Climate change and bank lending: the case of flood risk in Italy

Ivan Faiella   Filippo Natoli

Bank of Italy

Conference on Climate Change and its Impact in the Financial System
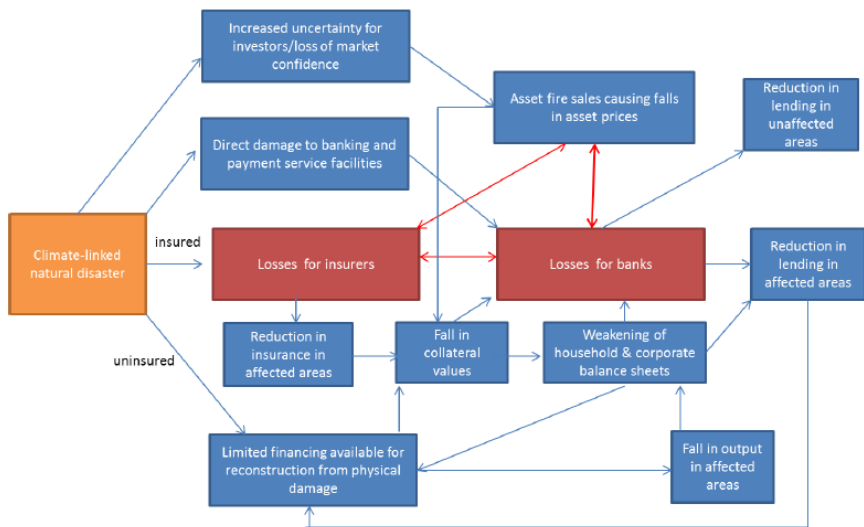Mexico City, 5-6 December 2019

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Climate change increases the frequency of natural catastrophes

Banks channel their effects to the economy
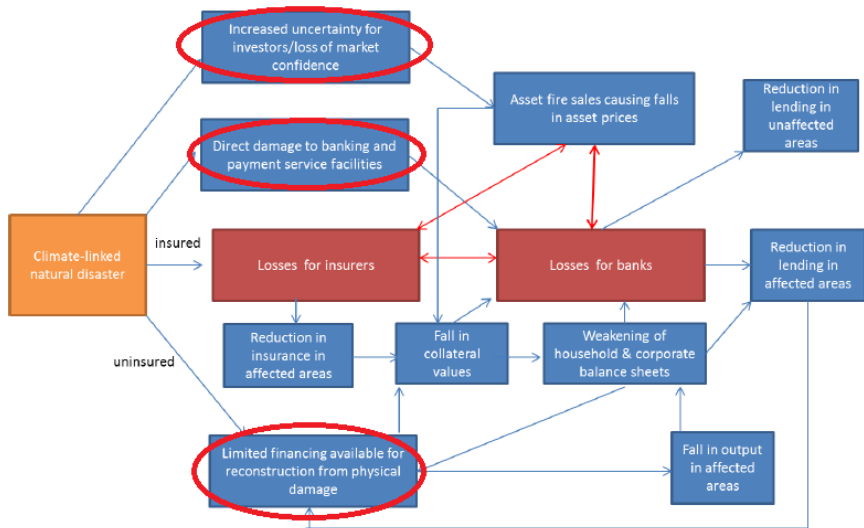
Banks channel their effects to the economy

