *Econometrica* 77 (3): 623–685.
- Bloom, N. 2014. "Fluctuations in Uncertainty." *Journal of Economic Perspectives* 28 (2): 153–176. doi:10.1257/jep.28.2.153.
- Bloom, N., S. Bond, and J. Van Reenen. 2007. "Uncertainty and Investment Dynamics." *The Review of Economic Studies* 74 (2): 391–415. doi:10.1111/j.1467-937X.2007.00426.x.
- Borio, C. 2014. "The Financial Cycle and Macroeconomics: What Have We Learnt?" *Journal of Banking & Finance* 45: 182–198. doi:10.1016/j.jbankfin.2013.07.031.
- Caggiano, G., E. Castelnuovo, and G. Nodari. 2017. "Uncertainty and Monetary Policy in Good and Bad Times." *Bank of Finland Research Discussion Paper* (8).
- Caldara, D., C. Fuentes-Albero, S. Gilchrist, and E. Zakrajšek. 2016. "The Macroeconomic Impact of Financial and Uncertainty Shocks." *European Economic Review* 88: 185–207. doi:10.1016/j.eurocorev.2016.02.020.
- Chamber of Commerce (2009), "Economic Bulletin of the Chamber of Commerce No. 7." June, "News and Trends", p. 22.
- Chodorow-Reich, G. 2014. "The Employment Effects of Credit Market Disruptions: Firm-Level Evidence from the 2008–9 Financial Crisis." *The Quarterly Journal of Economics*, 129 (1): 1–59. doi:10.1093/qje/qjt031.
- Clemente, J., A. Montañes, and M. Reyes. 1998. "Testing for a Unit Root in Variables with a Double Change in the Mean." *Economics Letters* 59 (2): 175–182. doi:10.1016/S0165-1765(98)00052-4.
- Crevoisier, O., T. Theurillat, and P. Araujo. 2011. "Les territoires de l'industrie financière: Quelles suites à la crise de 2008–2009?" *Revue d'économie industrielle* 134: 133–158. doi:10.4000/rei.5025.
- Damette, O., V. Fromentin, and M. Salesina. 2020. "Cross-border Dynamics of Employment: Examining Luxembourg's Financial Cluster." In *In Borders and Cross-border Labor Markets: Opportunities and Challenges*, edited



- by R. Belkacem and I. Pigeron-Piroth, 65–78, University of Lorraine & University of Luxembourg.
- Damette, O., and V. Fromentin. 2013. “Migration and Labour Markets in OECD Countries: A Panel Cointegration Approach.” *Applied Economics* 45 (16): 2295–2304. doi:10.1080/00036846.2012.661400.
- Damette, O., V. Fromentin, and M. Salesina. 2018. “Cluster financier luxembourgeois et travailleurs frontaliers dans la Grande Région-Regard croisés entre économie et gestion.” *Revue du marché commun et de l’Union Européenne* 617: 230–239.
- De Peretti, C., and D. Lang. 2009. “A Strong Hysteretic Model of Okun’s Law: Theory and A Preliminary Investigation.” *International Review of Applied Economics* 23 (4): 445–462. doi:10.1080/02692170902954775.
- Dustmann, C., A. Glitz and T. Vogel. 2010. “Employment, Wages, and The Economic Cycle: Differences Between Immigrants and Natives.” *European Economic Review* 54 (1): 1–17
- Dustmann, C., U. Schönberg, and J. Stuhler. 2017. “Labor Supply Shocks, Native Wages, and the Adjustment of Local Employment.” *The Quarterly Journal of Economics* 132 (1): 435–483. doi:10.1093/qje/qjw032.
- Enders, W., and P. L. Siklos. 2001. “Cointegration and Threshold Adjustment.” *Journal of Business and Economic Statistics* 19 (2): 166–176. doi:10.1198/073500101316970395.
- Engle, R. F., and C. Granger. 1987. “Co-integration and Error Correction: Representation, Estimation, and Testing.” *Econometrica: Journal of the Econometric Society* 55 (2): 251–276. doi:10.2307/1913236.
- Eriksson, R. H., E. Hane-Weijman, and M. Henning. 2018. “Sectoral and Geographical Mobility of Workers after Large Establishment Cutbacks or Closures.” *Environment and Planning A: Economy and Space* 50 (5): 1071–1091. doi:10.1177/0308518X18772581.
