Explosive temperatures

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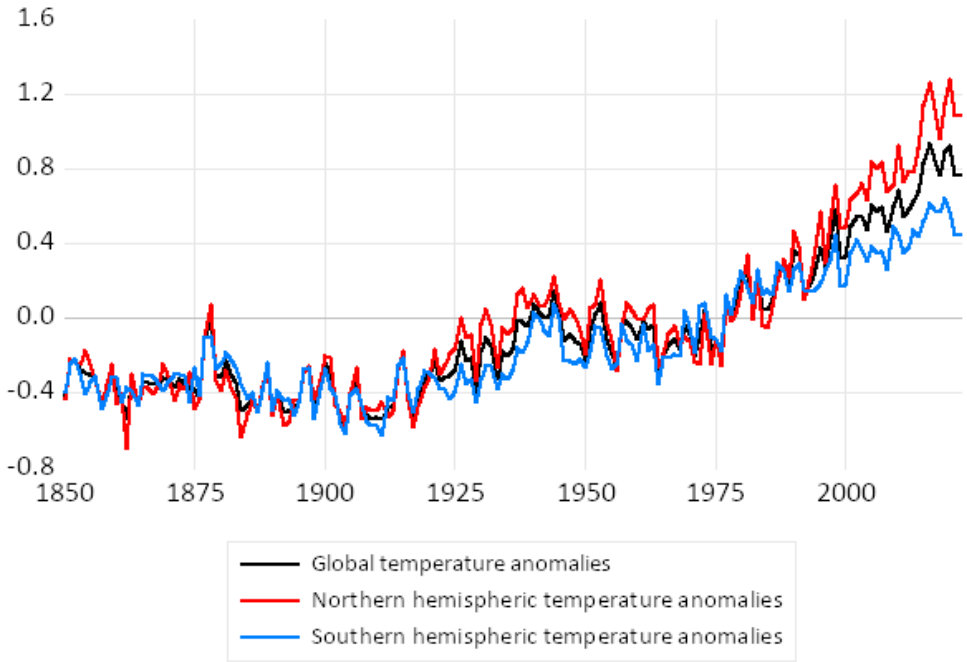
What is Climate Econometrics?

- Climate econometrics is the application of econometric methods to improve the understanding of interaction of human activity and climate change
- Zhang et al. (2018), Temperature effects on productivity and factor reallocation (JEEM)
- Somanathan et al. (2021), The impact of temperature on productivity and labor supply (Journal of Political Economy)
- Bruns et al (2020), A multicointegration model of global climate change (Journal of Econometrics)
- Diebold and Rudebusch (2021), Probability assessments of an ice-free Arctic (Journal of Econometrics)

Let's take a look at the data

Figure 1: Global as well hemispheric temperature anomalies.



Explosiveness?

- Explosive oil prices (Gronwald, 2016, EE)
  - Oil prices peaked in 2008.
  - Increase began in 2003.
- Explosive Bitcoin prices (Gronwald, 2020, FRL)
  - Bitcoin prices peaked in late 2017
  - Increase began in early 2017
- Nasdaq bubble (Phillips et al., 2011, IER)
  - Nasdaq index peaked in 2000
  - Increase began in early 1990s
- IPCC (2018): "human activities are estimated to have caused approximately 1.0 degree C of global warming above pre-industrial levels in 2017"
- Increase began only in 1975
- Are temperatures explosive?

Temperature anomalies

- Deterministic vs. stochastic trends:
  - Kaufmann et al (2013, Climatic Change) stochastic trends, Estrada et al (2013, Nature Geoscience) (broken) deterministic time trends
- Chang et al. (2020, Journal of Econometrics): Functional unit roots vs. functional deterministic trends or explosive behavior
  - Evidence of stochastic trends - two trends are present in Northern Hemisphere, one in Southern Hemisphere
- Holt and Terasvirta (2020, Journal of Econometrics): co-shifting between hemispheric temperature series
  - three (two) logistic function components are adequate to characterize the shifts in the mean of the northern (southern) series
- Different time series behaviour in the Northern and Southern hemispheres.

