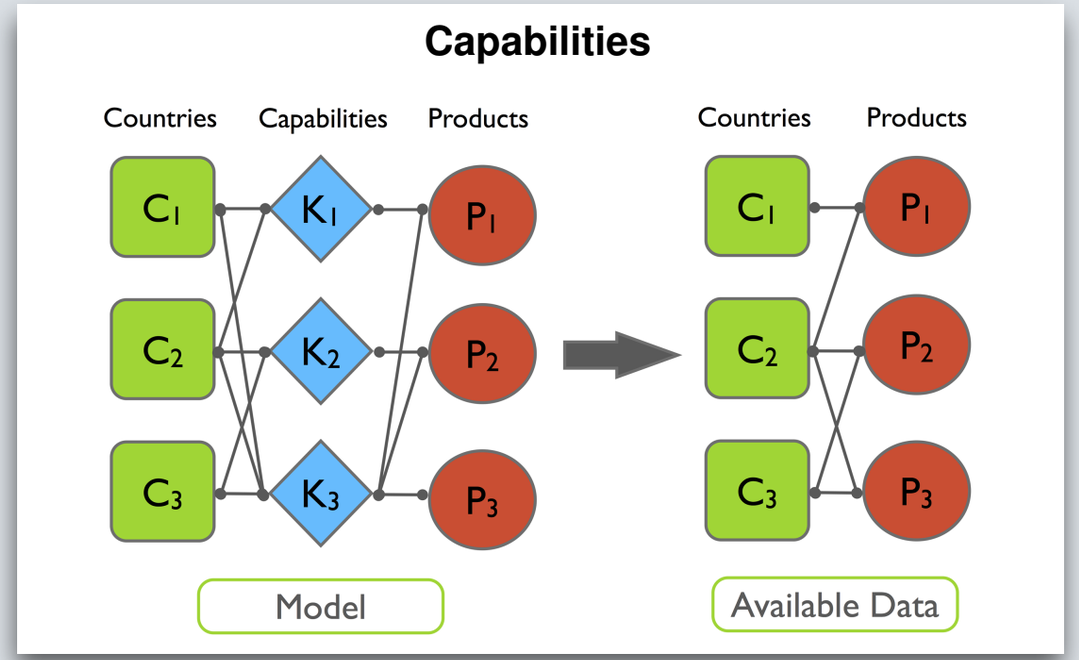
HIDDEN MARKOVIAN MODEL FOR COUNTRIES' TECHNOLOGICAL DEVELOPMENT

Dario Mazzilli, Andrea Tacchella, Luciano Pietronero

EXPORT'S TIME FLUCTUATIONS



To state if a country is competitive in the production of a commodity we look at the Revealed Comparative Advantage

RCA>1

↓

Competitive

$F_c^{(n)}$ $Q_p^{(n)}$

Short time fluctuations in the export data can't reflect dynamics in the capabilities' layer

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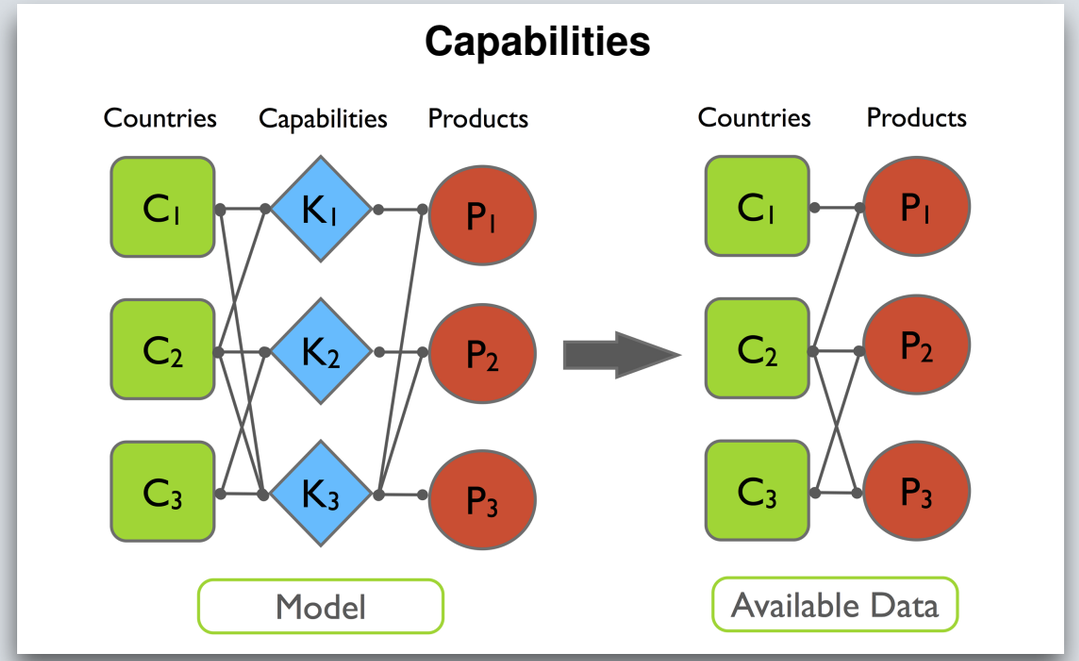
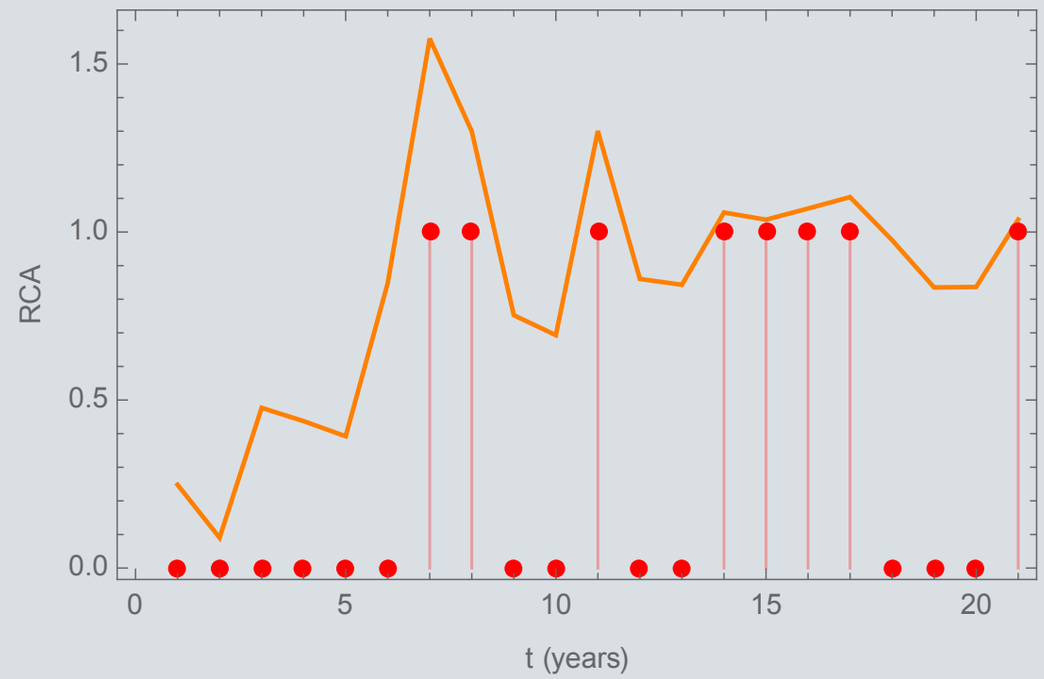


