International migration and climate change economic impact: a CGE assessment for SLR

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May 7, 2015
FEEM - Venice

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Outline

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Introduction: motivations

The relationship between climate change and international migration has been poorly understood in the literature (Stern, 2013; Licker and Oppenheimer, 2013).

Sea Level Rise (SLR) physical impacts could be associated with high economic losses (Bosello et al., 2007; Nicholls and Cazenave, 2010; Ackerman and Stanton, 2011; Hallegatte et al., 2013).

Two-fifths of the world population live in coastal zones, where flooding and storm surges caused from SLR could trigger large-scale migration (Ackerman and Stanton, 2011).

Introduction: literature

Beine and Parsons (2012) do not find a significant relevance of climate factors in the determination of international migration (**econometric estimation**). Marchiori and Schumacher (2011) find that climate change increases the number of migrants (**theoretical overlapping generation model**) and increase economic damages.

Two different **surveys** for the **Tuvalu** island. Mortreux and Barnett (2009) do not suggest a strong relationship between the concern of future climate change and the individual's decision to migrate in the small island. Sheen and Gemenne (2011) show evidence of climate change as a migration driver.

Black et al. (2011) see **migration** as a form of **adaptation**.

Introduction: research question

Under which economic conditions climate change can increase international migration and to what extent international migration can be beneficial or detrimental for the economic losses of climate change?

We try to answer to this questions using a *Computable General Equilibrium* (CGE) model.

International Migration as market driven or **autonomous adaptation** to **Climate Change**.

Methodology: the CGE tool

The standard CGE model

- Starting point: GTAP (*Global Trade Analysis Project*) database and model.

- GTAP 8 (Narayanan et al., 2012) database: *Social Accounting Matrices* (SAMs) for 129 regions (countries or groups of countries) and 57 sectors. The base year is 2007.

- GTAP model (Hertel, 1997). Neoclassical framework: firms and households maximize profits and consumption, respectively; perfect competition is assumed in all sectors; bilateral trade relationship are modelled; factors' endowments (**labor and capital**) are fully employed and **immobile** at the regional level.

Methodology: the CGE tool

The modified version of the CGE model

Factor endowments of capital (QK) and labor (QL) can move outside the region they belong according to the relative price mechanism (**PL** and **PK**). Endogenous supply of labor and capital via a *Constant Elasticity of Transformation* (CET) function. FOCs are:

$$QL_r = QL_W \left(\frac{PL}{PL_r} \right)^{\sigma_L} \quad \text{with } \sigma_L \leq 0$$

$$\sum_r QL_r PL_r = QL_W PL_W$$

$$QK_r = QK_W \left(\frac{PK_W}{PK_r} \right)^{\sigma_K} \quad \text{with } \sigma_K \leq 0$$

$$\sum_r QK_r PK_r = QK_W PK_W$$

- σ_K , σ_L $= 0$ imply immobility (**no international migration**)
- σ_K , σ_L $\rightarrow -\infty$ imply perfect mobility (**strong international migration**)

Methodology: the CGE geographical aggregation

CGE Regions
1. Oceania and Japan
2. China
3. India
4. Rest of Asia
5. Usa and Canada
6. Latin America
7. Europe
8. Middle East and North Africa
9. Sub Saharan Africa
10. Former Soviet Union

Methodology: the Bottom up DIVA model

DIVA (*Dynamic Interactive Vulnerability Assessment*) is a widely used bottom-up model (Hinkel and Klein, 2009; Vafeidis et al., 2008) that assesses biophysical and socio-economic consequences of SLR worldwide.

DIVA breaks the world's coastline into approximately 12,148 linear segments (mean average 45 km) and associates data on physical, ecological and socio-economic characteristics with each of these segments.

Basic idea: converting the output of the DIVA-based simulations into inputs feeding the CGE model by translating the DIVA physical impacts in negative exogenous shocks on productivity of primary factors (capital and labor).

Methodology: the reference scenario in the DIVA model

DIVA includes all the **SRES** (*Special Report on Emission Scenarios*) developed by the *Intergovernmental Panel on Climate Change* (IPCC). We focus on the SRES A2.

- **A2 →** more heterogeneous world**,** global population increases during all the 21st century, slower convergence among countries. One of the most pessimistic from an economic point of view.