Relationship between temperature anomalies and forcings

- Agliardi et al (2019, ERE): no evidence of non-linear cointegration
- Eroglu et al (2021, Econometric Reviews): no evidence of time-varying cointegration
- Chen et al. (2021, Journal of Econometrics): apply common trend appoach, without conditioning on exact nature of trend
- Gronwald and Jin (2022, WP): long-term covariability and TPMA: strong relationship, some evidence of time variation
- Eroglu et al (2021) finding of second trend in Northern Hemisphere: evidence against stable relationship

Temporary explosiveness

- Phillips et al. (2011): forward recursive application of an augmented Dickey-Fuller unit root test.

$$\Delta y_t = \hat{\alpha}_{r_1,r_2} + \hat{\beta}_{r_1,r_2} y_{t-1} + \sum_{i=1}^{k} \psi^i_{r_1,r_2} \Delta y_{t-i} + \hat{\epsilon}_t. \qquad (1)$$

- Null of Unit Root tested against explosive alternative

Temporary explosiveness

- Phillips et al.'s (2011,2015) SADF, GSADF, and BSADF tests
- Initially, a subset of the sample is used. In each subsequent regression, this subset is supplemented by successive observations.
  - SADF: starting point fixed, endpoint changes
  - GSADF: both starting point and endpoint change
  - BSADF: starting point fixed, endpoint changes
- Date stamping of explosive periods.

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Table 1: SADF and GSADF

	Global temperature anomalies					
Lag length selection	SADF			GSADF		
	fix	AIC	SIC	fix	AIC	SIC
Test statistic	1.5949 (0.027)	1.5949 (0.027)	1.0326 (0.134)	1.6768 (0.053)	1.6768 (0.053)	1.07767 (0.234)
	Northern hemispheric temperature anomalies					
Test statistic	1.619 (0.026)	1.1221 (0.114)	1.1221 (0.114)	1.7443 (0.045)	1.6395 (0.059)	1.1847 (0.187)
	Southern hemispheric temperature anomalies					
Test statistic	0.7700 (0.198)	0.4492 (0.329)	0.4492 (0.329)	0.7932 (0.347)	0.5021 (0.494)	0.5021 (0.494)

Explosive temperatures?

Figure 2: Testing for explosiveness: Global temperature anomalies

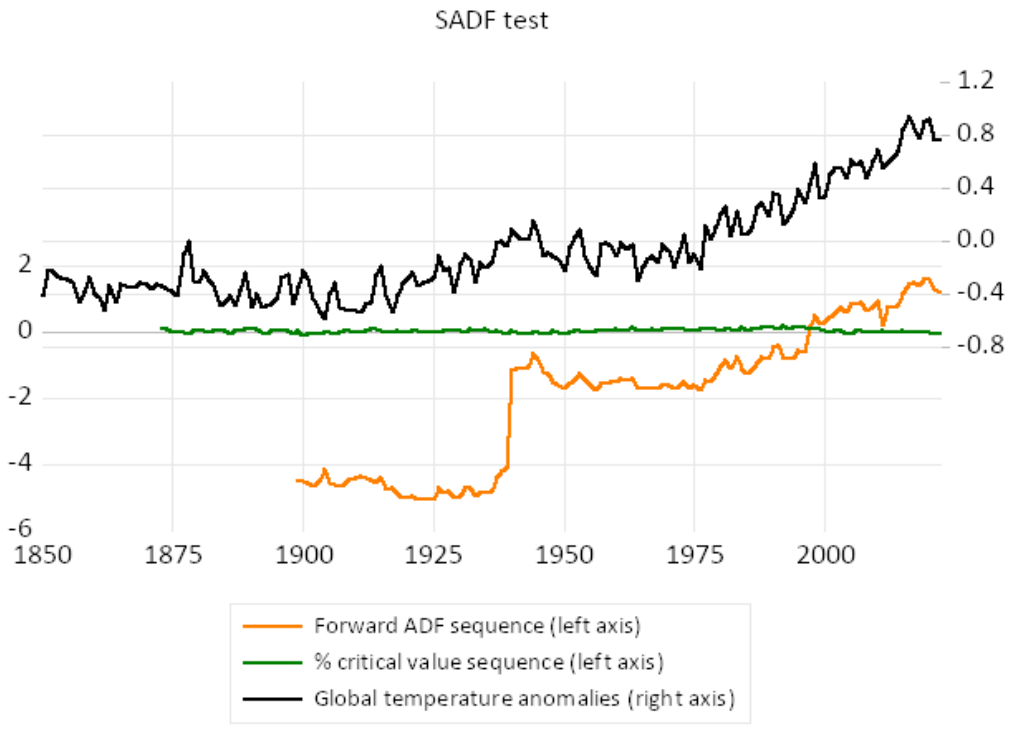

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Figure 3: Testing for explosiveness: Global temperature anomalies