The RCA's time series are very unstable



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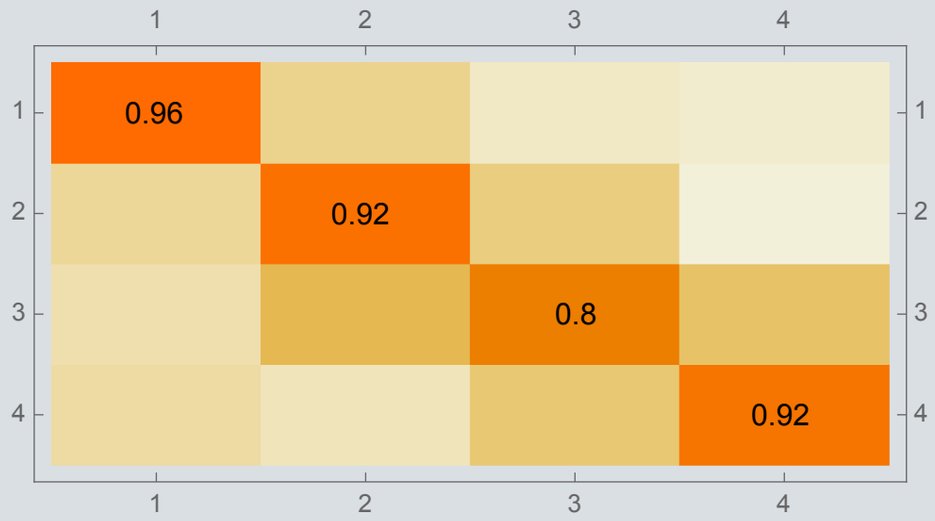
Short time fluctuations in the export data can't reflect dynamics in the capabilities' layer

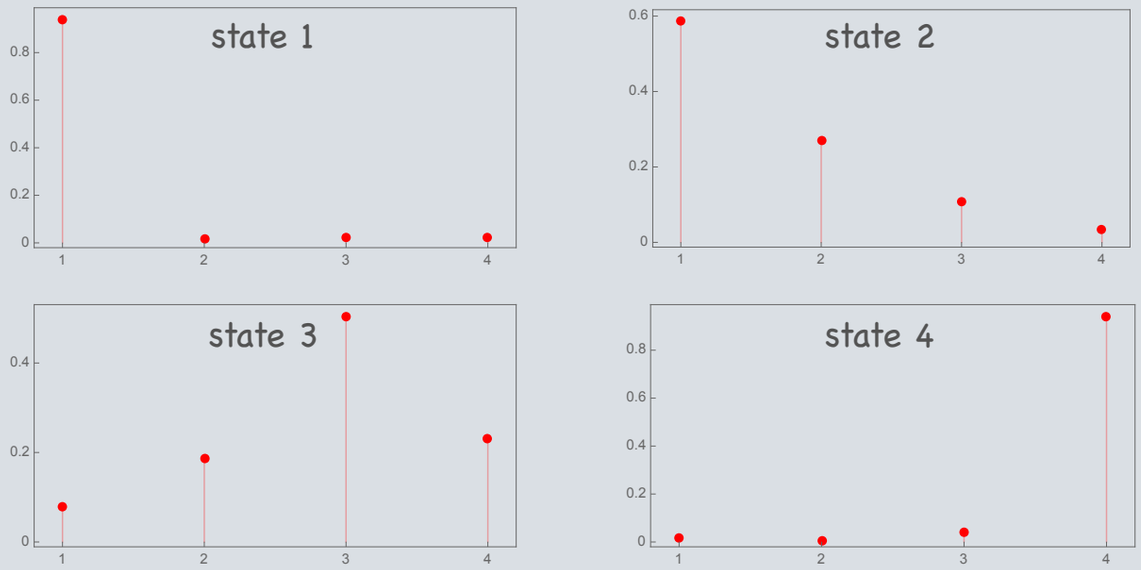
HIDDEN MARKOV MODEL (HMM)

- The capabilities' layer is described by a markov process with states stable through the time.
- We consider 4 states of increasing competitiveness in each product: 1) not competitive, 2) little competitive, etc.
- We bin RCA in quartiles.
- Each production states can emit any RCA's quartile with different probabilities.
- Each country is described by a different HHM

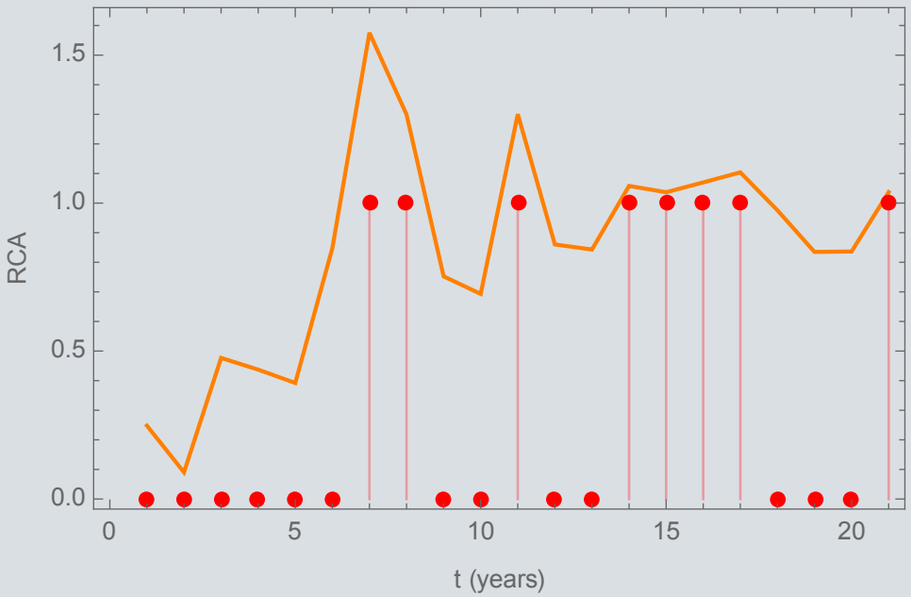
States' transition matrix



RCA (binned) emission distributions



Stabilization of time series



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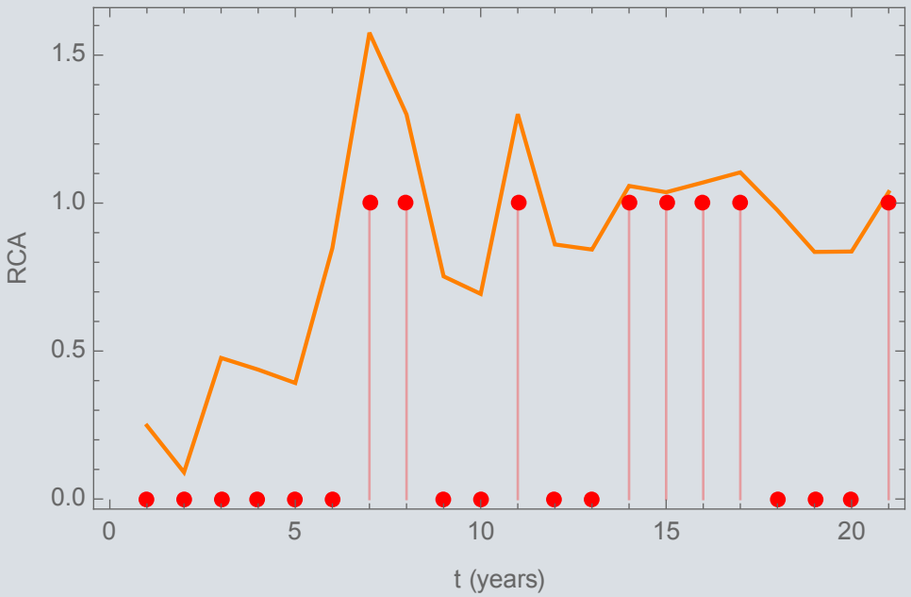

