Climate Change and Inequality - the role of mitigation and adaptation

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Overview

1. Climate projections in IAMs - towards considering country-level climates and other indices
2. Climate econometrics - linking climate to growth (and inequality), Adaptation?
3. Inequality in IAMs - calibration, projections, welfare evaluation, optimization
4. Preview of an implementation in Integrated Assessment Models

Climate data and projections

- Historical data & CMIP5/CMIP6
- Temperature, Precipitation, Climate Extreme Indices (CEIs)
- Scale: spatial/country level; 3 hours - daily - yearly
- Empirical, Modeling, IAM Optimization

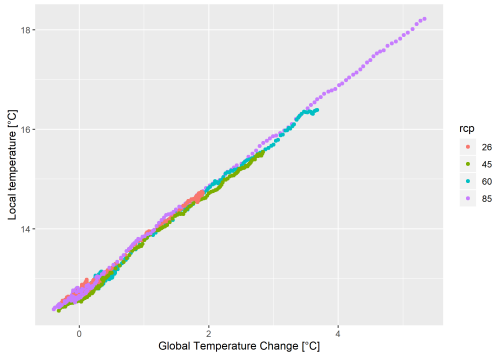
Climate data and projections

Country temperature projections

- Effect of global forcing from GHG emissions on regional temperatures
- CMIP5 database (Taylor et al., 2011), two RCPs, 26 models
- Population weighted data, $N = 169$

$$\Delta T_{it} = \alpha_i + \beta_i F_t$$

Example for Italy



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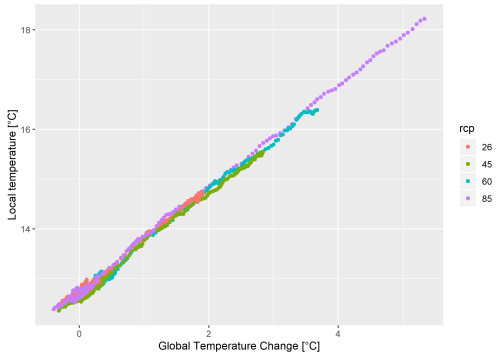
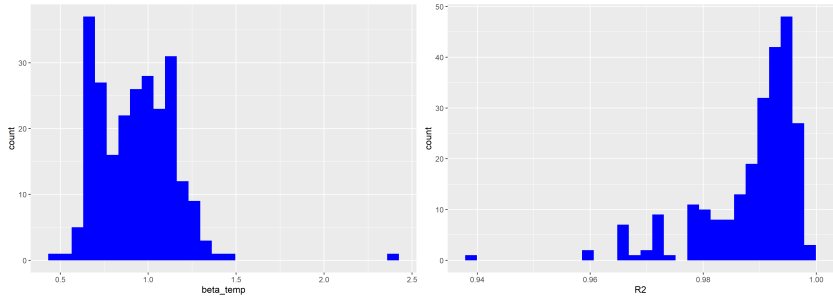


Estimated effect of Forcing

- Global average: around 0.7 $^{\circ}C/\frac{W}{m^2}$
- Relatively precisely estimated ($R^2 = 0.950 - 0.999$)
- significant variation (mainly due to latitude)
- estimated $\hat{\beta}_i$ across countries and R squared:

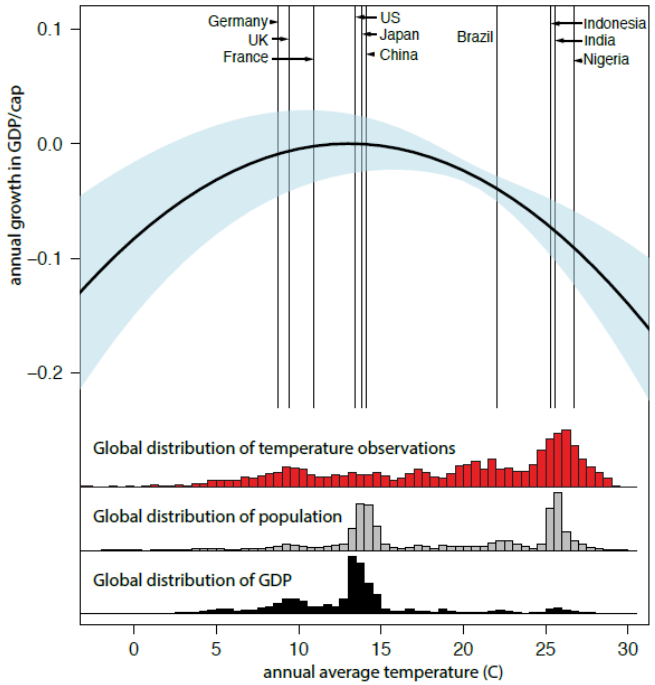


Climate data and projections

- Integrating CEIs in an IAM
  - Cooling Degree Days
  - Heating Degree Days
  - Days with higher than 30 degree maximum
  - Days with lower than 10 degree minimum
  - Yearly heat wave frequency
  - Standardised precipitation-evapotranspiration index (12 months)

	Dependent variable:					
	CDD18 (1)	HDD18 (2)	TXGE30 (3)	TMLT10 (4)	YHF (5)	SPEI12 (6)
mean_temp_weighted	-23.178*** (1.721)	-366.039*** (1.650)	12.975*** (0.275)	-10.444*** (0.179)	11.778*** (0.703)	0.051** (0.020)
mean_temp_weighted_squared	6.123*** (0.063)	5.158*** (0.063)			0.094*** (0.026)	-0.005*** (0.001)
daily_temp_Variance	4.106*** (0.061)	4.046*** (0.068)	0.490*** (0.021)	-0.167*** (0.014)	0.704*** (0.027)	-0.012*** (0.001)
mean_temp_weighted*tropical	198.946*** (7.234)	101.234*** (10.686)	25.115*** (0.513)	2.348** (0.927)	24.019*** (4.213)	-0.077 (0.100)
mean_temp_weighted^2*tropical	-2.871*** (0.160)	-0.628*** (0.240)			-0.158* (0.089)	0.006*** (0.002)
Observations	7,301	5,996	6,093	4,037	5,520	7,870
R^2	0.933	0.956	0.630	0.474	0.391	0.039
Adjusted R^2	0.931	0.955	0.620	0.459	0.369	0.015
F Statistic	19,822.380*** (df = 5; 7115)	25,488.940*** (df = 5; 5833)	3,365.034*** (df = 3; 5927)	1,178.217*** (df = 3; 3927)	684.906*** (df = 5; 5328)	62.668*** (df = 5; 7673)
Note:						*p**p***p<0.01