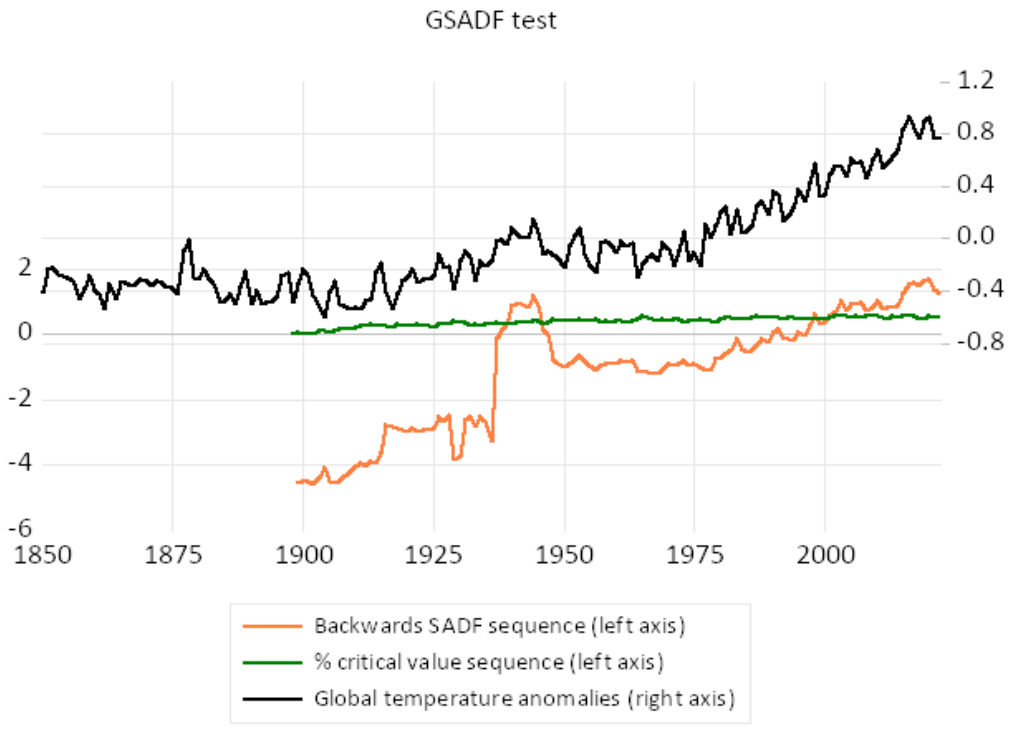

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Figure 4: Testing for explosiveness: Northern Hemisphere.