Figure: Batten et al. (2016).
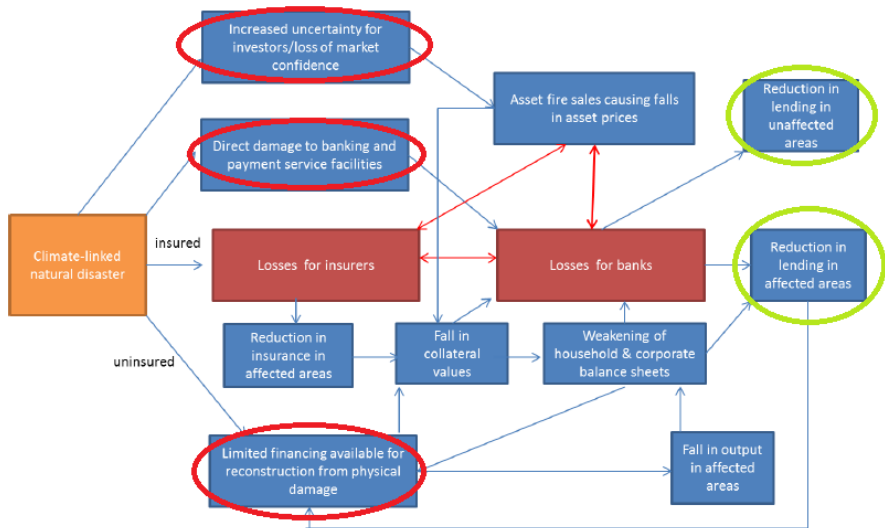
Banks channel their effects to the economy

Figure: Batten et al. (2016).

Effect on bank lending

- Banks are exposed to climate-related catastrophes through their long-term assets

- May discriminate borrowers ex-ante based on their risk exposure

- This can affect the amount of loans they grant

Floods occurrence is increasing fast

Globally, Floods are Increasing

Hydrological events like floods are just one type of disaster that's been on the rise worldwide in recent years. Extreme heat and storms are also up, according to data tracked by the insurance industry.

GLOBAL TRENDS IN NATURAL CATASTROPHES
Percentage change each year in number of events compared to 1980
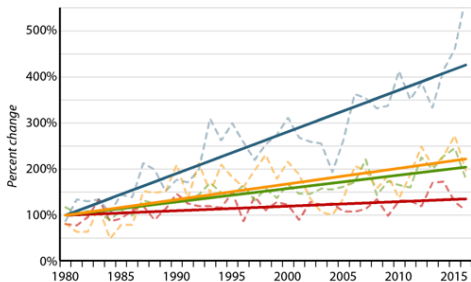
EVENTS
- **Geophysical** (earthquake, volcanic eruption)
- **Meteorological** (storm)
- **Hydrological** (flood, landslide)
- **Climatological** (heat wave, drought, fire)

SOURCES: MunichRe NatCatSERVICE; European Academies Science Advisory Council

InsideClimate News

Floods in Italy

Flood: *"overflow of a large amount of water beyond its normal limits, especially over what is normally dry land"* (Oxford English Dictionary)
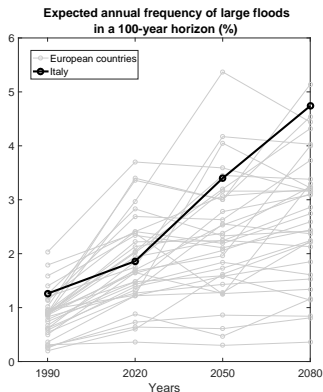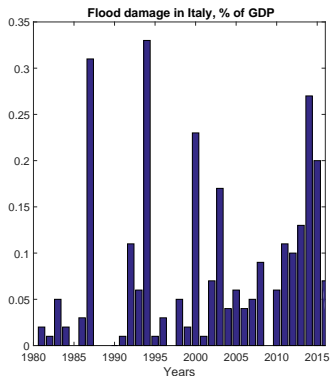
- Flood damage is increasing (left panel)
- Italy one of the most risky countries in EU (right panel, from Alfieri et al 2015)

What we do

- We explore the effect of banks' catastrophe risk exposure on lending

- We exploit a **new map of flood risk areas** of Italy at municipal level

- We **match** firms at risk with data on business loans

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Research questions:

1. Does perceived climate risk affect credit supply?

2. Has bank attitude changed in the last years?

(short) literature review

1) Climate risk and the financial system

Battiston et al 2017, de Greiff et al 2018, Krueger et al 2018

2) Natural catastrophes and bank lending

Garmaise and Moskowitz 2009, Klomp 2014, Cortes and Strahan 2017

2) Flood risk

Lamond et al. 2010, Belanger and Bourdeau-Brien 2017 (UK), Koetter et al 2016 (GE)