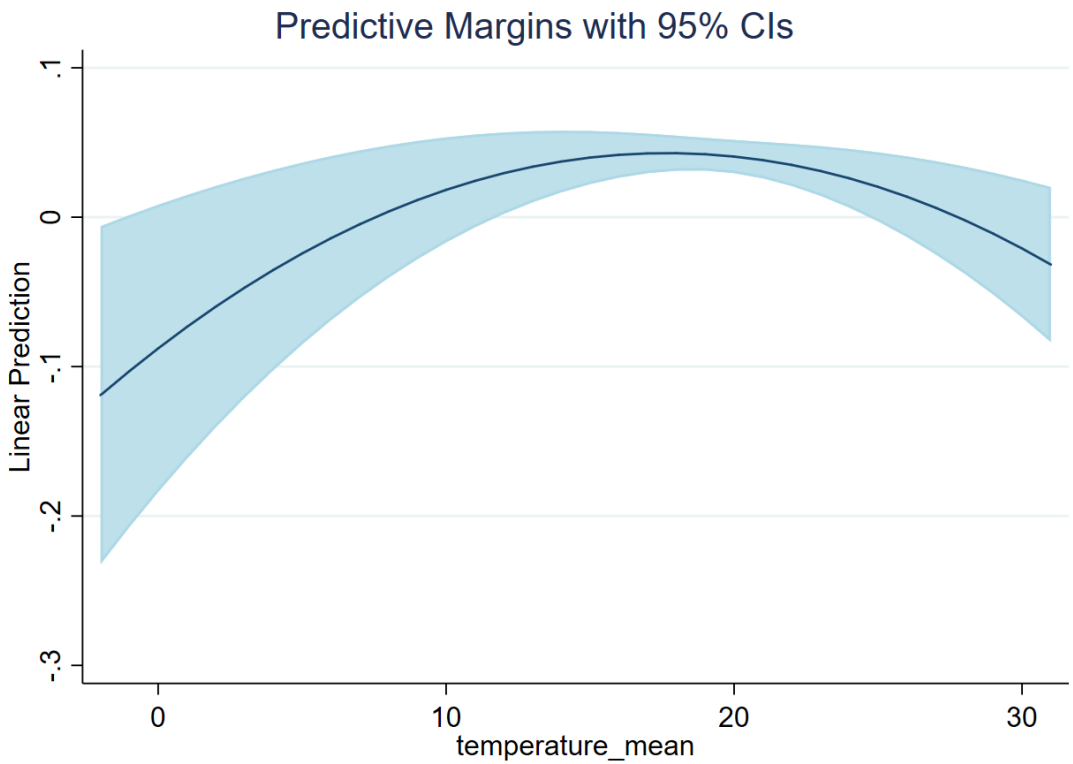
Climate Econometrics and Growth



Burke et al. (2015)

Climate Econometrics and Growth

- Adaptive Capacity? Consider institutions, reduced inequalities, education:



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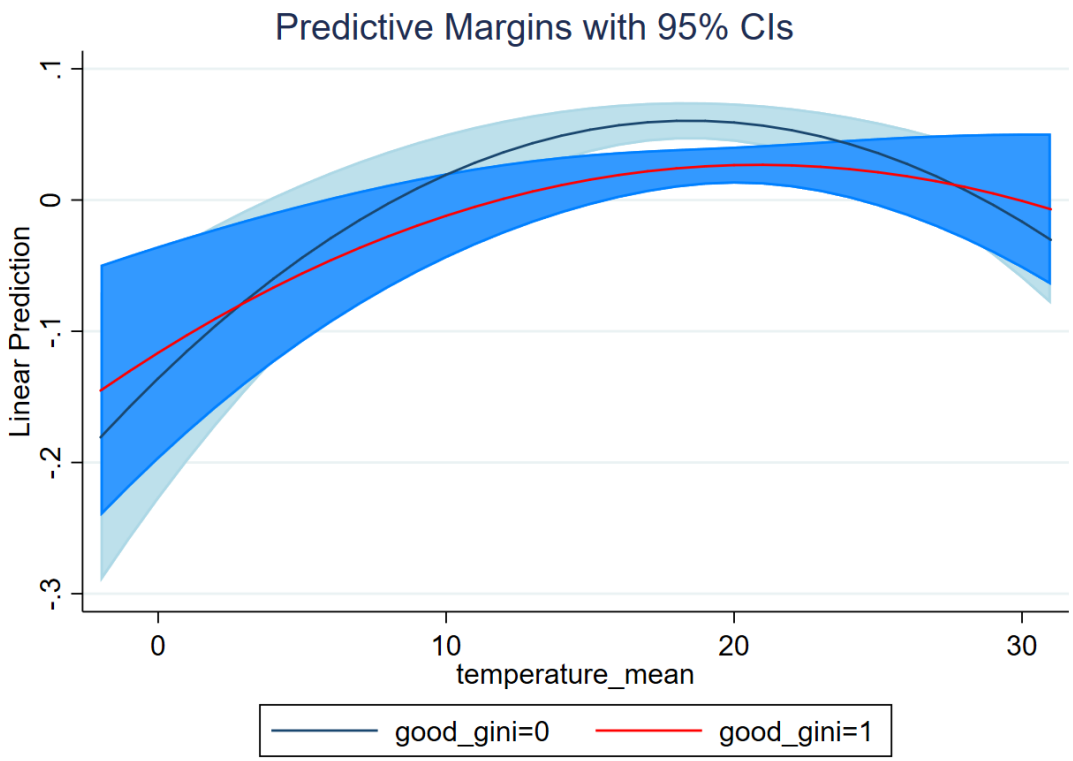