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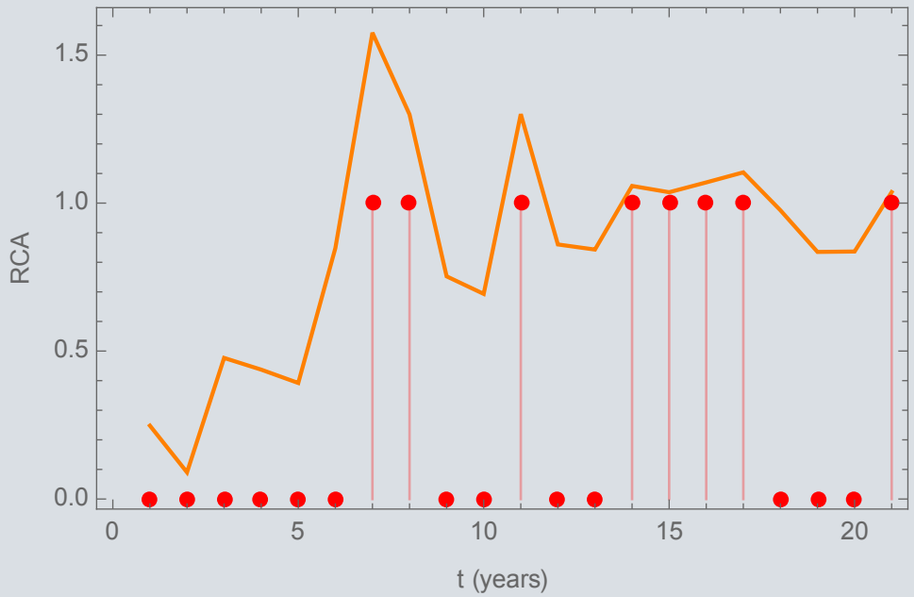

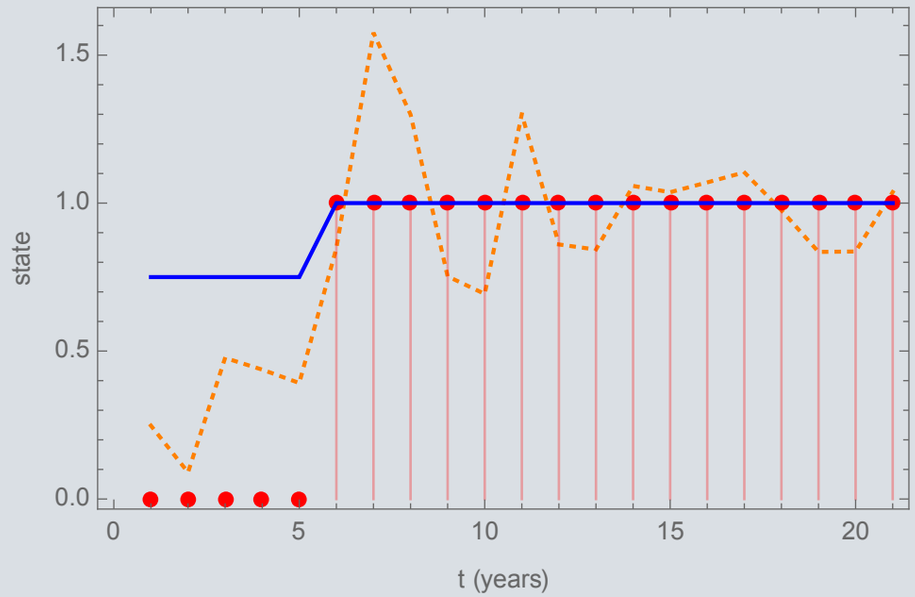

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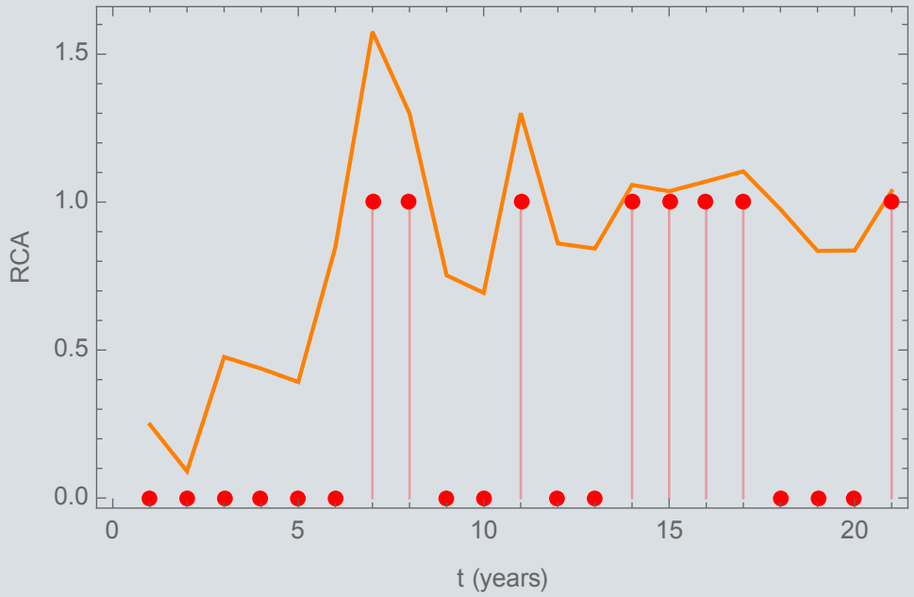
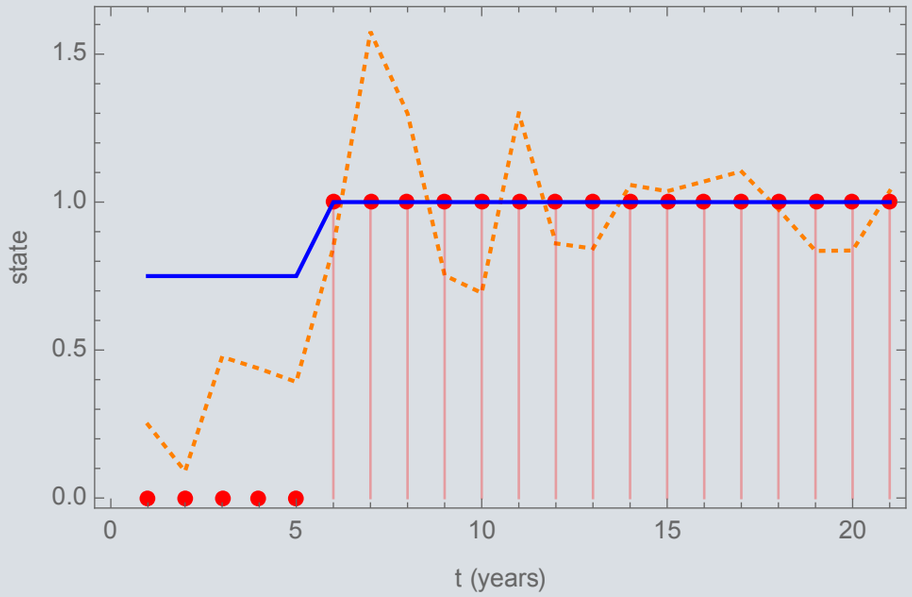
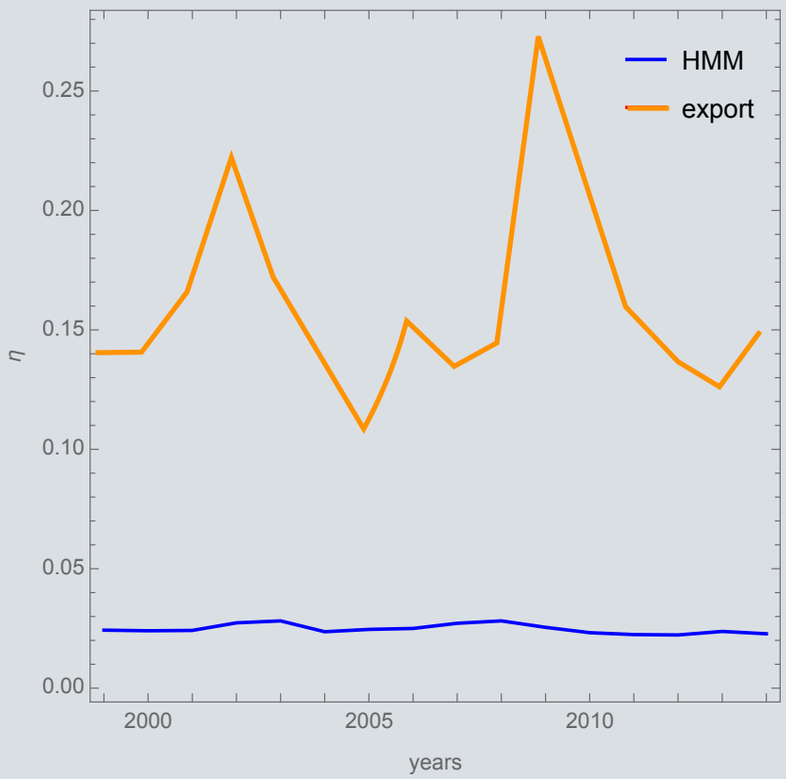