- Escudero, V. (2009). “Effects of the Crisis on the Financial Sector: Trends and Policy Issues.” Geneva: International Institute for Labour Studies, Discussion Paper 97.
- European Commission. 2020. Country Report Luxembourg 2020.
- European Commission (2014). “Document De Travail Des Services De La Commission.” *Déséquilibres macroéconomiques*, Luxembourg.
- Eurostat. 2016. Statistics on Commuting Patterns at Regional Level. *Statistics Explained*
- Fama, E. F., and G. W. Schwert. 1977. “Human Capital and Capital Market Equilibrium.” *Journal of Financial Economics* 4 (1): 95–125. doi:10.1016/0304-405X(77)90038-1.
- Fehlen, F., and I. Pigeron-Piroth. 2009. “Globalisation of Labour and Plurality of Labour Markets: The Example of Luxembourg.” *XIIIèmes Journées Internationales de Sociologie du Travail* 1–15.
- Feldmann, H. 2011. “Stock Markets and Unemployment in Industrial Countries.” *Applied Economics Letters* 18 (9): 845–849. doi:10.1080/13504851.2010.503929.
- Findlay, A., A. Geddes, and D. McCollum. 2010. “International Migration and Recession.” *Scottish Geographical Journal* 126 (4): 299–320. doi:10.1080/14702541.2010.549346.
- Fries-Tersch, E., T. Tugran, and H. Bradley (2018). “2017 Annual Report on intra-EU Labour Mobility.” Final Report January. European Commission.
- Fromentin, V. 2015. “L’impact de la taxation sur les ventes de cigarettes en France.” *Revue économique* 66 (3): 601–614. doi:10.3917/reco.pr2.0044.
- Fromentin, V., O. Damette, and B. Zou. 2017. “The Global Economic Crisis and the Effect of Immigrant Workers on Native-born Employment in Europe.” *The World Economy* 40 (6): 1068–1088. doi:10.1111/twec.12394.
- Fromentin, V., and Y. Tadjeddine. 2020. “Cross-border Workers and Financial Instability: A Frequency Domain Causality Analysis Applied to the Luxembourg Financial Centre.” *Applied Economics Letters* 27 (4): 280–285. doi:10.1080/13504851.2019.1613496.
- Garmaise, M. J. 2007. “Production in Entrepreneurial Firms: The Effects of Financial Constraints on Labor and Capital.” *The Review of Financial Studies* 21 (2): 543–577. doi:10.1093/rfs/hhm081.
- Gilchrist, S., and E. Zakrajšek. 2012. “Credit Spreads and Business Cycle Fluctuations.” *The American Economic Review* 102 (4): 1692–1720. doi:10.1257/aer.102.4.1692.
- Gregory, A. W., and B. E. Hansen. 1996. “Residual-based Tests for Cointegration in Models with Regime Shifts.” *Journal of Econometrics* 70 (1): 99–126. doi:10.1016/0304-4076(99)41685-7.
- Guarda, P. 2000. “Luxembourg’s Cross-Border Workers: Estimating a System of Factor Demands.” *CREA WP 00–4*.
- Guery-Stevenot, A., and L. Guery. 2006. “L’influence des Capital Investisseurs sur la gestion des ressources humaines des entreprises financées: Dimensions, enjeux et limites.” *Gestion* 23: 3. 2000.
- Haltenhof, S., S. J. Lee, and V. Stebunovs. 2014. “The Credit Crunch and Fall in Employment during the Great Recession.” *Journal of Economic Dynamics & Control* 43: 31–57. doi:10.1016/j.jedc.2014.03.013.
- Hamilton, J. D. 1989. “A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle.” *Econometrica: Journal of the Econometric Society* 57 (2): 357–384. doi:10.2307/1912559.
- Hamilton, J. D. 1989. “A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle.” *Econometrica: Journal of the econometric society*: 357–384.
- Huang, H. C., and Y. K. Chang. 2005. Investigating Okun’s Law by the Structural Break with Threshold Approach: Evidence from Canada. *The Manchester School* 73 (5): 599–611.
- INSEE (2008). “La Lorraine dans la Grande-Région.” Rapport No. 128, INSEE, France, Mai.
- Jermann, U., and V. Quadrini. 2012. “Macroeconomic Effects of Financial Shocks.” *American Economic Review* 102 (1): 238–271. doi:10.1257/aer.102.1.238.

- Johansen, S. 1991. "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models." *Econometrica: Journal of the Econometric Society* 59 (6): 1551–1580. doi:10.2307/2938278.