Our dataset

A merge of environmental-firm data with credit data. Two main sources, (A) and (B):

(A) <u>Environment-firm</u>: municipal-level dataset taken from ISPRA (2015)

Number of Local Business Units located in areas at risk of flood within municipalities

LBUs are sub-units of firms.

e.g., one firm has administrative offices (and legal residence) in the city center, plants close to the river and warehouses close to the highway (3 distinct business units)

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1 **Geomapping** of flood risk areas, data from river basin authorities

   Land is classified at low, medium, high or no risk

   - low risk= at least one flood in more than 200 years
   - medium risk= once in 100-200 years
   - **high risk= once in 20-50 years**

Our dataset

2 **Match Census data** on Local Business Units (LBUs) over Italy with risk mapping (by census area)

- Vulnerability assumed to be the same for all LBUs

- # of LBUs at risk in each area based on the share of land at low, medium and high risk

- Data are aggregated and provided at municipal level

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Still granular (Average land surface of municipalities: 20 km^2)!

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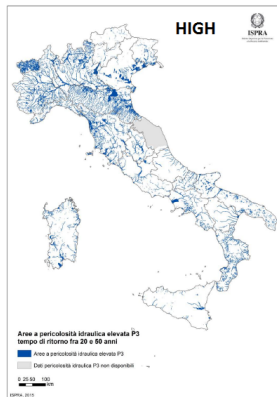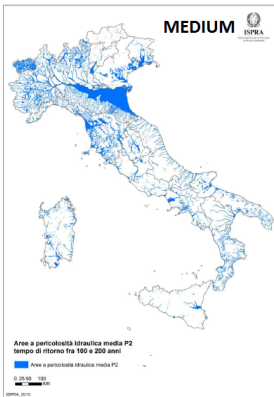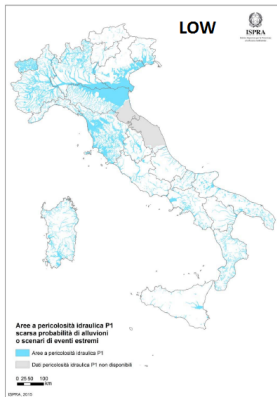
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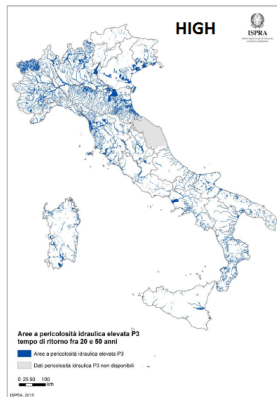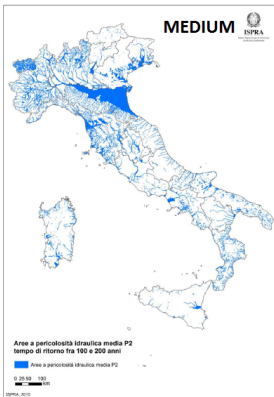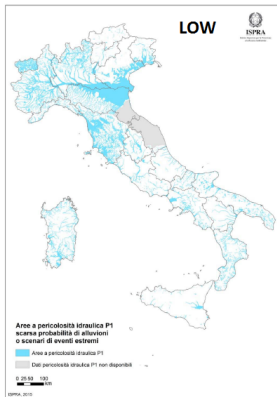
Descriptives on ISPRA dataset:

- 4.8 mln LBUs in Italy

- 18% at risk of flood, 4% at high risk

ClimRisk indicator

We compute an indicator of climate-related catastrophe risk borne by banks

For each municipality j

$$\textbf{ClimRisk}_j = \frac{\text{LBUs at } \textbf{high} \text{ risk of flood }_j}{\text{total number of LBUs}_j}$$

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- Geomapping based on long-run forecasts on temperatures and rainfall
  $\rightarrow$ ClimRisk takes into account climate change by reflecting physical risk for lenders

- High flood risk has a horizon compatible with that of long-term loans (20-50y)

- It proxies risk *ex-ante*, i.e. independently from flood occurrences

Our dataset - cont'd

(B) <u>Credit data</u> from Italian Central Credit Register

- CCR has loan-level data but needs to match municipal frequency
  - retain info on loan amount
  - retain info on borrower's sector