Reduction of the estimated noise



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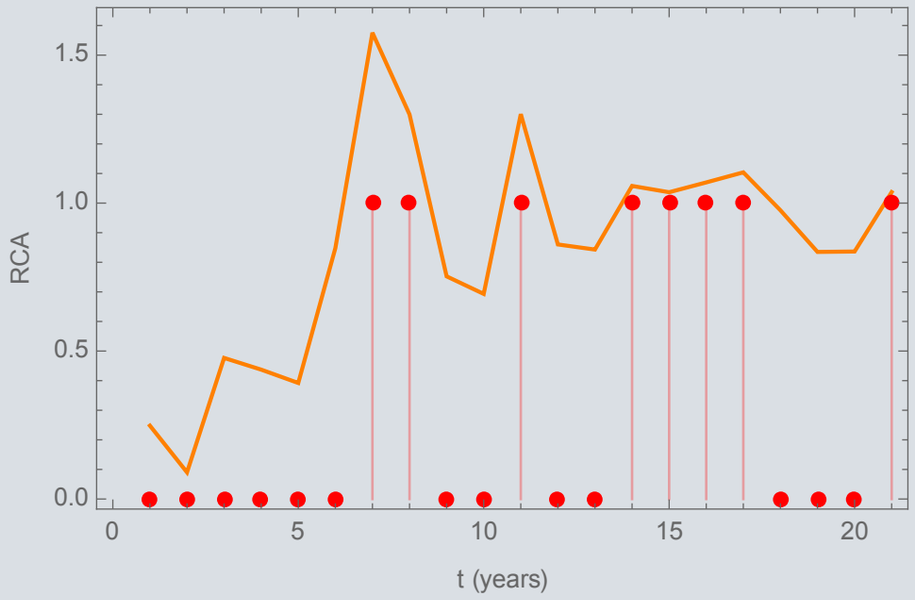