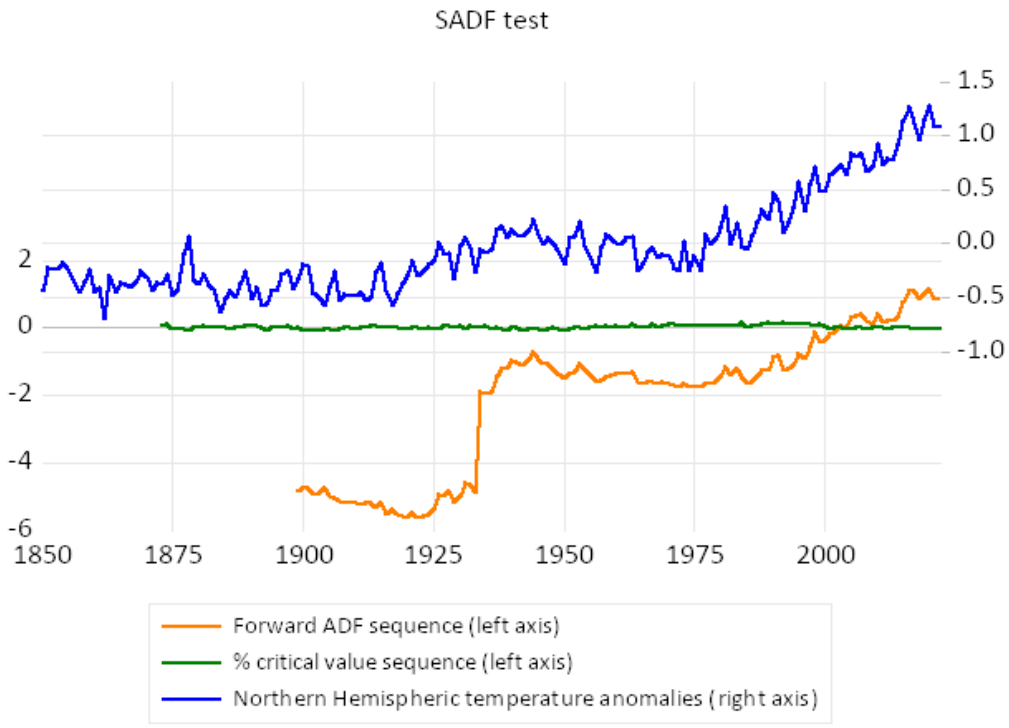

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Figure 5: Testing for explosiveness: Northern Hemisphere.

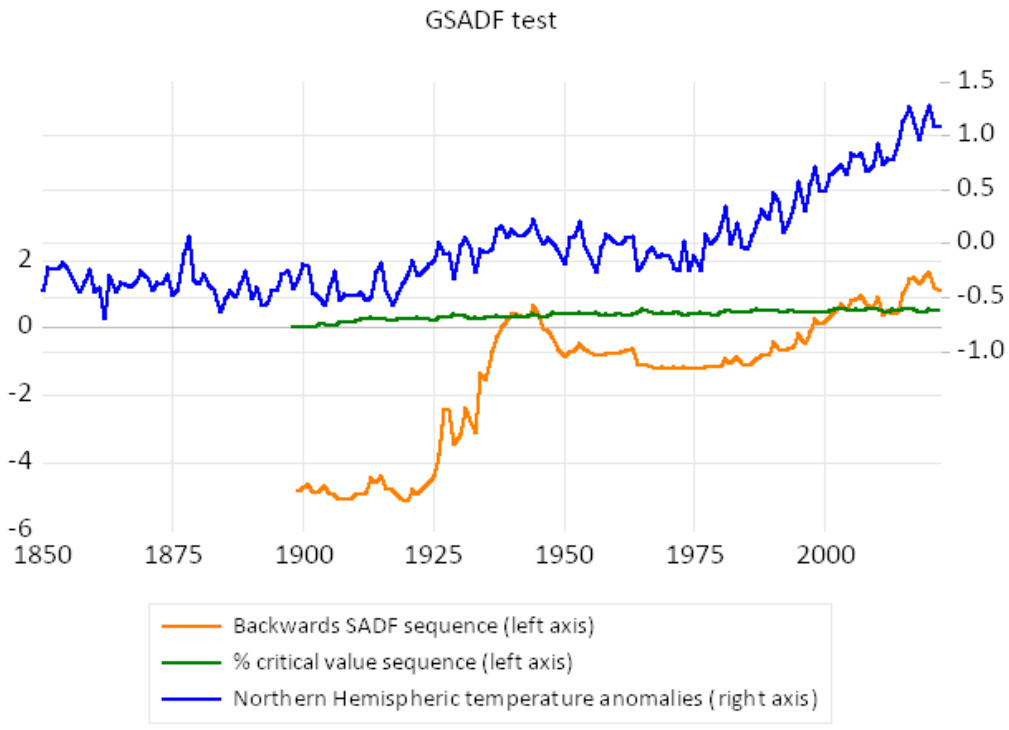

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Figure 6: Testing for explosiveness: Southern Hemisphere.

