Spatial Analysis of internal migration in Luxembourg

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Aims

- to look at the spatial patterns of internal migration in Luxembourg
- to model internal migration in Luxembourg using contemporary methods
- add Luxembourg in the international map of internal migration studies

Internal migration @ Luxembourg

- Most research on migration in Luxembourg refers to cross border studies, inter-regional moves (the Greater Region of Luxembourg) and international migration (Portuguese being the largest group)
- Internal migration has not been looked at before
- New 5-year and 12-months migration questions were asked at the 2011 Census of Population in Luxembourg
- Data are now available at local authority (commune) level of geography (116 Communes in 2011)

What do we expect?

- Housing conditions and housing costs to play a key role in internal migration decisions
- Labour market factors not to play an important role in internal migration decisions because of monocentric structure (most economic activity takes place in Lux. Ville)
- Cultural characteristics to result in variable migration behaviour among nationalities

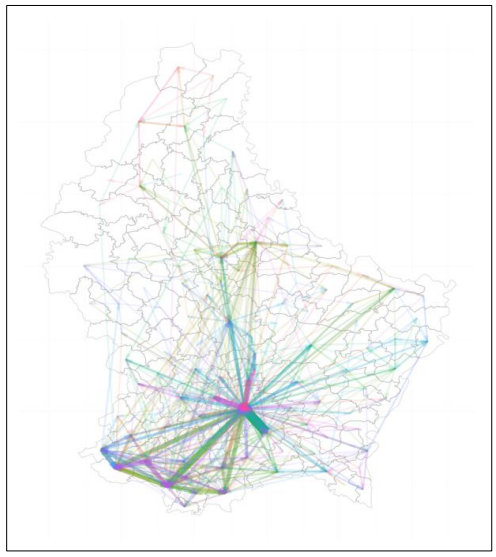
Data and their sources

- Migration flows by commune (STATEC , 2011 Census)
  - Limitations: aggregated, no sex/age/nationality disaggregation
  - 12-months and 5-year migration questions
- Explanatory Variables (STATEC, 2011 Census)
  - Population, Citizenship, Tenure, Economic Activity, Rental cost, Languages
- Real Estate data (CEPS website, Observatory)
  - Housing cost, estimates for missing communes
- Labour market data (available at the Institute GSP, Uni.Lu)
  - Unemployment in 2008, Industry (Lab, Fonc. & Independent workers)
- Own calculations (in R):
  - Distance (Euclidean based on LA centroid)
  - Destination Accessibility (Based on 2010 total population)
  - Regional (Geographical) Variables

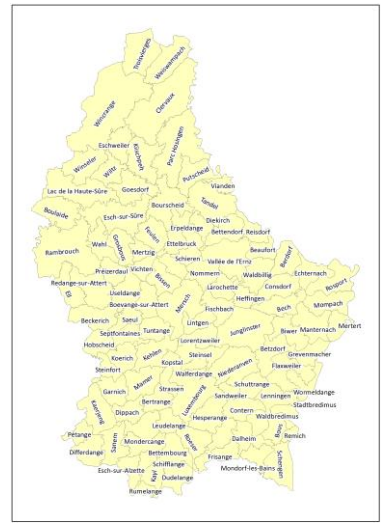
Migration Trends

- 17,344 people or 3.7% of the total population moved from one commune to another within Luxembourg in just one year (between 2010 and 2011).
- Most of the moves are between Luxembourg Ville and other communes as well as among communes in the south (Esch-sur-Alzette; Differdange).
- Most of the 3,128 people leaving Luxembourg Ville in 2010/11 selected a neighbour municipality or a large town (Hesperange; Esch-sur-Alzette; and Strassen are the top 3 destinations)