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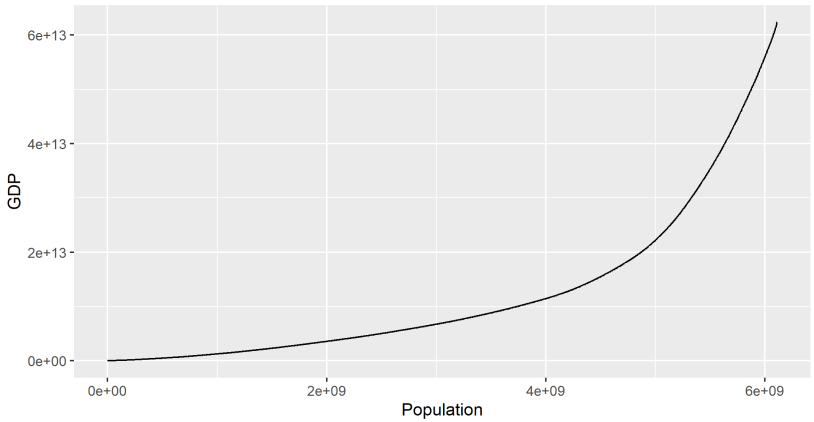
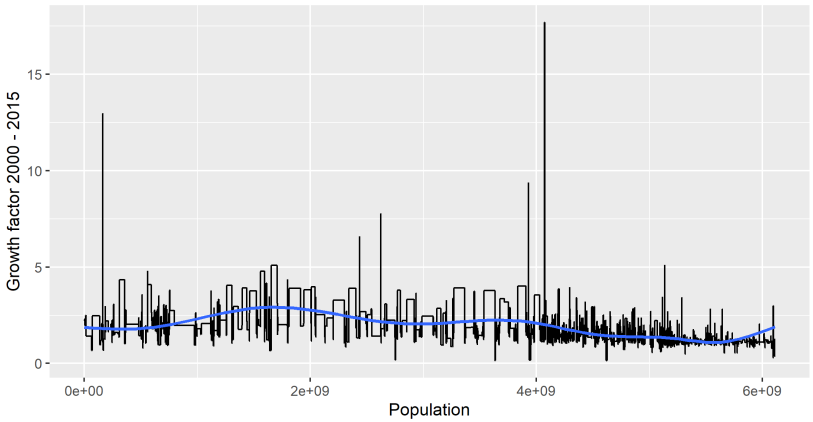
Climate Econometrics and Growth

- Spatial Analysis (based on Kummu et al. (2019)), 1990 - 2016, 10x10km





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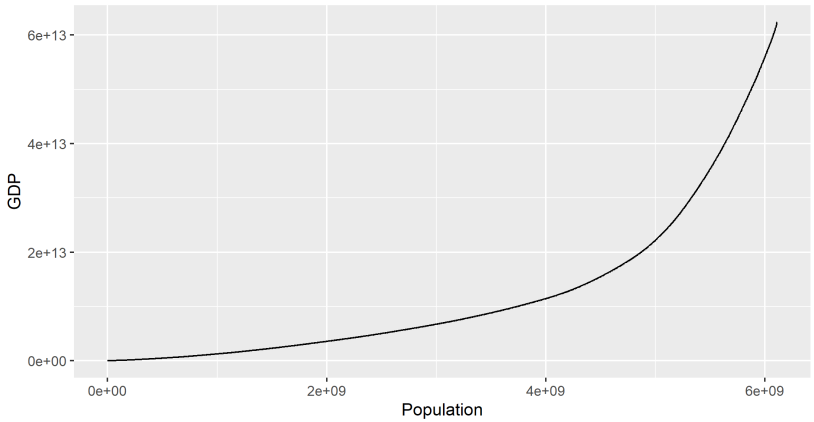
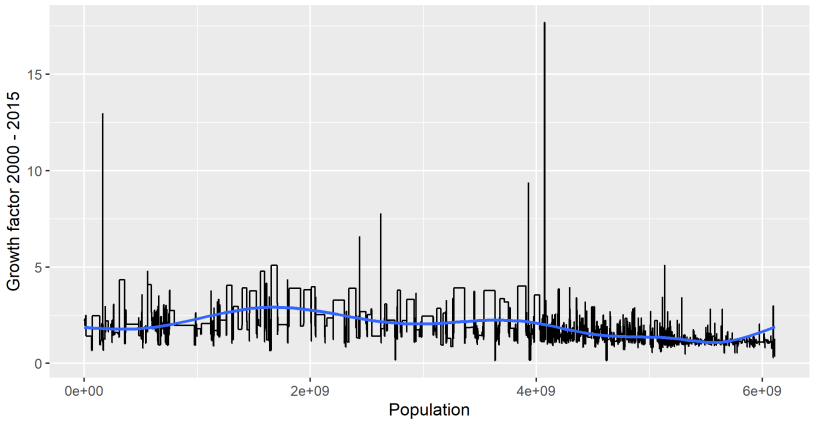
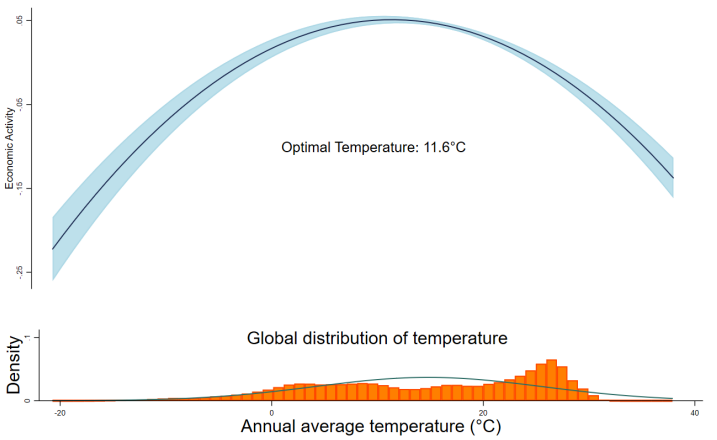