Methodology: coupling the CGE and the DIVA model

DIVA considers 2 main types of SLR geophysical impact:

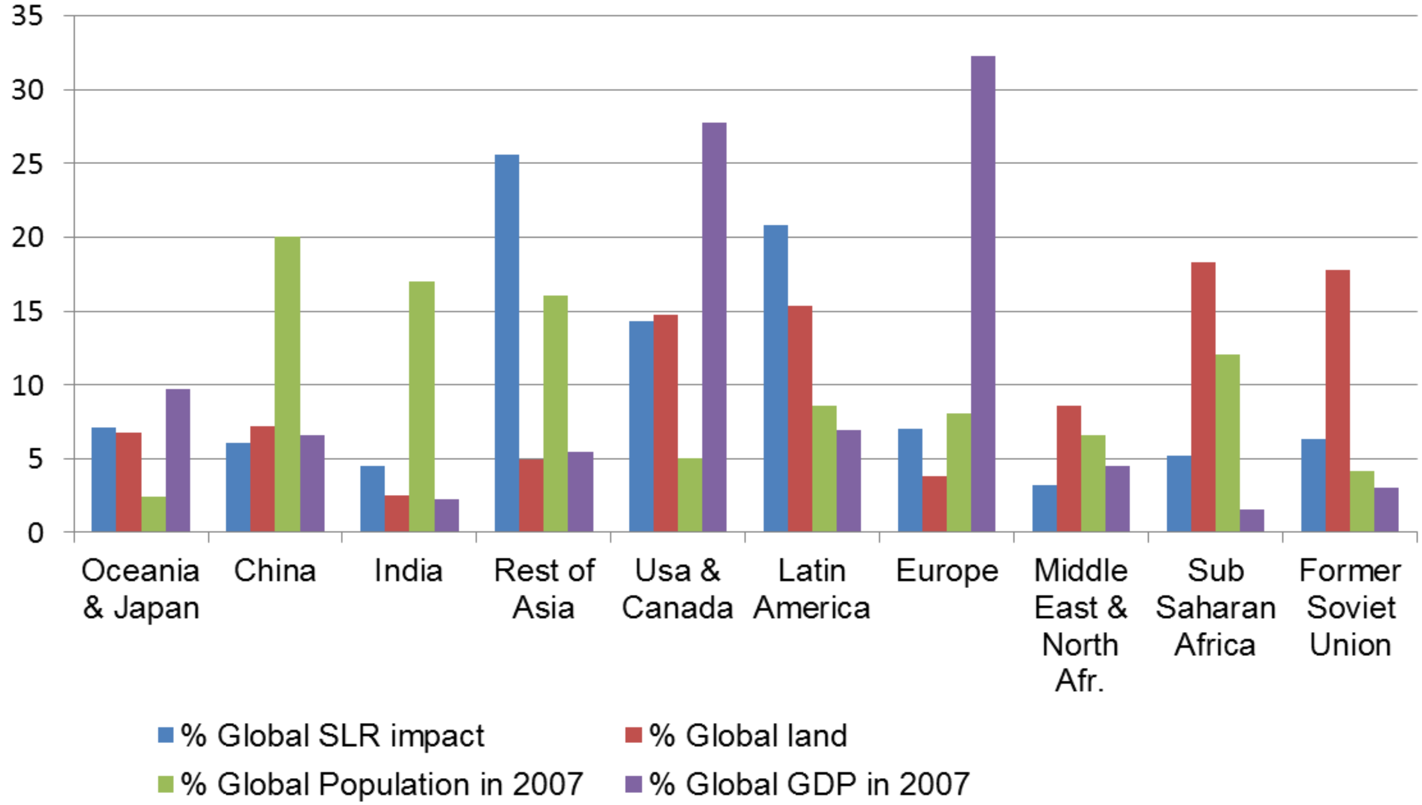
- land loss (submergence)
- land loss (erosion)

The ratio between the land impacted by SLR over the period 2007-2100 and the total surface of the region in 2007 has been used as a proxy to quantify the cumulative % productivity loss of labor and capital in the CGE model.