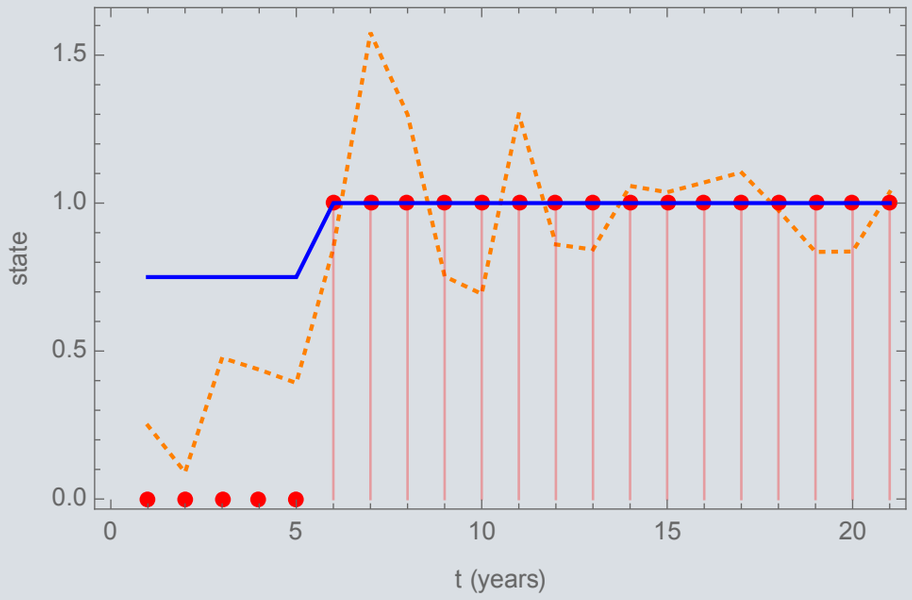

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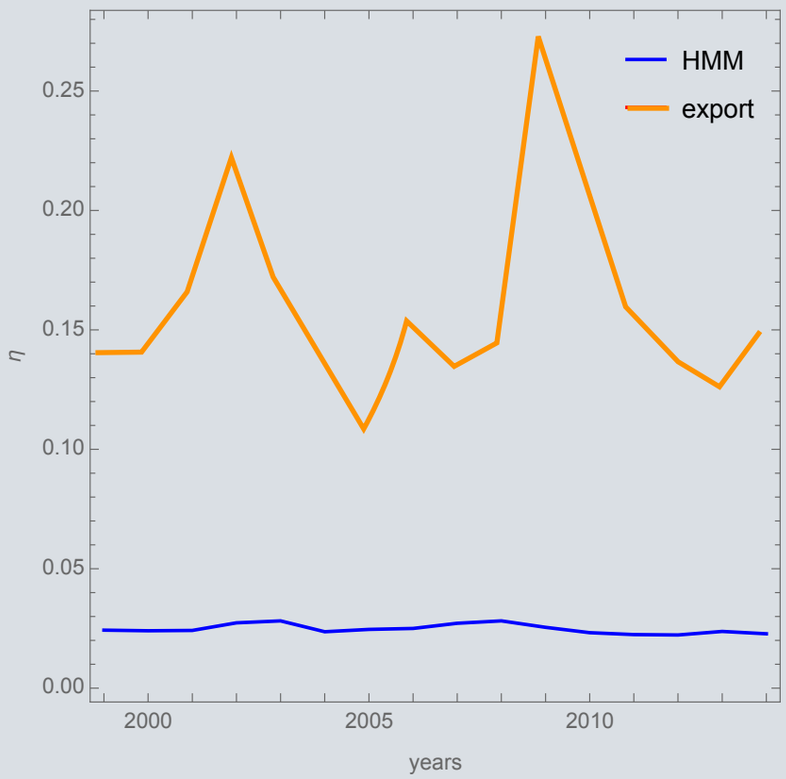
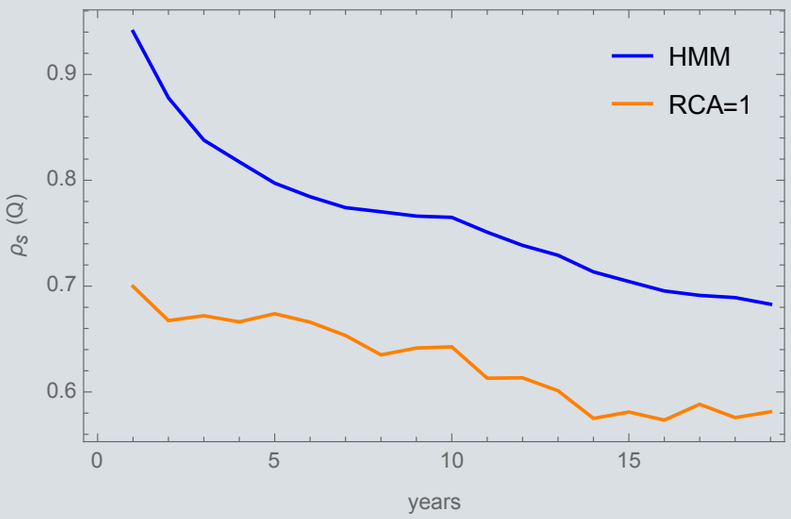
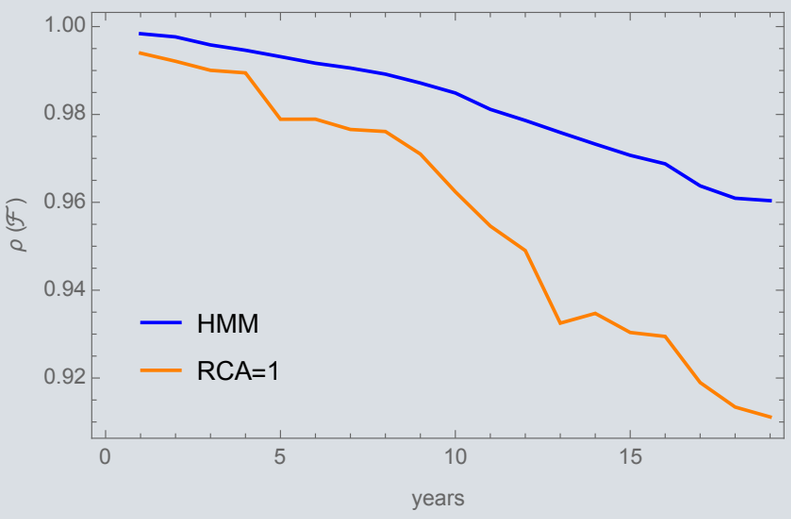
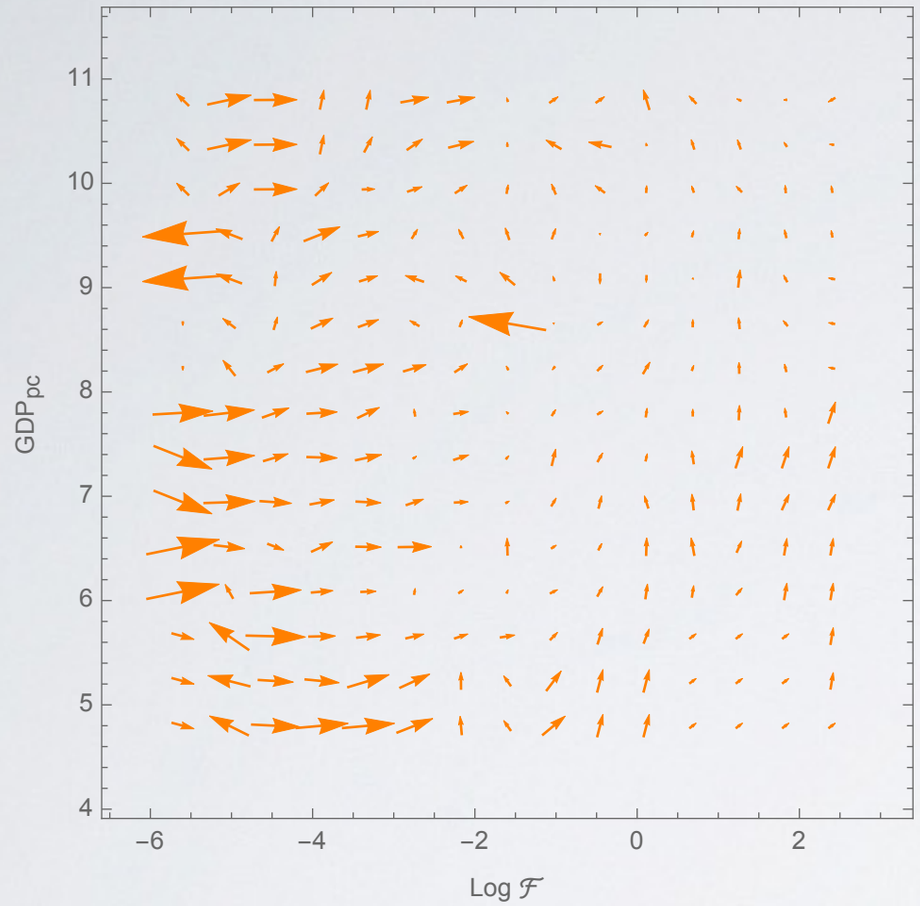


Higher autocorrelation of Fitness and Complexity through the time





Method of analogues, the selective predictability scheme (sps)



The plane GDP-Fitness can be used to predict a country growth by looking at the trajectories of all the other countries that were near to its current position

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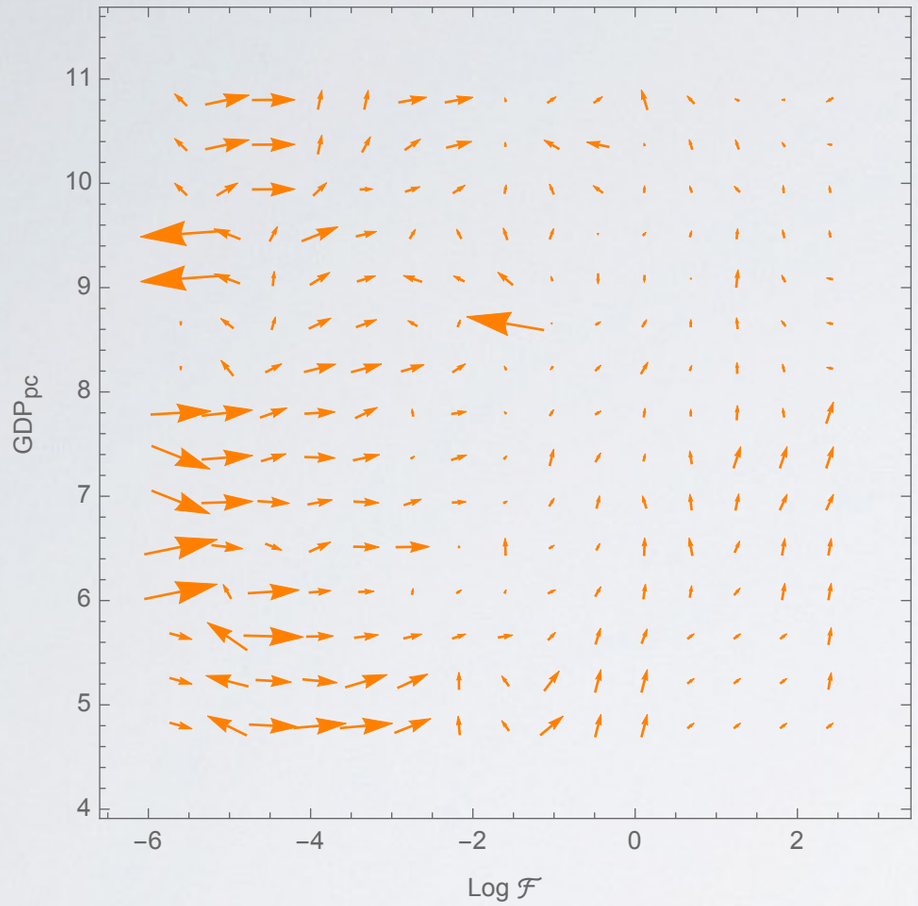

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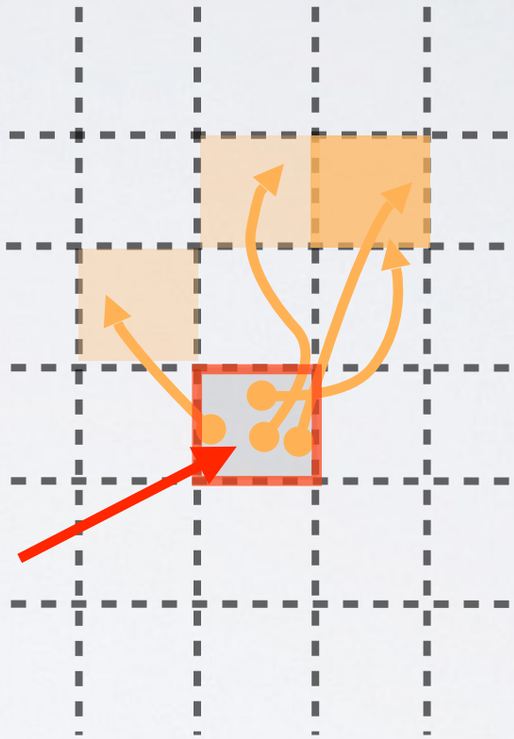