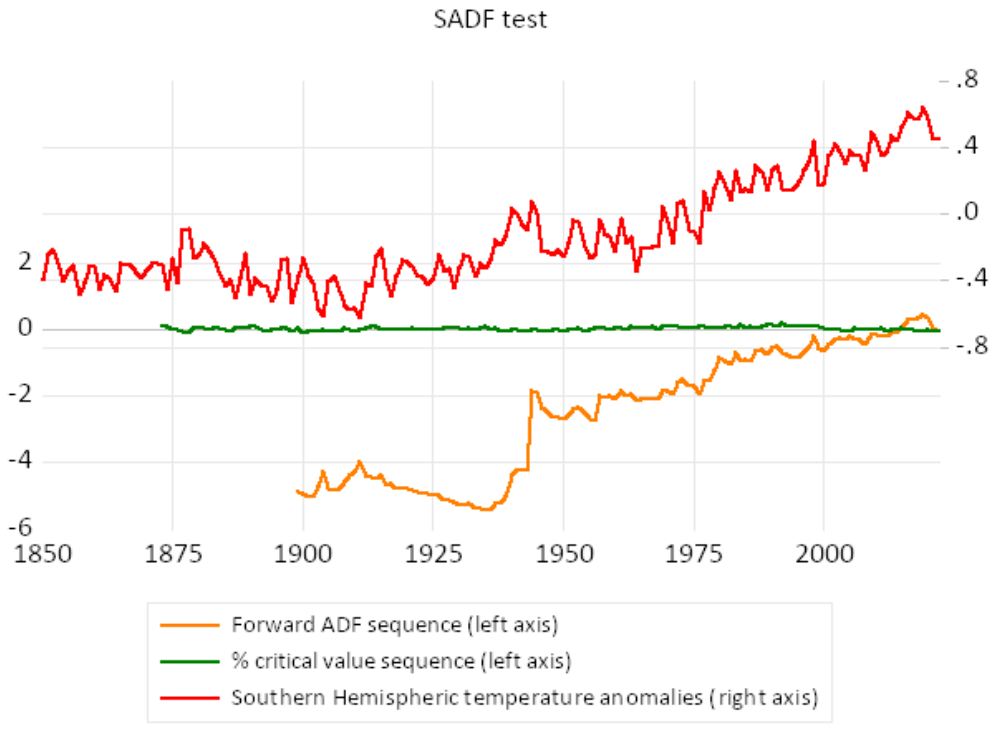

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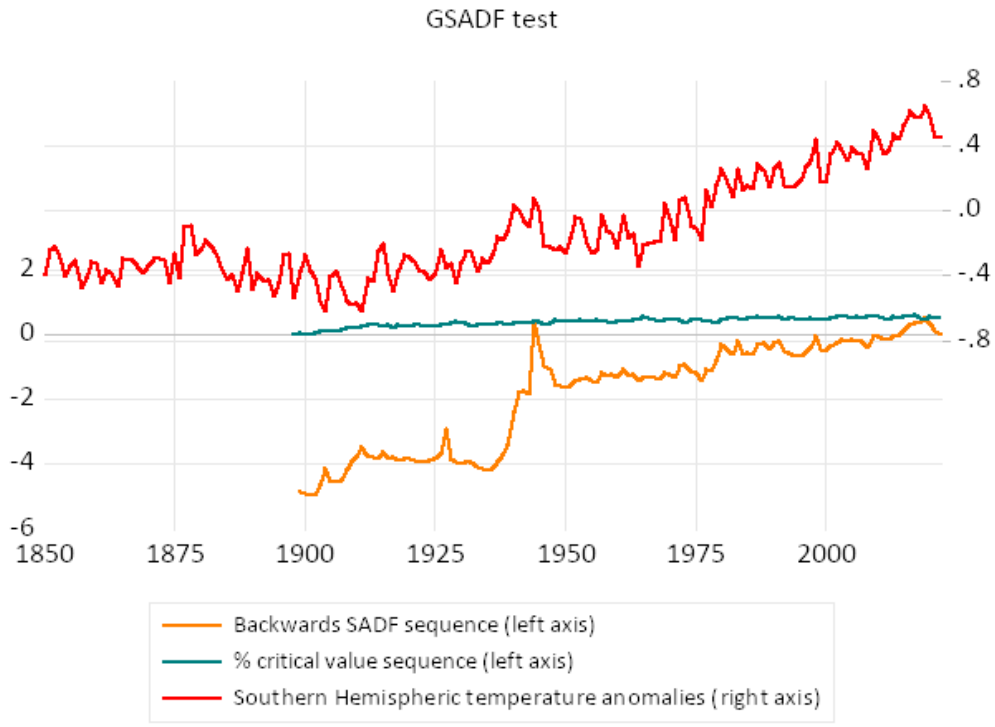
Figure 7: Testing for explosiveness: Southern Hemisphere.



Conclusions

- Temperature anomalies are explosive
- Time series properties of temperature anomalies differ across hemispheres
- Relationship between temperatures and warming?
- Climate science vs. climate economics
  - Ignoring polar amplification results in suboptimal climate policy.
  - Inadequatly modelling climate dynamics results in suboptimal climate policy.
- Climate econometrics: evaluation of climate economic models