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- To make aggregation with ISPRA data:

    - (ideally) impute credit geographically according to its final use destination

      credit used for offices is at lower risk of default (from floods) than that used to finance production close to the river (especially if LBUs are separately managed)

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  $\rightarrow$ We assume it is closer than the legal residence to the use destination of credit
  Use this lender-side info to aggregate loans and match ISPRA data

Our dataset - final

Total stock of business loans (year-end amount outstanding)

- by municipality $\times$ sector (22)

- annual cross section, data for years 2010 to 2016

Reference year is that of geomapping (2014). Loan stock: 776 bln euros

- Construction, trade and real estate sectors are the most exposed ▸ sector

- LBUs at high risk concentrated in high value added regions... ▸ LBUs

- ...and so is the stock of credit ▸ credit

...flood-related credit risk is material!

Regression analysis

- <u>Baseline estimates</u>:
  stock of loans of year y, sector h, province v and municipality j on ClimRisk

$$\log(\text{loans})_{y,h,v,j} = \beta_0 + \beta_1 \log(\text{ClimRisk})_{v,j} + \delta \textbf{ controls }_{y,h,v,j} + \epsilon_{y,h,v,j}$$

White standard errors are clustered at province level (108 clusters).

- <u>Other estimates</u>:
  - robustness using other credit data sources

Specifications

1. no controls, sectors are aggregated, province FE

   $\rightarrow$ significant with negative sign. Rsquared of 13%

Baseline results

	(1) loans2014	(2) loans2014	(3) loans2015	(4) loans2016	(5) loans2016	(6) loans2016
ClimRisk	-0.174^{***}	-0.164^{***}	-0.160^{***}	-0.165^{***}	-0.109^{***}	-0.109^{***}
VAmunic2013		0.402^{***}				
VAmunic2014			0.398^{***}			
VAmunic2015				0.393^{***}	0.310^{***}	0.310^{***}
floods2014			0.517	0.580^{*}	0.302	0.302
lowinsured2016						-0.247^{***}
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	No	Yes	Yes
Observations	$5,539$	$5,539$	$5,499$	$5,442$	$64,795$	$64,795$
R^2	0.131	0.184	0.189	0.196	0.189	0.189

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3 control for 2014 flooded municipalities

- no long-term risk perception? banks discriminate based on recent occurrences
- demand for reconstruction

list of flooded **municipality who got tax exemption** by Ministry of Finance

→ Climrisk remains significant

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6 discriminate non-insured firms?

- No data available. We collect data from the **Bank of Italy firms' Survey** on 2016
- We construct dummy=1 for low-insured provinces (% insured firms below 25 pctl)

$\rightarrow$ insurance coverage significance but does not affect Climrisk significance

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Time dimension

As in the rest of the world, **media coverage on climate change** in Italy has sharply increased in the last few years

News articles on climate change in Italian
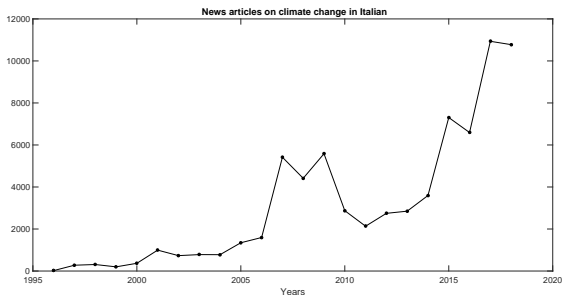
Figure: Number of newspaper articles in Italian containing words related to climate change, made with the FACTIVA news search tool. The words included are "cambiamento climatico" (climate change), "riscaldamento globale" (global warming), "effetto serra" (greenhouse effect).