Dependent variable: GDP growth rate	
Mean temperature	0.358***
	(0.000)
Mean temperature squared	-0.015***
	(0.000)
Constant	-0.807***
	(0.000)
Observations	908,387
Robust pval in parentheses	
*** p<0.01, ** p<0.05, * p<0.10, + p<0.15	
Grid cell Fixed Effects	YES



Inequality

1. Evolvement of within- and between country inequality in the SSPs
2. Impact of inequality on welfare evaluations (discount rate, equity concerns)
3. heterogeneous impacts
4. heterogeneous savings rates
5. varying energy expenditure shares

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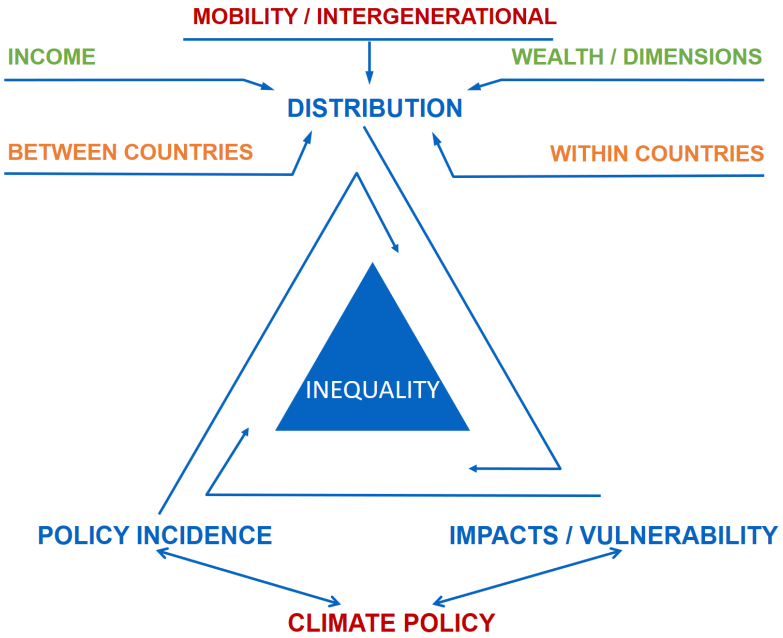