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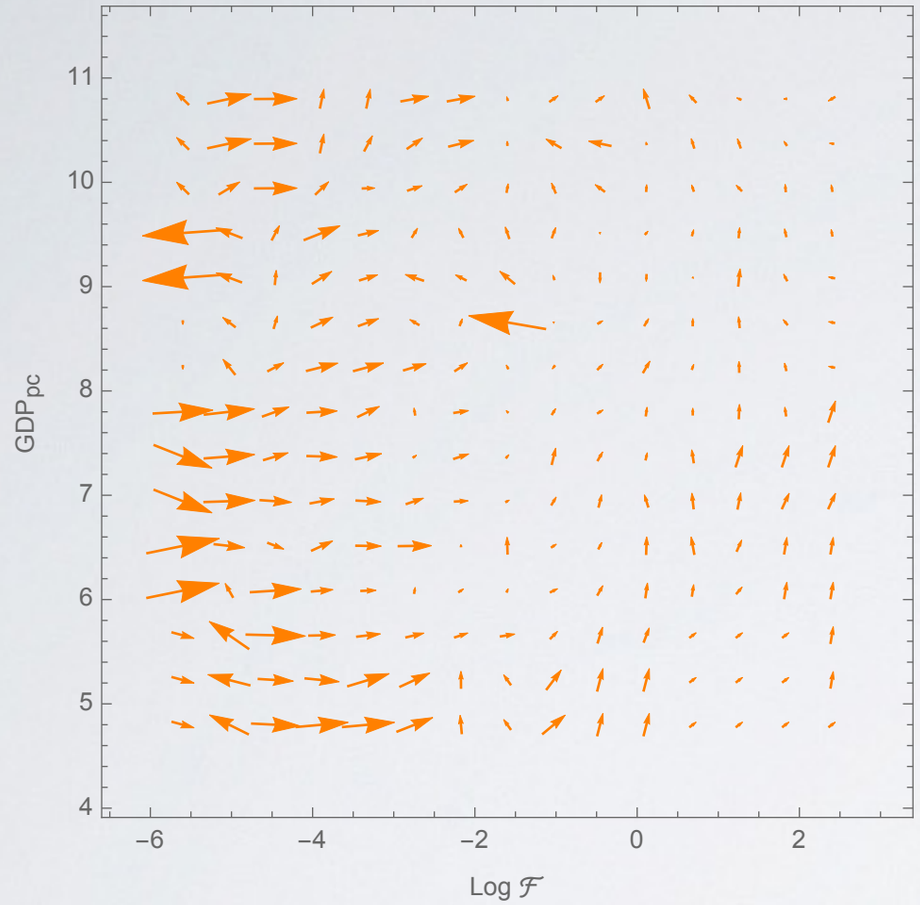

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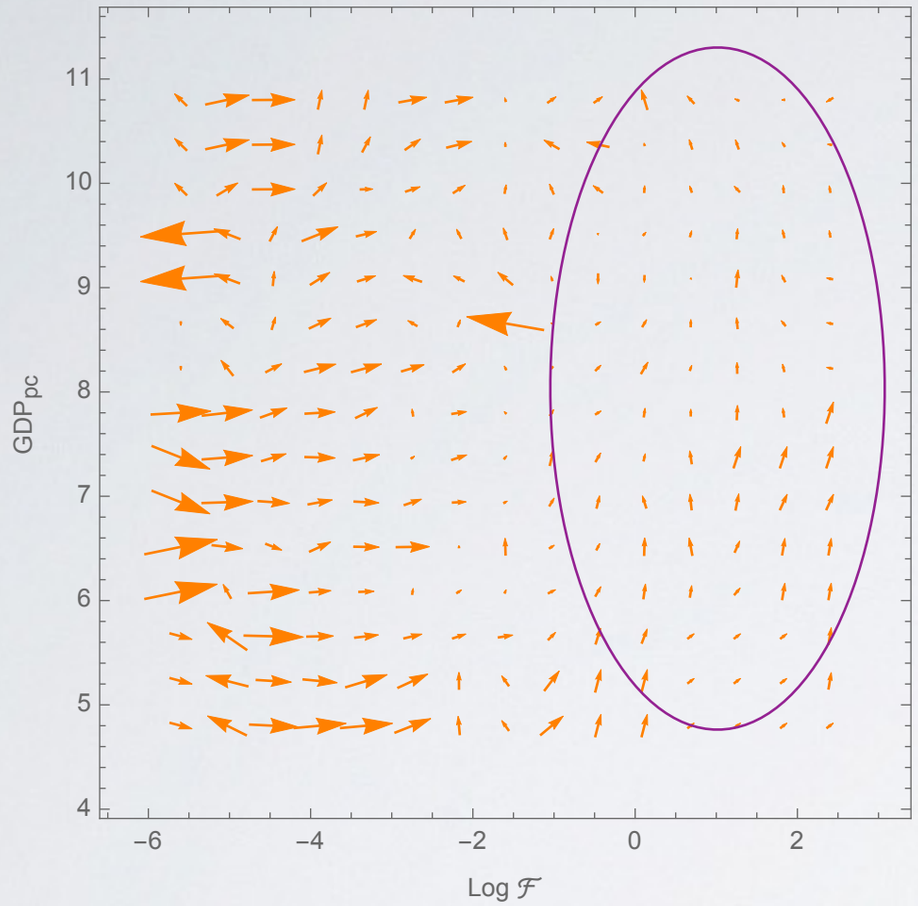

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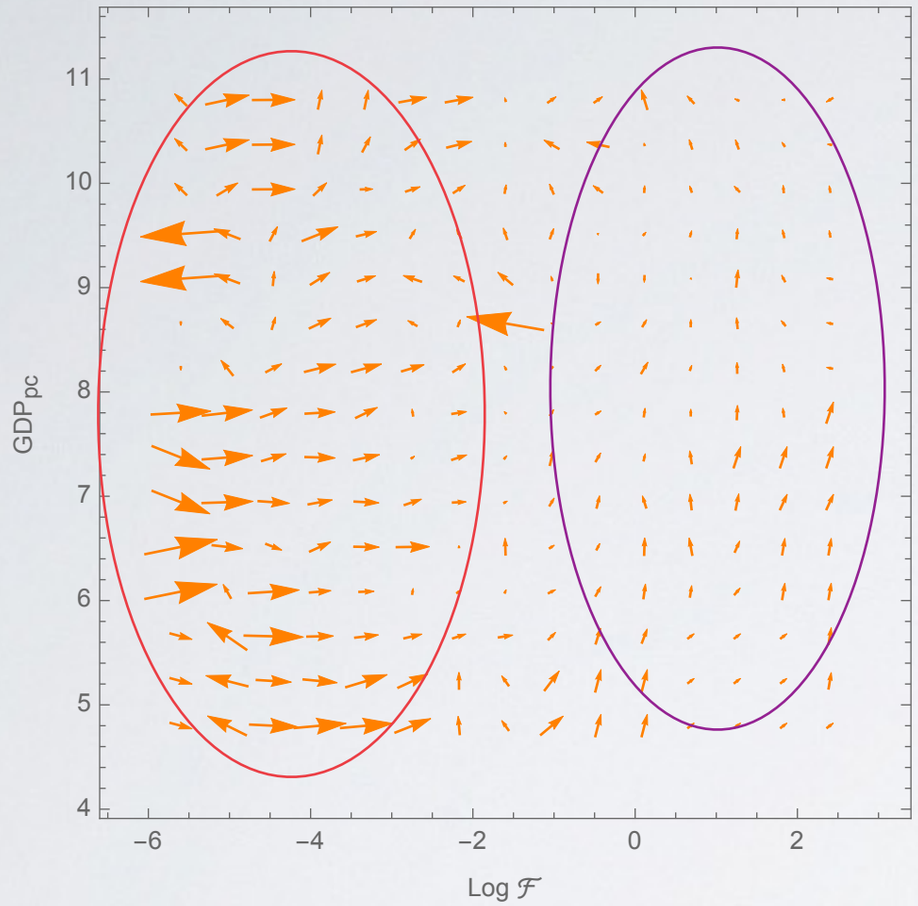