- Kirov, V. N., and P. Thill. 2018. "The Impact of Crisis and Restructuring on Employment Relations in Banking: The Cases of France, Luxembourg and Romania." *European Journal of Industrial Relations* 24 (3): 297–313. doi:10.1177/0959680117752047.
- Krolzig, H. M. 1997. "Markov-switching Vector Autoregression." *Lecture Notes in Economic and Mathematical Systems*.
- Lang, D., and C. De Peretti. 2009. "A Strong Hysteretic Model of Okun's Law: Theory and a Preliminary Investigation." *International Review of Applied Economics* 23 (4): 445–462.
- Larue, B. 2016. *Regards Sur La Relation Entre Fluctuations Boursières Et Performance Économique*. Regards 21/2016. Luxembourg: STATEC.
- Leduc, S., and Z. Liu. 2016. "Uncertainty Shocks are Aggregate Demand Shocks." *Journal of Monetary Economics* 82: 20–35. doi:10.1016/j.jmoneco.2016.07.002.
- Lee, J. 2000. "The Robustness of Okun's Law: Evidence from OECD Countries." *Journal of Macroeconomics* 22 (2): 331–356. doi:10.1016/S0164-0704(00)00135-X.
- Lee, J., and M. C. Strazicich. 2003. "Minimum LM Unit Root Test with Two Structural Breaks." *Review of Economics and Statistics* 63: 1082–1089. doi:10.1162/003465303772815961.
- Lee, J., and M. C. Strazicich (2004). "Minimum LM Unit Root Test with One Structural Break. No 04–17." Working Papers, Department of Economics, Appalachian State University, USA.
- Levine, R. 2005. "Finance and Growth: Theory and Evidence." In *Handbook of Economic Growth, Edition 1, Volume 1, Chapter 12*, edited by P. Aghion and S. Durlauf, 865–934. Amsterdam: Elsevier.
- Marchiori, L., and O. PIERRARD. 2017. "How Does Global Demand for Financial Services Promote Domestic Growth in Luxembourg? A Dynamic General Equilibrium Analysis." *Economic Modelling* 62: 103–123. doi:10.1016/j.econmod.2016.12.020.
- Mathä, T. Y., C. Veiga and L. Wintr. 2016. "Employment, Wages and Prices: How did Firms Adjust During the Economic and Financial Crisis: Evidence from a Survey of Luxembourg Firms." *Central Bank of Luxembourg* (104).
- Mathä, T. Y., A. Porpiglia, and M. Ziegelmeyer. 2017. "Cross-border Commuting and Consuming: An Empirical Investigation." *Applied Economics* 49 (20): 2011–2026. doi:10.1080/00036846.2016.1231902.
- Mayers, D. 1972. "Nonmarketable Assets and Capital Market Equilibrium under Uncertainty." In *Studies in the Theory of Capital Markets*, edited by M. C. Jensen, 223–248. New York: Praeger .
- Mian, A., and A. Sufi. 2014. "What Explains the 2007–2009 Drop in Employment?" *Econometrica* 82 (6): 2197–2223. doi:10.3982/ECTA10451.
- Næs, R., J. A. Skjeltorp, and B. A. Ødegaard. 2011. "Stock Market Liquidity and the Business Cycle." *The Journal of Finance* 66 (1): 139–176. doi:10.1111/j.1540-6261.2010.01628.x.
- Netšunajev, A., and K. Glass. 2017. "Uncertainty and Employment Dynamics in the Euro Area and the US." *Journal of Macroeconomics* 51: 48–62. doi:10.1016/j.jmacro.2016.12.002.
- Nunes, L., P. Newbold, and C. Kuan. 1997. "Testing for Unit Roots with Breaks: Evidence on the Great Crash and the Unit Root Hypothesis Reconsidered." *Oxford Bulletin of Economics and Statistics* 59: 435–448. doi:10.1111/1468-0084.00076.
- Ochoa, M. (2013). "Volatility, Labor Heterogeneity and Asset Prices." Finance and Economics Discussion Series 2013–71, Board of Governors of the Federal Reserve System (U.S.), revised 2013.
- Olsen, E. D. H. 2015. "Eurocrisis and EU Citizenship." In *Europe's Prolonged Crisis: The Making or the Unmaking of a Political Union*, edited by H. J. Trenz, C. Ruzza, and V. Guiraudon, 85–103. Basingstoke: Routledge.