Inequality - Data

- Sources
  1. World Income Inequality Database (WIID) (UNU-WIDER)
  2. Standardized World Income Inequality Database (SWIID) (Solt, 2016)
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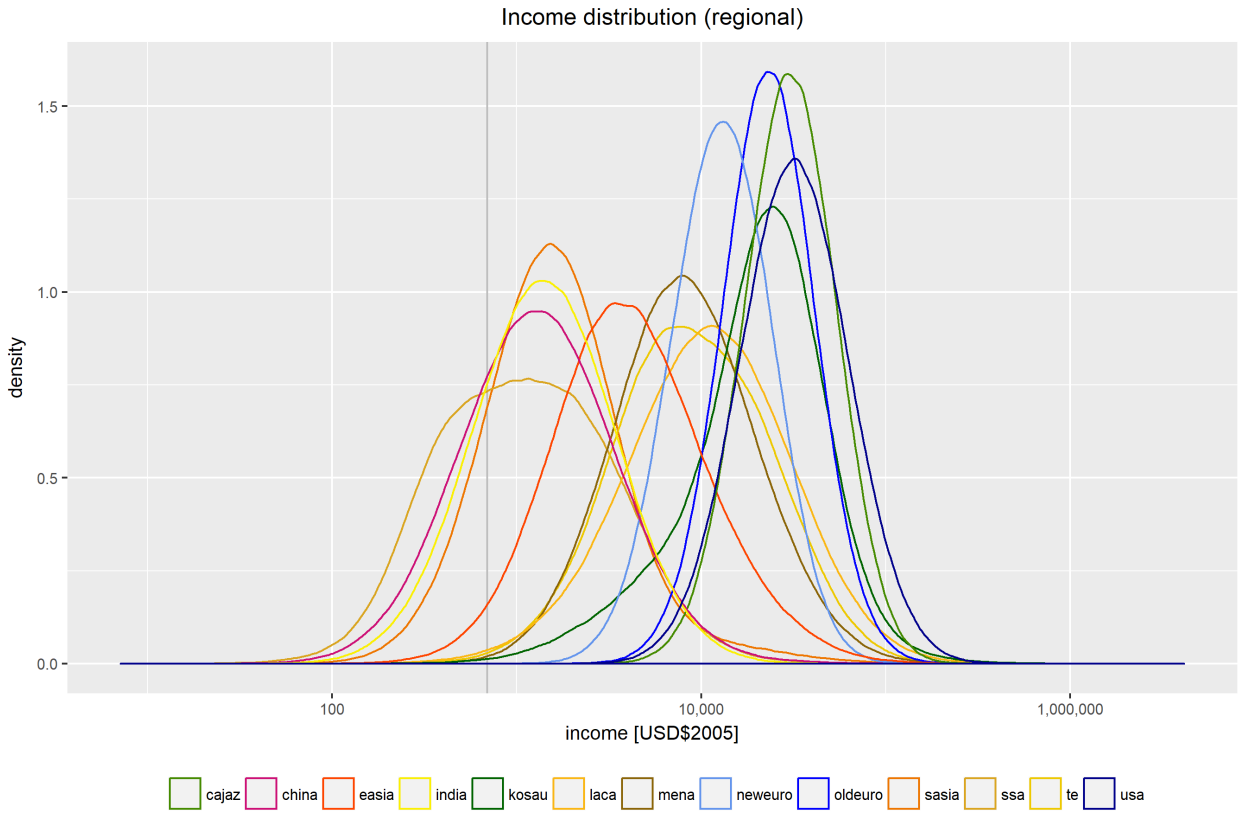
- Estimate quintiles (5 agents per region) or parametric distributions
- GINI and GDP: two parameters $\Rightarrow$ mixture of lognormal distribution (2 parameters, within country): $c_{rt} \sim LN(\mu_{rt}, \sigma^2_{rt})$: $Gini = 2\Phi(\sigma_{rt}/\sqrt{2}) - 1$
- and Beta-Dagum (5 parameters, (Bandourian et al., 2002), within regions)
- SSP Projection: GDP (Dellink et al., 2017), Population (KC and Lutz, 2017), Gini within countries (Rao et al., 2018)

Inequality - Income distribution for 2005



- Gini index estimated at 68.3 (compare to Milanovic (2009) estimate of 0.68)
- Absolute poverty: 14.6% compared to 22.4% in Ravallion et al. (2009) ==> lower tail could be improved!
- Top 10%: 43902 USD, Top 1%: 124755 USD (136000 $ according to CNN for one household)