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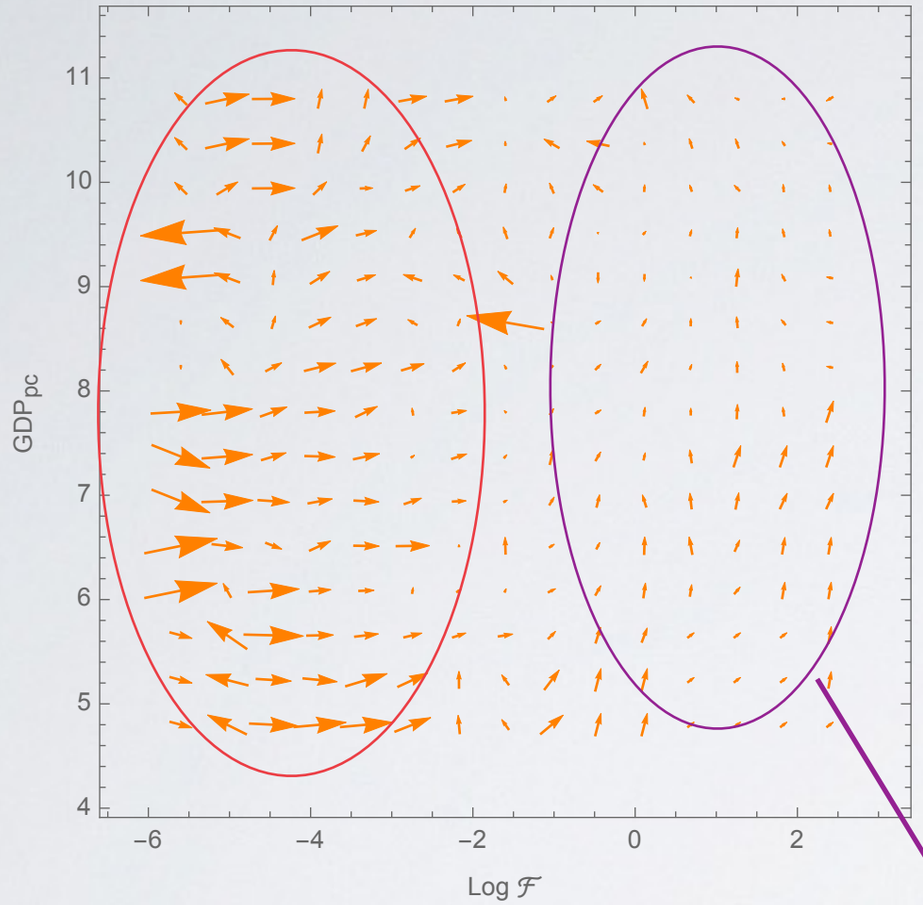

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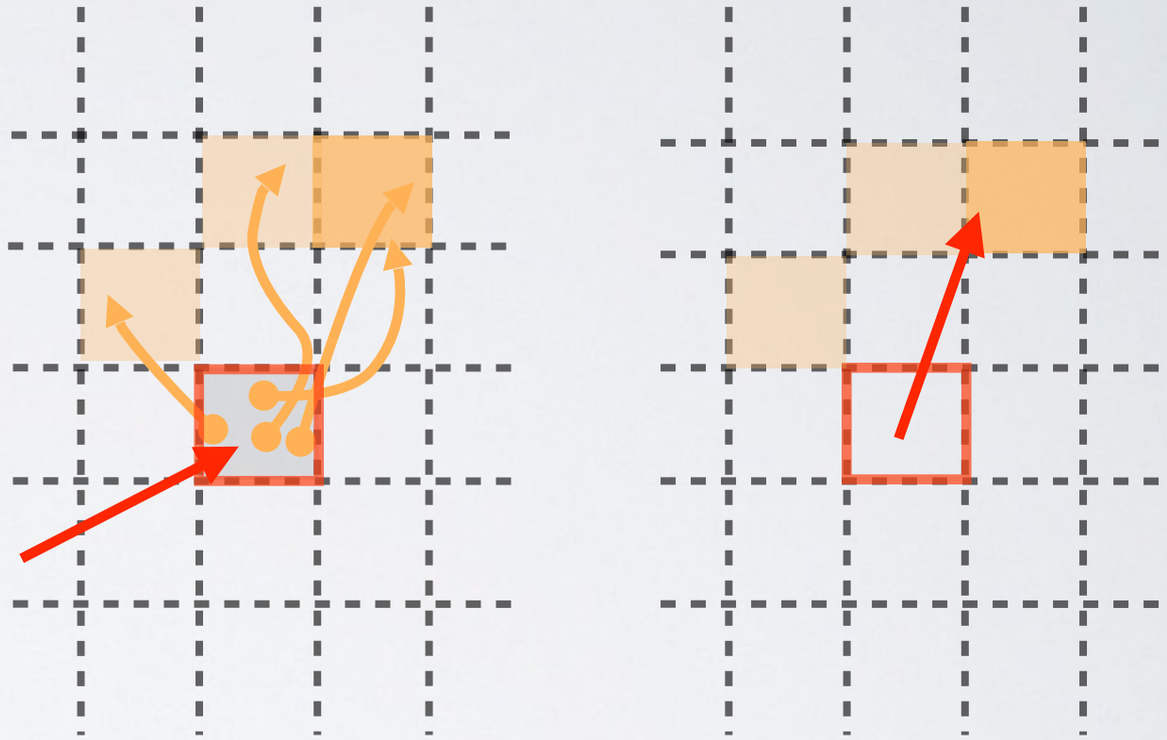