- Pagano, M., and G. Pica. 2012. "Finance and Employment." *Economic Policy* 27 (69): 5–55. doi:10.1111/j.1468-0327.2011.00276.x.
- Palley, T. I. 1993. "Okun's Law and the Asymmetric and Changing Cyclical Behaviour of the USA Economy." *International Review of Applied Economics* 7 (2): 144–162. doi:10.1080/758530144.
- Pan, W. F. 2018. "Does the Stock Market Really Cause Unemployment? A Cross-Country Analysis." *The North American Journal of Economics and Finance* 44: 34–43
- Parenti, A., and C. Tealdi (2019). "Does the Implementation of the Schengen Agreement Boost Cross-Border Commuting?" *Evidence from Switzerland*. IZA Discussion Papers 12754, Institute of Labor Economics (IZA).
- Perron, P. 1997a. "L'estimation de modèles avec changements structurels multiples." *L'Actualité économique* 73-1: 457–505. [https://www.academia.edu/3826504/G%C3%A9ographie\\_des\\_activit%C3%A9s\\_%C3%A9conomiques\\_m%C3%A9ropolitaines\\_au\\_Luxembourg](https://www.academia.edu/3826504/G%C3%A9ographie_des_activit%C3%A9s_%C3%A9conomiques_m%C3%A9ropolitaines_au_Luxembourg)
- Perron, P. 1997b. "Further Evidence from Breaking Trend Functions in Macroeconomic Variables." *Journal of Econometrics* 80: 355–385. doi:10.1016/S0304-4076(97)00049-3.
- Perron, P., and T. J. Vogelsang. 1992. "Nonstationarity and Level Shifts with an Application to Purchasing Power Parity." *Journal of Business and Economic Statistics* 10 (3): 301–320.
- Pesaran, M. H., and Y. Shin. 1998. "An Autoregressive Distributed-lag Modelling Approach to Cointegration Analysis." *Econometric Society Monographs* 31: 371–413.
- Pesaran, M. H., Y. Shin, and R. Smith. 2001. "Bounds Testing Approaches to the Analysis of Level Relationships." *Journal of Applied Econometrics* 16: 289–326. doi:10.1002/jae.616.
- Phillips, P. C., and S. Ouliaris. 1990. "Asymptotic Properties of Residual Based Tests for Cointegration." *Econometrica: Journal of the Econometric Society* 58 (1): 165–193. doi:10.2307/2938339.

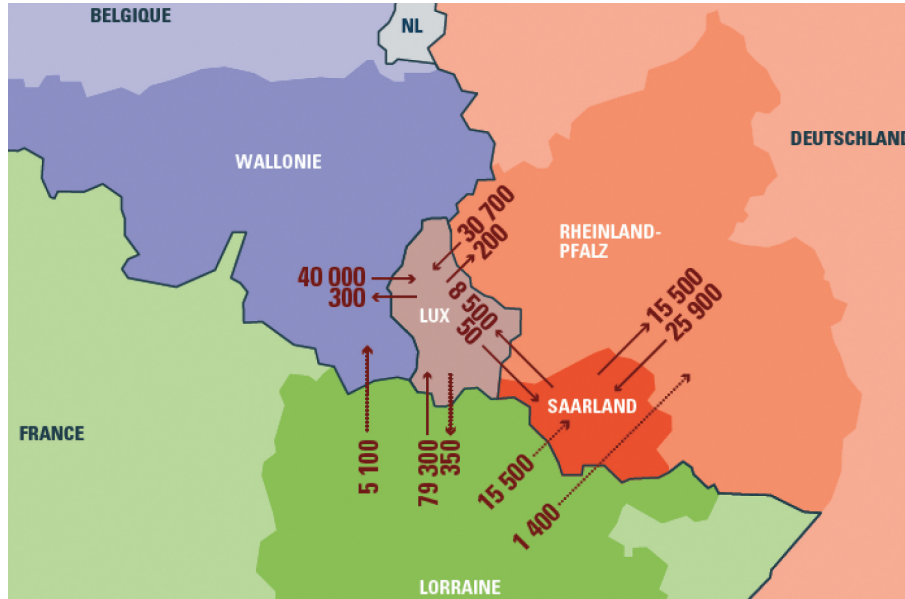
- Pigeron-Piroth, I., and R. Belkacem. 2020. "Socioeconomics Profiles of Cross-border Commuters at the French: Common Features and Territorial Specificities." *Borders in Perspective* 3: 8–22.