Internal Migration flows in Luxembourg



Map created using R code developed by Geoffrey Caruso



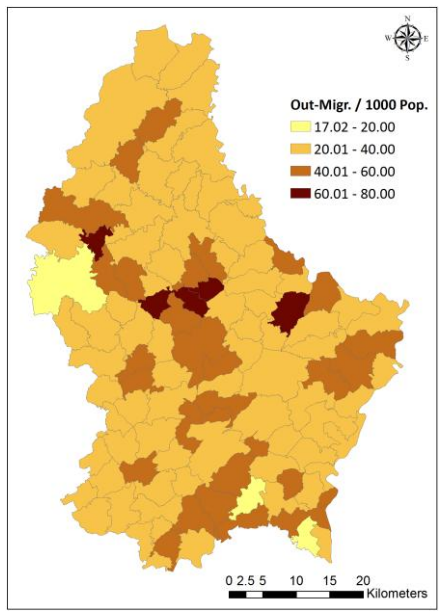
Reference Map of the current communes

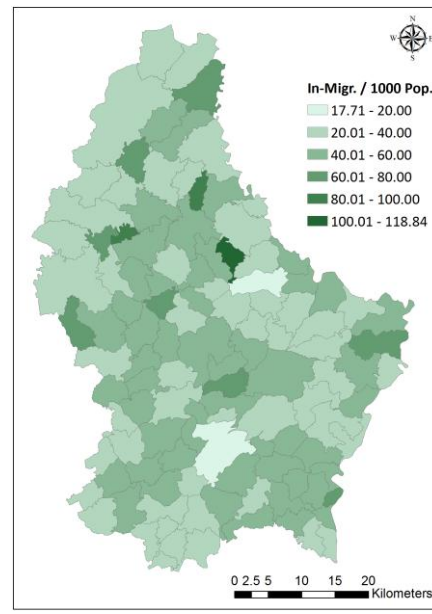
Out-migration trends

Top 10 out-migration communes					Top 10 out-migration rate communes			
Commune	Pop. 31/1/2010	**Out-Migrants**	Rate (‰)		Commune	Pop. 31/1/2010	Out-Migrants	**Rate (‰)**
Luxembourg	82 914	3 128	37.73		Neunhausen	300	24	80.00
Esch-Alzette	27 528	1 013	36.80		Colmar-Berg	1 873	131	69.94
Differdange	20 802	709	34.08		Schieren	1 480	96	64.86
Hesperange	11 978	559	46.67		Waldbillig	1 337	86	64.32
Dudelange	17 351	553	31.87		Vichten	929	57	61.36
Sanem	13 912	464	33.35		Septfontaines	698	41	58.74
Pétange	14 928	442	29.61		Wahl	819	48	58.61
Bettembourg	9 518	398	41.82		Clervaux	1 910	108	56.54
Ettelbruck	7 336	353	48.12		Grosbous	863	47	54.46
Mersch	7 392	349	47.21		Biwer	1 614	81	50.19

In-migration trends

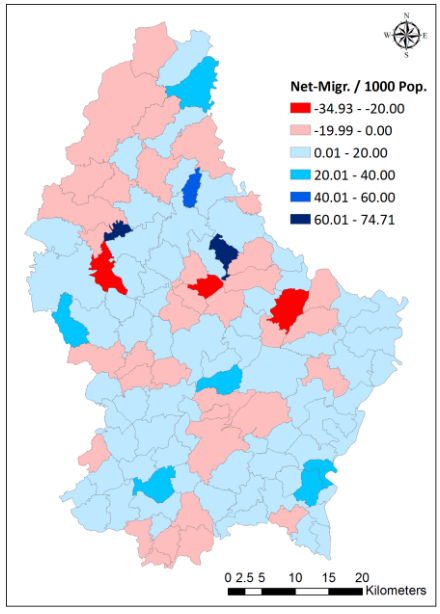
Top 10 in-migration communes				Top 10 in-migration rate communes			
Commune	Population 31/1/2010	**In-Migrants**	Rate (‰)	Commune	Population 31/1/2010	In-Migrants	**Rate (‰)**
Luxembourg	82 914	1 468	17.71	Diekirch	5 621	668	118.84
Esch-sur-Alzette	27 528	882	32.04	Hoscheid	566	56	98.94
Differdange	20 802	730	35.09	Esch-sur-Sûre	270	26	96.30
Diekirch	5 621	668	118.84	Lorentzweiler	3 281	235	71.62
Pétange	14 928	584	39.12	Ell	1 004	68	67.73
Hesperange	11 978	581	48.51	Neunhausen	300	19	63.33
Sanem	13 912	568	40.83	Remich	3 084	193	62.58
Dudelange	17 351	537	30.95	Vichten	929	58	62.43
Mersch	7 392	396	53.57	Mompach	989	61	61.68
Schifflange	8 618	323	37.48	Heinerscheid	1 135	69	60.79