Has bank attitude changed in the last years?

	without VAcom		with VAcom	
	Climrisk	R^2	Climrisk	R^2
2010	-0.107^{***}	0.107	-0.097^{***}	0.158
2011	-0.117^{***}	0.114	-0.108^{***}	0.166
2012	-0.115^{***}	0.119	-0.106^{***}	0.174
2013	-0.113^{***}	0.126	-0.104^{***}	0.184
2014	-0.121^{***}	0.131	-0.111^{***}	0.192
2015	-0.122^{***}	0.130	-0.112^{***}	0.192
2016	-0.118^{***}	0.125	-0.112^{***}	0.192
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Yes, but not much! R^2 from 11 to 13%

Other estimates

Robustness with a proprietary credit dataset

from surveillance reports of banks compiled for the Bank of Italy

- only province-level, only firm's legal residence available

- info on bank size (big/small) and firm type (large vs SME vs producer household)

- include interaction terms with ClimRisk

Main results:

- confirm negative effect on lending only when borrowers are SMEs

- lending positively correlated with ClimRisk when lenders are big banks (strategic?)

Conclusion and next steps

- Results suggest a supply-side story:
  banks consider risk ex-ante and ration credit in risky municipalities

- In particular to small and medium-sized enterprises

- Slightly tighter screening as long as the debate on climate change gained traction

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Caveat: no causation, but set of controls quite exhaustive

Next step: evaluate effect of climate risk on credit rationing

Appendix

# Business Units at high risk are in high value added regions

	# LBUs	LBUs at risk (%)			Value Added
		high	medium	low	(% of tot VA)
Abruzzo	109.925	1,9	12,2	3,2	1,9
Basilicata	38.043	0,6	0,9	0,9	0,6
Calabria	117.904	3,3	4,2	5,7	1,9
Campania	362.502	1,7	4,2	4,9	6,2
Emilia Romagna	403.272	10,1	63,1	39,7	9,0
Friuli	95.940	2,7	7,8	10,2	2,2
Lazio	456.377	1,5	2,9	11,9	11,4
Liguria	140.737	17,8	26,6	33,8	2,9
Lombardia	888.054	2,1	3,2	11,0	22,1
Marche	142.657	0,6	5,0	2,5	2,5
Molise	23.254	0,5	1,9	2,3	0,4
Piemonte	369.062	2,1	5,1	15,7	7,6
Puglia	269.834	1,8	2,9	3,8	4,3
Sardegna	117.588	4,2	6,6	16,5	1,9
Sicilia	291.506	0,3	0,6	0,6	5,3
Toscana	358.984	6,5	29,4	71,8	6,8
Trentino	91.614	1,7	2,4	5,6	2,3
Umbria	75.262	3,6	7,6	12,2	1,3
Valle D'Aosta	12.876	4,5	9,7	40,5	0,3
Veneto	440.623	7,2	9,8	25,0	9,2
total	**4.806.014**	**3,9**	**12,0**	**18,3**	100

Appendix. Why just floods?

- No aggregate flood-plus-landslide risk categorization

- The damage per event is much larger than in case of landslides (Faiella 2013)

- Floods in Italy are fastly increasing in frequency and intensity because of climate change (Alfieri et al., 2015)

(◂ Go Back)

Appendix. Plot of CatRisk
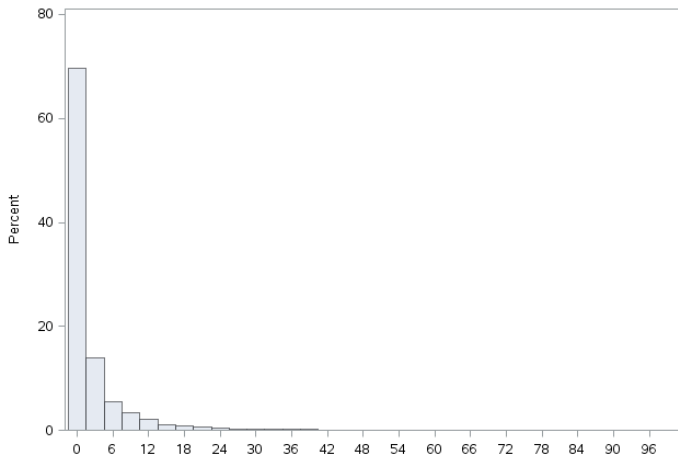
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HIF and LIF municipalities