Methodology: coupling the CGE and the DIVA model

	% impacted land in the region
Oceania and Japan	0.99
China	0.79
India	1.71
Rest of Asia	4.88
Usa and Canada	0.92
Latin America	1.28
Europe	1.75
Middle East and North Africa	0.35
Sub Saharan Africa	0.27
Former Soviet Union	0.33
World	0.95

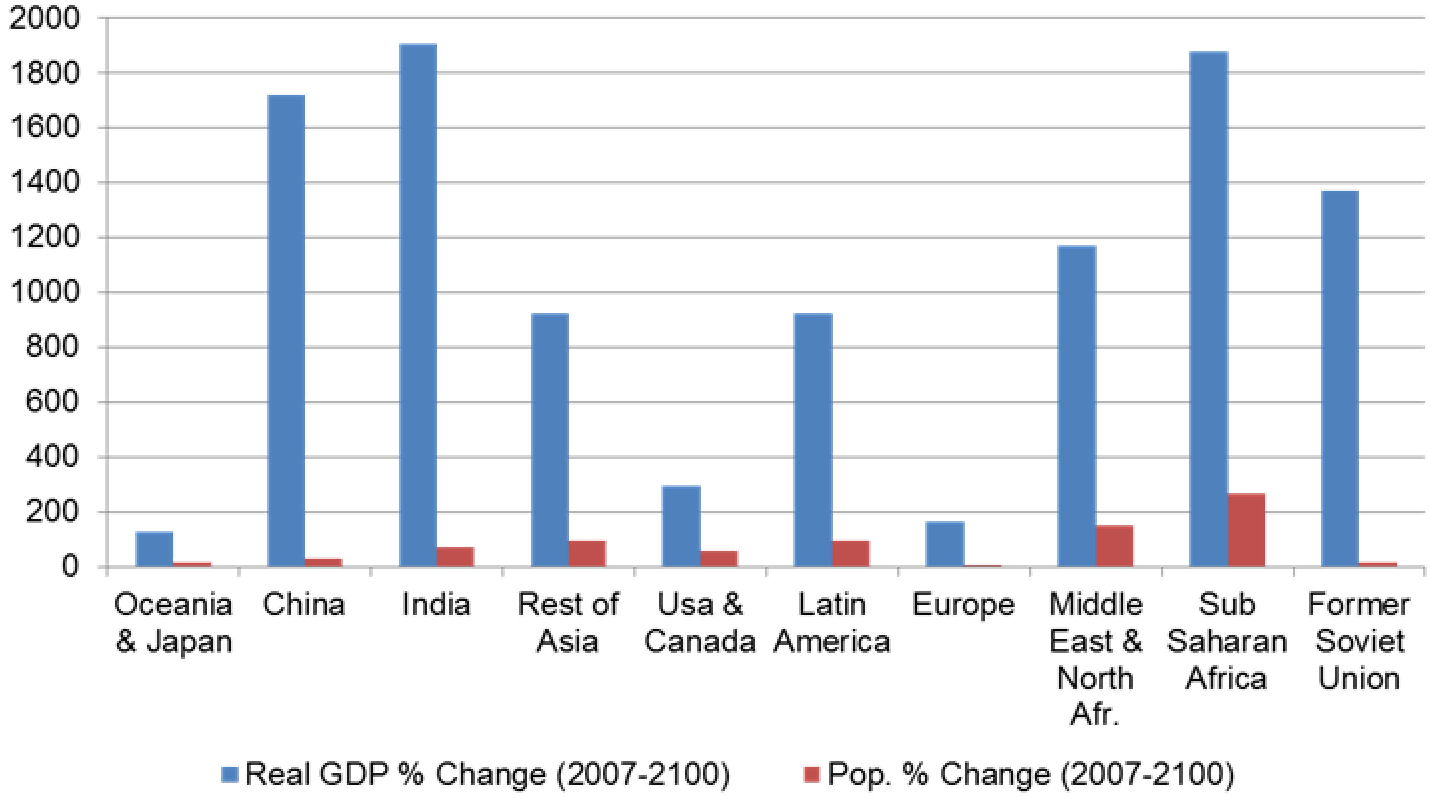
Methodology: coupling the CGE and the DIVA model



Our elaboration using GTAP and DIVA data.