Net migration trends

Top 10 net-migration communes				Top 10 net-migration rate communes			
Commune	Population 31/1/2010	**Net-Migrants**	Rate (‰)	Commune	Population 31/1/2010	Net-Migrants	**Rate (‰)**
Diekirch	5621	446	79.35	Diekirch	5621	446	79.35
Pétange	14928	142	9.51	Esch-Sûre	270	19	70.37
Lorentzweiler	3281	136	41.45	Hoscheid	566	35	61.84
Sanem	13912	104	7.48	Lorentzweiler	3281	136	41.45
Junglinster	5952	88	14.78	Ell	1004	40	39.84
Grevenmacher	4144	83	20.03	Heinerscheid	1135	44	38.77
Reckange	2007	67	33.38	Reckange	2007	67	33.38
Remich	3084	62	20.10	Bous	1317	33	25.06
Mersch	7392	47	6.36	Stadtbredimus	1452	33	22.73
Redange	2417	47	19.45	Lenningen	1523	31	20.35
Luxembourg	82914	-1660	-20.02	Schieren	1480	-52	-35.14
Esch-sur-Alzette	27528	-131	-4.76	Wahl	819	-25	-30.53
Bettembourg	9518	-83	-8.72	Waldbillig	1337	-35	-26.18
Niederanven	5163	-57	-11.04	Luxembourg	82914	-1660	-20.02
Walferdange	6803	-57	-8.38	Biwer	1614	-32	-19.83
Schieren	1480	-52	-35.14	Colmar-Berg	1873	-35	-18.69
Wiltz	4495	-47	-10.46	Neunhausen	300	-5	-16.67
Ettelbruck	7336	-46	-6.27	Septfontaines	698	-11	-15.76
Kayl	7331	-44	-6.00	Niederanven	5163	-57	-11.04
Waldbillig	1337	-35	-26.18	Schieren	1480	-52	-10.46



- Populous communes exhibit the highest volumes of internal in-migrants between 2010 and 2011
- Diekirch is the champion in terms of in-migration rate and the top net population winner in terms of internal migration
- Luxembourg Ville appears to be the top net internal migration loser.
- However, international migrants take the place of those left the capital of the country

Models

- In- & Out-Migration Models
  - Gravity model: Linear, log-linear with classic and robust standard errors
  - robust regression
  - Seemingly unrelated regression (SUR)
- Flow Models
  - Unconstrained Gravity Model with Poisson, Negative Binomial and Zero Inflated Poisson and Zero Inflated Binomial regression

Tests

- bptest: Breusch – Pagan test for heteroscedasticity and Random Coefficient Variation
- coeftest (R package lmtest): returns robust standard errors (same coefficient but much more conservative p-value using heteroskedastic consistent standard errors)
- petest: MacKinnon-White-Davidson PE test for comparing linear vs. log-linear specifications in linear regressions
- Residual spatial autocorrelation: Moran's I statistic
- Vuong's test for non-nested model comparison
- ANOVA: analysis of deviance table for one or more generalized linear model fits

TABLE 2. Linear and log-linear robust s.e. and robust regression for out-migration

Dependent variable: OutRate_P10				
	OLS robust st.errors		*Robust regression (huber)*	
	(linear)	(log-linear)	(linear)	(log-linear)
gwPop11	1.302	0.101*	2.102**	0.086**
	(2.304)	(0.060)	(0.934)	(0.037)
PC_LandAvBld07	0.239	−0.014	0.127	−0.025
	(0.147)	(0.113)	(0.107)	(0.031)
PC_FreeRent11	2.783***	0.201***	2.337***	0.193***
	(0.641)	(0.074)	(0.694)	(0.073)
PC_Rent11	0.365	0.378**	0.438**	0.428***
	(0.263)	(0.152)	(0.198)	(0.114)
MRent11	0.007	0.486	0.010	0.623**
	(0.015)	(0.310)	(0.012)	(0.265)
SurfaceHH11	0.347**	1.446**	0.368***	1.736***
	(0.169)	(0.688)	(0.111)	(0.454)
RSurface11	−0.341**	−0.735**	−0.318***	−0.741**
	(0.135)	(0.330)	(0.121)	(0.335)
PC_Wage10	1.227**	2.580*	1.138***	2.836***
	(0.570)	(1.423)	(0.355)	(0.843)
gwUnem10	−8.333	−0.254	−10.676***	−0.326***
	(6.848)	(0.184)	(3.118)	(0.107)
BL_French11	−0.455**	−0.081	−0.409*	−0.087
	(0.223)	(0.077)	(0.219)	(0.063)
BL_Deutsch11	−1.861**	−0.187**	−1.796***	−0.172***
	(0.757)	(0.076)	(0.696)	(0.062)
BL_English11	1.856	0.028	1.612*	0.002
	(1.300)	(0.054)	(0.865)	(0.030)
PupilStudentTotalPop	−1.837**	−1.103**	−1.671***	−1.019***
	(0.740)	(0.437)	(0.566)	(0.358)
Constant	−56.457	−12.470	−57.644	−16.329***
	(53.517)	(8.578)	(37.123)	(4.651)
Observations			116	116
Residual Std. Error (df = 102)			7.420	0.210
Note:				*p<0.1; **p<0.05; ***p<0.01

TABLE 4. Linear and log-linear robust s.e. and robust regression for in-migration