- Porter, M. E. 1998. "Clusters and the New Economics of Competition." *Harvard Business Review* 76 (6): 77–90.
- Prahalad, C. K., and G. Hamel. 1990. "The Core Competence of the Corporation." *Harvard Business Review* 68 (3): 79–91.
- Recchi, E., and A. Favell, edited by. 2009. *Pioneers of European Integration: Citizenship and Mobility in the EU*. Cheltenham and Northampton: Edward Elgar Publishing.
- Ross, S. A. 1976. "The Arbitrage Theory of Capital Asset Pricing." *Journal of Economic Theory* 13 (3): 341–360. doi:10.1016/0022-0531(76)90046-6.
- Rouabah, A., and J. Theal. 2015. "MVAR Impulse Response Functions Compared to a VAR Model: A First Assessment of the Macro-financial Linkages of the Banking Sector." *Revue de stabilité financière* 105–111.
- Schorderet, Y. 2001. "Revisiting Okun's Law: An Hysteretic Perspective"
- Schorderet, Y. 2003. *Asymmetric Cointegration*. Unpublished manuscript. Switzerland: University of Geneva.
- Sharma, S., and H. Winkler. 2018. "The Labour Market Effects of Financial Crises: The Role of Temporary Contracts in Central and Western Europe." *Economics of Transition* 26 (1): 35–60. doi:10.1111/ecot.12141.
- Shin, Y., B. Yu, and M. Greenwood-Nimmo. 2014. "Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework." In *Festschrift in Honor of Peter Schmidt*, edited by R. Sickles and W. C. Horace, 281–314. New York: Springer.
- Silvapulle, M. J., P. Silvapulle, and I. A. Moosa. 2004. "Asymmetry in Okun's Law." *Canadian Journal of Economics/Revue Canadienne D'économique* 37 (2): 353–374. doi:10.1111/j.0008-4085.2004.00006.x.
- Sohn, C., and O. Walther. Juin 2008. "Géographie des activités économiques métropolitaines au Luxembourg." *Population et territoire*. CEPS/INSTEAD. 14.
- Stephan, G. (2014). "La déformation de la loi d'Okun au cours du cycle économique." PhD Thesis, University of Rennes 1, France.
- Termote, M. G. (1980). "Migration and Commuting: A Theoretical Framework." IIASA Working Paper. Laxenburg: International Institute for Applied Systems Analysis
- THILL-DITSCH, G. 2010. "Regards Sur La Population Par Nationalités." *Luxembourg: STATEC. Regards* 6: 2010.
- Tiryaki, A., R. Ceylan, and L. Erdogan. 2019. "Asymmetric Effects of Industrial Production, Money Supply and Exchange Rate Changes on Stock Returns in Turkey." *Applied Economics* 51 (20): 2143–2154. doi:10.1080/00036846.2018.1540850.
- Trausch, G. 2014. "175 ans d'histoire luxembourgeoise: D'une économie rurale à une place financière internationale." *Cahier économique*.
- Trenz, H. J., and A. Triandafyllidou. 2017. "Complex and Dynamic Integration Processes in Europe: Intra EU Mobility and International Migration in Times of Recession." *Journal of Ethnic and Migration Studies* 43 (4): 546–559. doi:10.1080/1369183X.2016.1251013.
- Wiesböck, L., R. Verwiebe, C. Reinprecht, and R. Haindorfer. 2016. "The Economic Crisis as A Driver of Cross-border Labour Mobility? A Multi-method Perspective on the Case of the Central European Region." *Journal of Ethnic and Migration Studies* 42 (10): 1711–1727.
- Zanardelli, M., and J. Brosius. 2009. "Les recrutements au Luxembourg." *Population & emploi* 41 6.
- Zivot, A., and D. W. K. Andrews. 1992. "Further Evidence on the Great Crash, the Oil Price Shock and the Unit Root Hypothesis." *Journal of Business and Economic Statistics* 10 (3): 251–270.

## Appendix

### Map of the Greater Region

Source: CES/Transport-Mobilité-Logistique 2017.

Note: 78% of cross-border workers in the *Grande Région* actually work in Luxembourg (Source: OIE) and their number is estimated to increase further by 100,000 between 2014 and 2035.



Source: Author's calculations with data from STATEC and Yahoo Finance.