The experiment design: the baseline

The Real GDP and population growth for the SRES A2 of the *International Institute for Applied Systems* Analysis (IIASA):



The experiment design: the baseline

- Capital accumulation, capital productivity and the *Total Factor Productivity* (TFP) is used to roughly replicate the IIASA GDP targets in 2100 for the SRES A2.

- Demographic trends are exogenous in the model.

The experiment design

2 cases:

1. Labor immobility case: **no International Migration**

- σ_K = -2
- σ_L = 0

2. Labor mobility case: **International migration**

- σ_K = -2
- σ_L = -0.5

4 scenarios:

1.1 Labor immobility baseline scenario

1.2 Labor immobility impact scenario

2.1 Labor mobility baseline scenario

2.2 Labor mobility impact scenario

Results

Difference between % real change of 2007 GDP in the impact scenario and % real change of 2007 GDP in the baseline scenario:

%ΔGDP(**1.2**) - %ΔGDP(**1.1**) → labor immobility case with and without SLR impacts.

%ΔGDP(**2.2**) - %ΔGDP(**2.1**) → labor mobility case with and without SLR impacts.

No **transitional dynamics** is considered.

The migration process is entirely determined by the movements of workers across the 10 macro-regions. The workers react to the price signals induced by climate change in the market through the productivity shocks (**market-driven** or **autonomous adaptation**).