Dependent variable: InMigrRate_p10				
	OLS robust st.errors		*Robust regression (huber)*	
	(linear)	(log-linear)	(linear)	(log-linear)
d_i	0.297	0.153*	0.197*	0.141***
	(0.181)	(0.086)	(0.119)	(0.033)
gwPop11	5.483***	0.158***	4.991***	0.145***
	(1.517)	(0.053)	(0.869)	(0.042)
PC_LandAvBld07	−0.278	−0.073**	−0.105	−0.067***
	(0.254)	(0.031)	(0.110)	(0.026)
NewBld_06_10	−1.820*	−0.057*	−1.408	−0.052**
	(1.040)	(0.033)	(0.874)	(0.027)
PC_Rent11	0.797*	0.183	0.504**	0.197**
	(0.472)	(0.119)	(0.207)	(0.098)
MRent11	0.056***	1.139***	0.042***	1.038***
	(0.015)	(0.265)	(0.010)	(0.208)
gwRentPMsq	−24.333*	−0.612**	−23.563**	−0.576**
	(12.619)	(0.309)	(10.196)	(0.224)
SurfaceHH11	−0.456***	−1.078**	−0.424***	−0.976***
	(0.148)	(0.413)	(0.103)	(0.369)
PC_Unemp10	−1.520*	−0.059	−1.840***	−0.085
	(0.831)	(0.122)	(0.706)	(0.097)
Jobs_sqkm	−0.018***	−0.0003	−0.018***	−0.019
	(0.004)	(0.027)	(0.004)	(0.024)
PC_Foreign11	−0.816***	−0.504***	−0.527***	−0.407***
	(0.278)	(0.140)	(0.163)	(0.125)
PupilStudentTotalPop	−1.141	−1.079***	−0.845	−1.015***
	(1.010)	(0.404)	(0.580)	(0.320)
ActiveInBEDEFR_1000empl	−5.336	−0.031*	−2.665	−0.023**
	(5.478)	(0.016)	(2.324)	(0.012)
Constant	129.440***	5.779***	123.616***	5.504***
	(24.203)	(2.174)	(18.936)	(1.755)
Observations			116	116
Residual Std. Error (df = 102)			7.542	0.169
Note:				*p<0.1; **p<0.05; ***p<0.01

Modelling results

- Most explanatory variables of in- and out-migration models have a significant effect in linear, log-linear and robust models
- Communes with higher proportions of house non-owners, public workers (fonctionnaires), big house owners, speaking English the best or having neighbour communes with higher population generate more out-migrants per population
- The opposite appears for French and German speaking areas, areas with high proportion of pupil/student population and those with neighbour communes exhibiting higher unemployment rate

- A commune attracts higher proportions of in-migrants when it is further away from Luxembourg Ville, it has higher proportion of rented accommodation or higher rents
- In-migration rates are lower to communes with higher proportions of newly build houses or land available to built new houses, higher employment density, higher unemployment rates, higher household surface or higher proportion of daily commuters from Belgium, France or Germany
- Areas with high proportions of foreigners or pupil/student population are also less attractive for in-migrants

Model issues discussion

- The MacKinnon-White-Davidson PE test shows that both linear and log-linear regressions are significant but the log model brings a higher estimate and more significance
- One serious issue is heteroskedasticity, especially for out-migration models
- Log transforms do not resolve the issue but lead to a slightly better fit
- Two or three outliers impact our regressions. These are not the same for in- and out-migration models
- Computing heteroskedasticity consistent standard errors lead to several important variables to be insignificant and others to be significant
- Given heteroskedasticity and outliers, robust regression seems the best choice
- There is more correlation in residuals of in- and out- models if log forms are used

Concluding Remarks

- Out-migration rates are high in low populated communes in the north of the Grand Duchy of Luxembourg (GDL)
- There are high migration flows between Luxembourg Ville and neighbour /major cities in the south of the GDL
- Labour force variables (e.g. unemployment rate) have significant effect on migration decisions. This could be linked with the Lowry debate
- Housing related variables as well as cultural characteristics of the population play a significant role in migration decisions
- SUR models suggest that there is no link between in- and out-migration processes as one might expect

Unconstrained Gravity Model

- We fit a classic unconstrained gravity model for all pairs of migration flows in the system using characteristics of the origin, the destination as well as distance
- We applied Poisson, Negative Binomial (NB) as well as Zero Inflated Poisson (ZIP) and Zero Inflated NB (ZINB) methods
- The classic gravity model results is the expected effects (+ for origin/destination population and - for distance)
- The inclusion of more explanatory variables improves the performance of the model
- ZIP and ZINB are improvement of Poisson and NB regressions with ZINB providing the best model fit

Overall Conclusions

- This is the first time internal migration in Luxembourg is analysed and models to explain migration decisions fit
- Luxembourg is a very specific case because of border proximity and cross-border commuting
- The models we fit explain 38 – 45% of the variation of the internal migration rates – Can be improved
- Labour market variables, tenure, housing costs and cultural characteristics are key determinants in migration decisions in Luxembourg