Inequality evolvement in the past

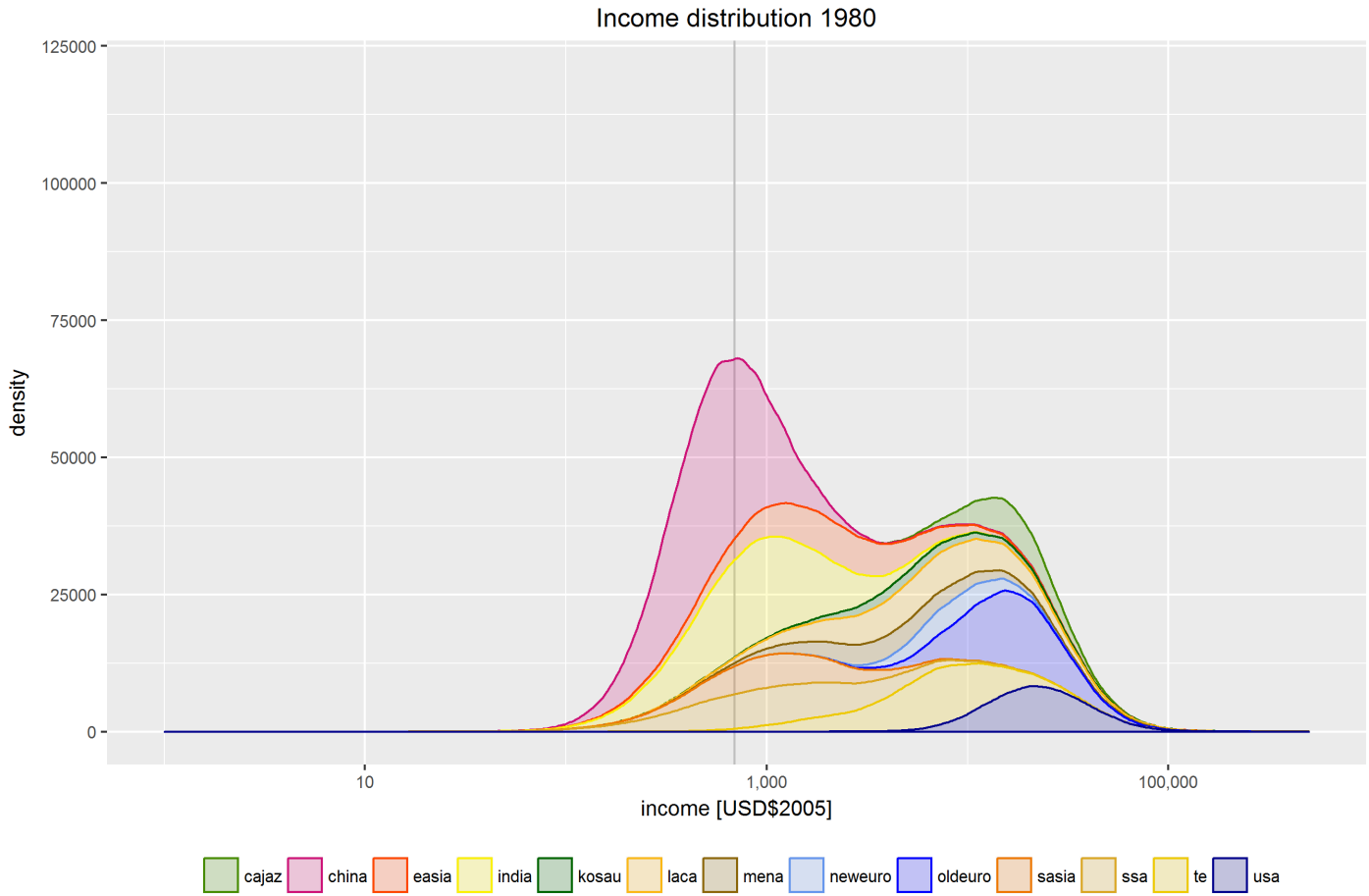


Figure: Evolvement of the global income distribution over time

Inequality evolvement and across the SSPs

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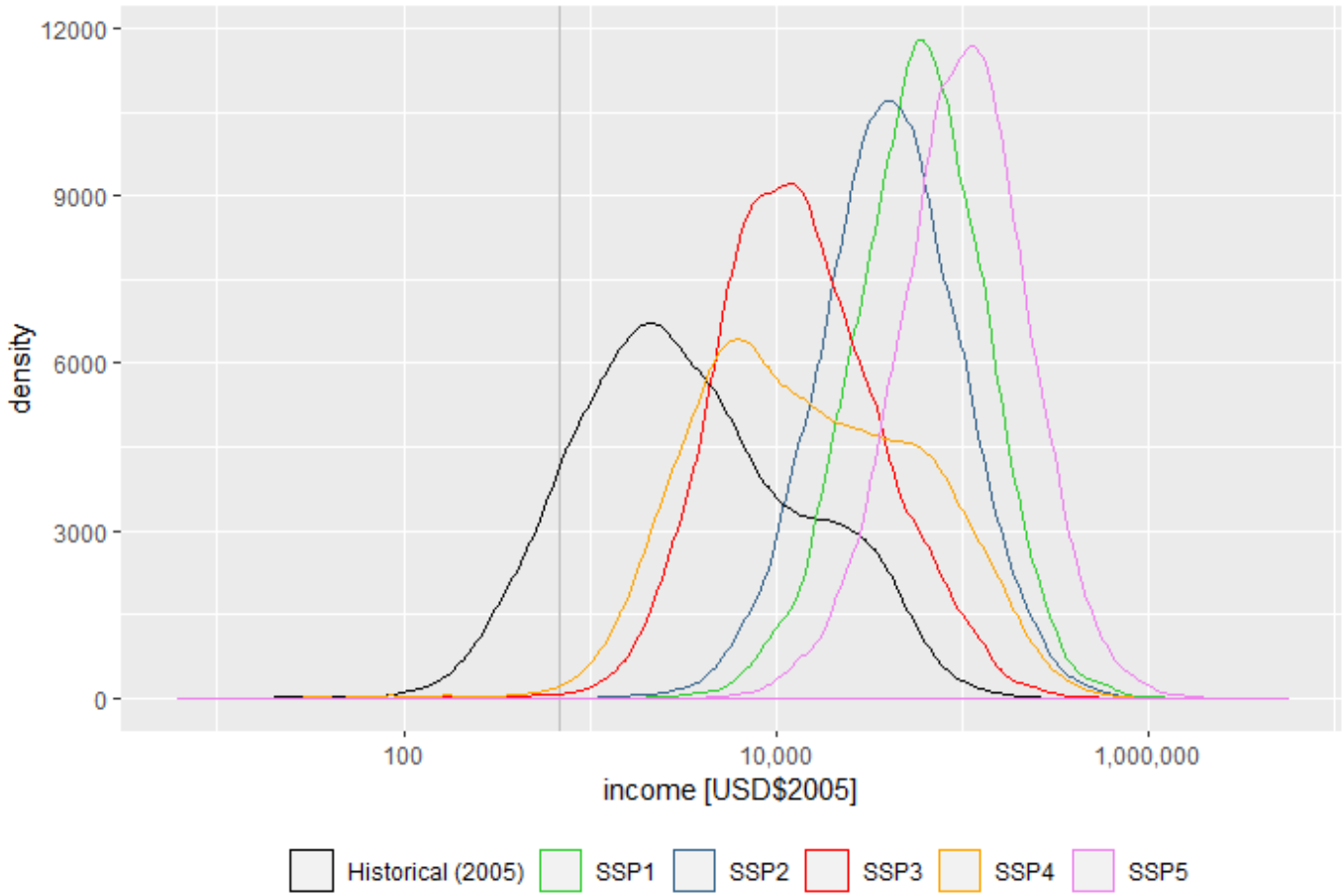

Figure: The global inequality distribution across SSPs in 2100

Conclusion

- Future research areas
  - Integrating policy incidence curves
  - Analytical models of inequality
  - Integrate extreme percentiles (WID)
  - Micro-data based spatial analysis

Thank you!

Backup

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