Region	LIF	HIF	Total
Abruzzo	290	15	305
Basilicata	128	3	131
Calabria	287	122	409
Campania	475	76	551
Emilia-Romagna	174	174	348
Friuli-Venezia Giulia	187	31	218
Lazio	340	38	378
Liguria	98	137	235
Lombardia	1228	316	1544
Marche	24	9	33
Molise	134	2	136
Piemonte	855	351	1206
Puglia	212	46	258
Sardegna	310	67	377
Sicilia	378	12	390
Toscana	155	132	287
Trentino	315	18	333
Umbria	65	26	91
Valle d'Aosta	24	50	74
Veneto	481	100	581
All	6160	1725	7885

Appendix. Bank lending to firms by class of flooding impact and industry

#	Industry sector	LIF	HIF	Total
1	Mining	1.294	454	1.748
2	Food Products	22.462	6.105	28.567
3	Textiles	14.471	5.787	20.258
4	Wood and Products of Wood	9.229	2.694	11.923
5	Paper and Paper Products	6.874	2.134	9.009
6	Chemicals and Pharmaceuticals	12.173	2.592	14.764
7	Rubber and Plastic Products	7.932	2.025	9.956
8	Basic Metals and Metal Products	38.001	13.272	51.273
9	Electrical Equipment	8.751	2.174	10.924
10	Machinery and Equipment	16.490	4.787	21.276
11	Transport Equipment	7.795	1.718	9.512
12	Other Manufacturing	6.612	1.830	8.442
13	Electricity and Gas	33.882	5.608	39.490
14	**Construction**	106.765	**30.639**	137.404
15	**Wholesale and Retail Trade**	101.226	**27.430**	128.656
16	Transportation and Storage	34.246	5.903	40.149
17	Accommodation and Food Service	22.113	8.149	30.262
18	Information and Communication	13.031	1.556	14.587
19	**Real Estate Activities**	91.854	**24.646**	116.499
20	Professional Activities	25.929	5.596	31.525
21	Rental and Leasing Activities, Travel Etc	16.697	3.063	19.760
22	Other Service Activities	15.776	3.795	19.571
	All	613.601	161.956	775.557

◂ Go Back

Credit at risk by region

- High-Impact Flooding (HIF) municipalities: $\text{ClimRisk}_j \geq 75\text{thpercentile} = 3\%$

- Low-Impact Flooding (LIF) municipalities: $\text{ClimRisk}_j < 75\text{thpercentile}$

Region	# LIF	# HIF	Total
Abruzzo	9.763	1.037	10.801
Basilicata	2.040	18	2.059
Calabria	2.531	1.785	4.316
Campania	25.030	1.733	26.763
Emilia Romagna	52.734	**26.091**	78.825
Friuli-Venezia Giulia	11.057	2.649	13.706
Lazio	64.498	2.006	66.504
Liguria	223	15.611	15.834
Lombardia	227.927	**39.873**	267.800
Marche	1.997	1.533	3.529
Molise	1.191	1	1.193
Piemonte	48.561	6.481	55.042
Puglia	15.261	2.950	18.211
Sardegna	4.927	2.814	7.740
Sicilia	18.366	37	18.404
Toscana	49.059	**22.860**	71.919
Trentino	20.161	1.847	22.008
Umbria	6.105	2.933	9.038
Valle d'Aosta	580	262	842
Veneto	51.587	**29.435**	81.023
All	613.601	161.956	775.557

[◂ Go Back]

Appendix. Firms insured against hydrogeological events

Bank of Italy's Survey of Industrial and Service Firms (INVIND) for 2016:

- 44% of firms with 20+ employees are insured against damages from hydrogeological events (floods + landslides).
- the share is higher in industry.
- highest in Northeast regions, lowest in the South and Islands.

	Industry	Services	Total
Northwest	50.4	41.4	46.0
Northeast	51.0	42.6	47.3
Center	44.1	44.1	44.1
South and Islands	39.2	28.7	32.7
Italy	48.0	39.6	43.7