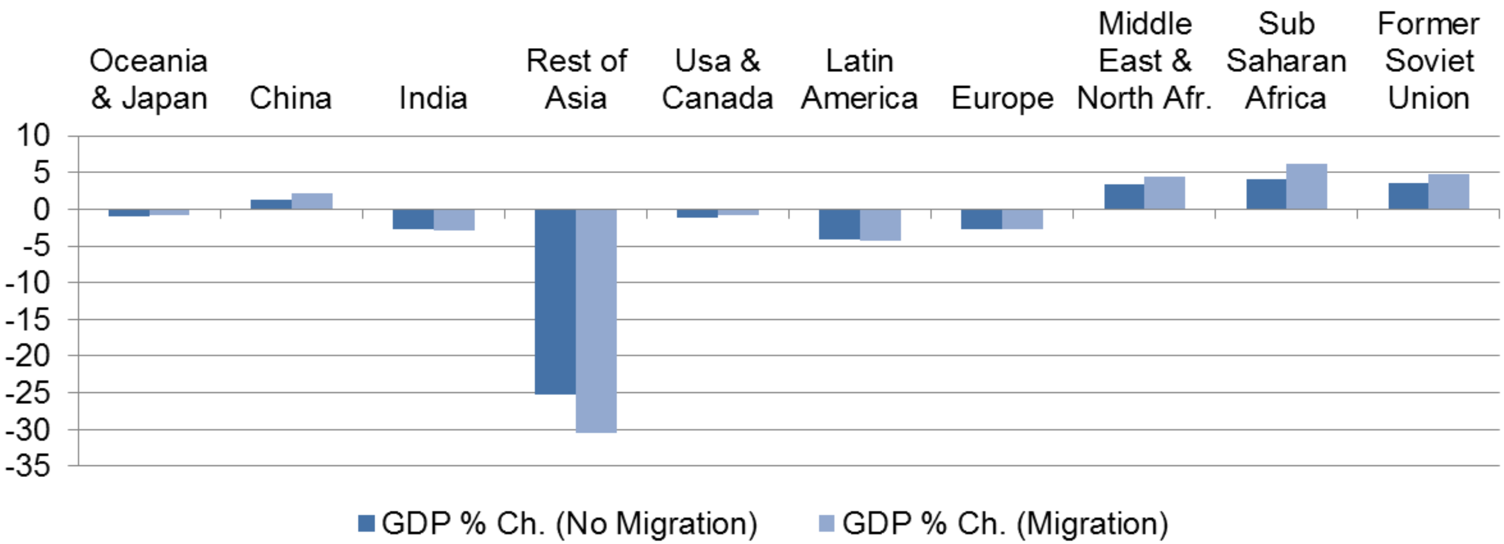
Results

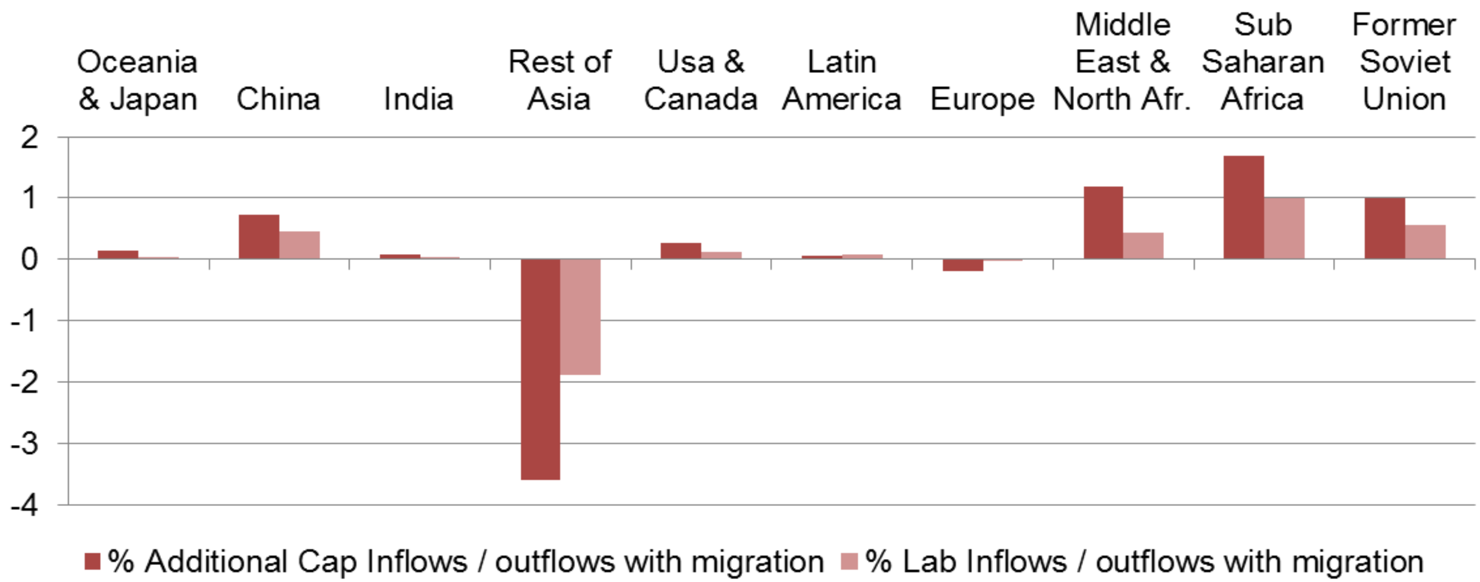
	% Productivity loss on capital and labor	% GDP change (labor immobility case)	% GDP change (labor mobility case)	Net Migration flow - millions people (labor mobility case)
Oceania and Japan	-0.99	-1.05	-0.73	0.25
China	-0.79	1.24	2.13	9.57
India	-1.71	-2.66	-2.96	0.91
Rest of Asia	**-4.88**	**-25.32**	**-30.48**	**-32.55**
Usa and Canada	-0.92	-1.22	-0.77	0.86
Latin America	-1.28	-4.19	-4.36	0.34
Europe	-1.75	-2.74	-2.68	-0.75
Middle East and North Africa	-0.35	3.34	4.39	5.17
Sub Saharan Africa	-0.27	4.11	6.16	13.43
Former Soviet Union	-0.33	3.58	4.81	2.76
World	-0.95	**-2.64**	**-2.59**	0.00

Results

- 2.64% GDP loss at the world level → No International migration
- 2.59% GDP loss at the world level → International migration
- 30 billion $ in 2007 values → Gain in absolute terms when allowing for International migration

Results: interpretation





Conclusions

International migration driven by a more integrated labor market at the global level could represent a useful adaptation strategy option to slightly decrease the economic impact of **SLR**. However, it cannot substitute in any way the adoption of strong mitigation policy to reduce damages, especially in the Rest of Asia.

Further research

- Detailing the geographical aggregation.
- Refining the calibration of the labor mobility parameter (econometric estimation) or carrying out a more extensive sensitivity analysis on it.
- Adding other climate impacts, such as extreme events or crop productivity change.

Acknowledgments

The research leading to these results has received funding from the Italian Ministry of Education, University and Research and the Italian Ministry of Environment, Land and Sea under the GEMINA project.

Thanks

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