Laminar and predictable region

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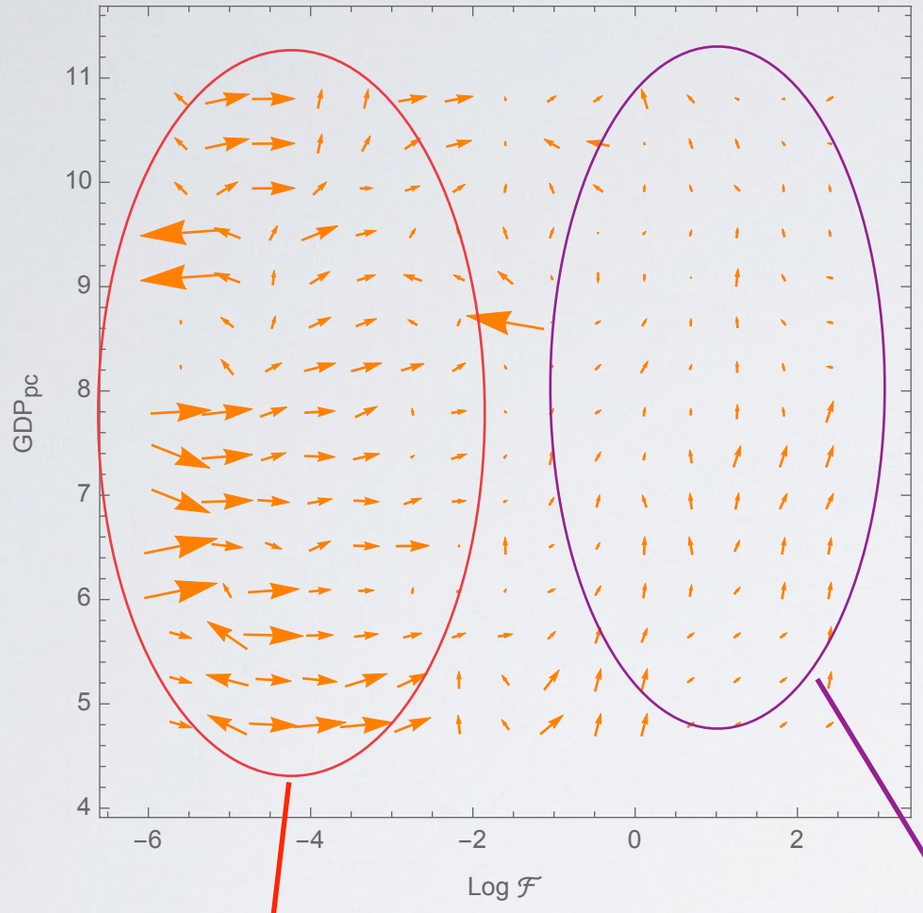
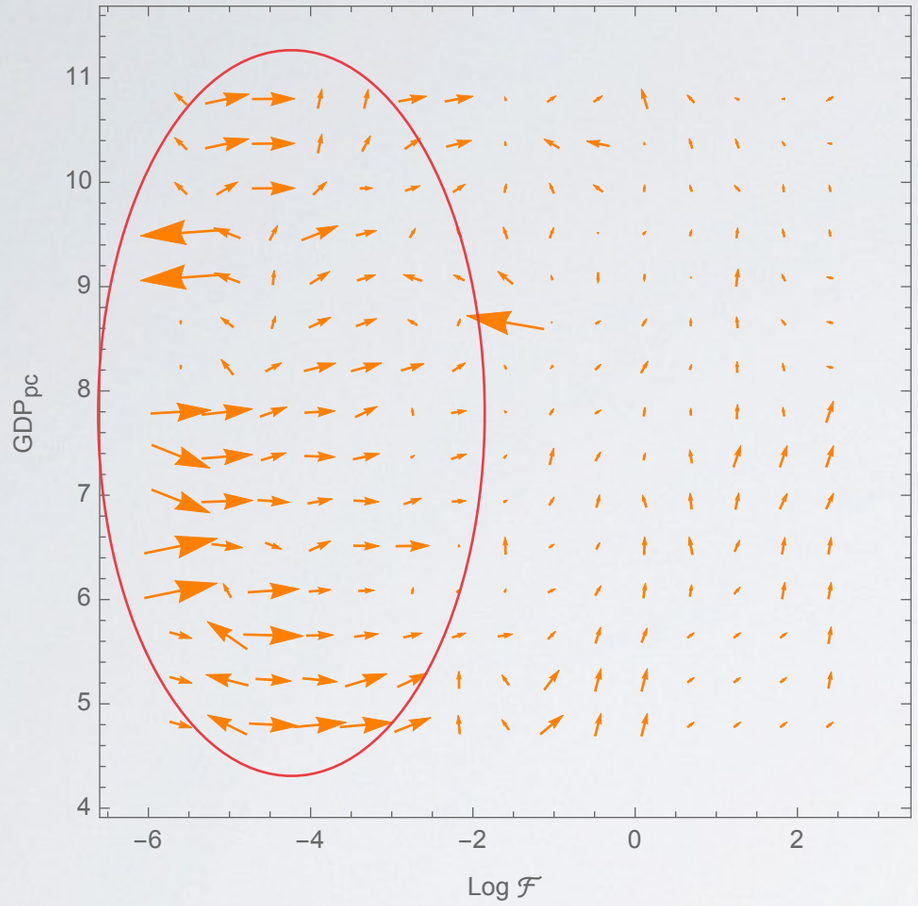


Chaotic and unpredictable region

The plane GDP-Fitness can be used to predict a country growth by looking at the trajectories of all the other countries that were near to its current position

Laminar and predictable region

CAOS OR NOISE?



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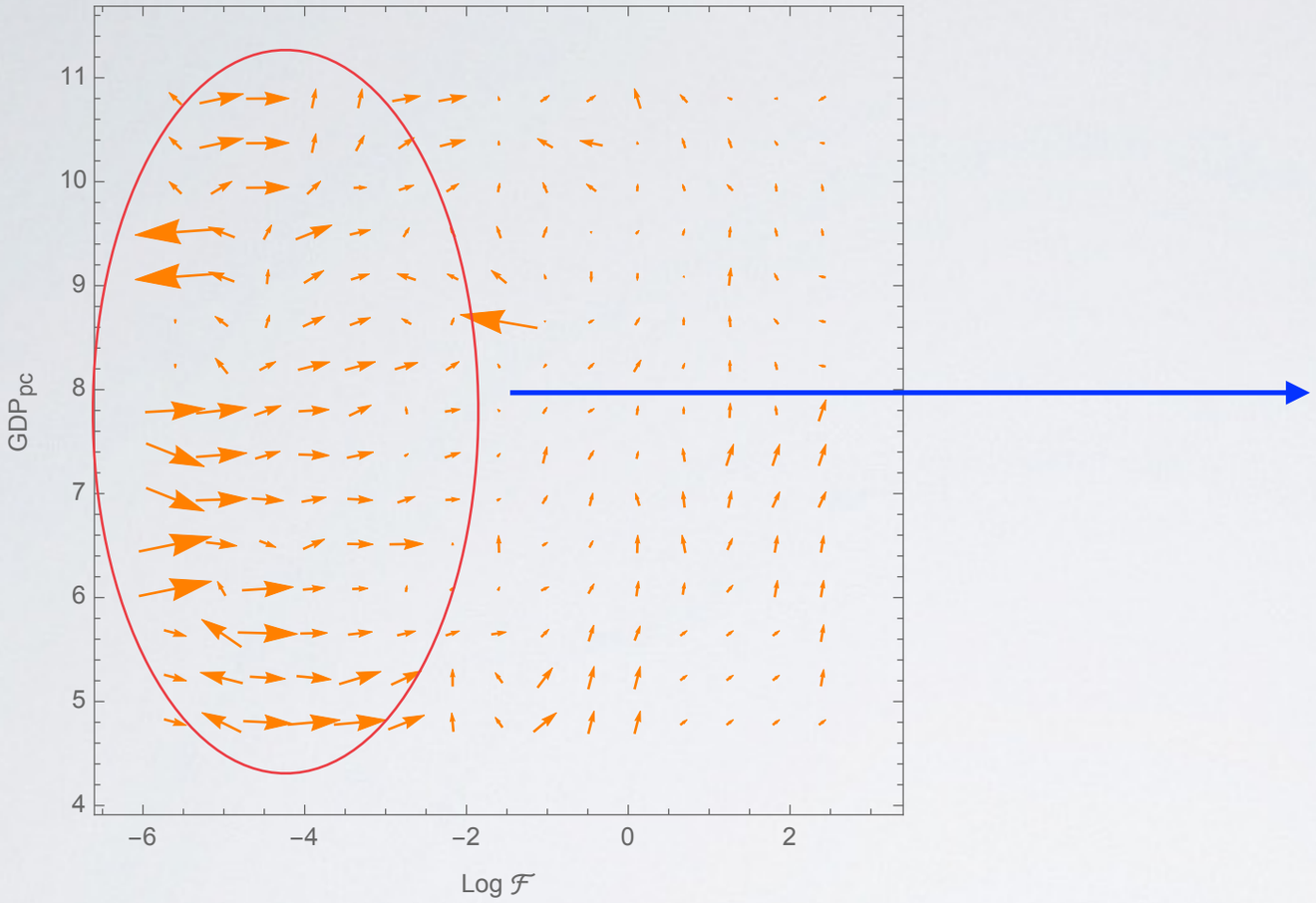

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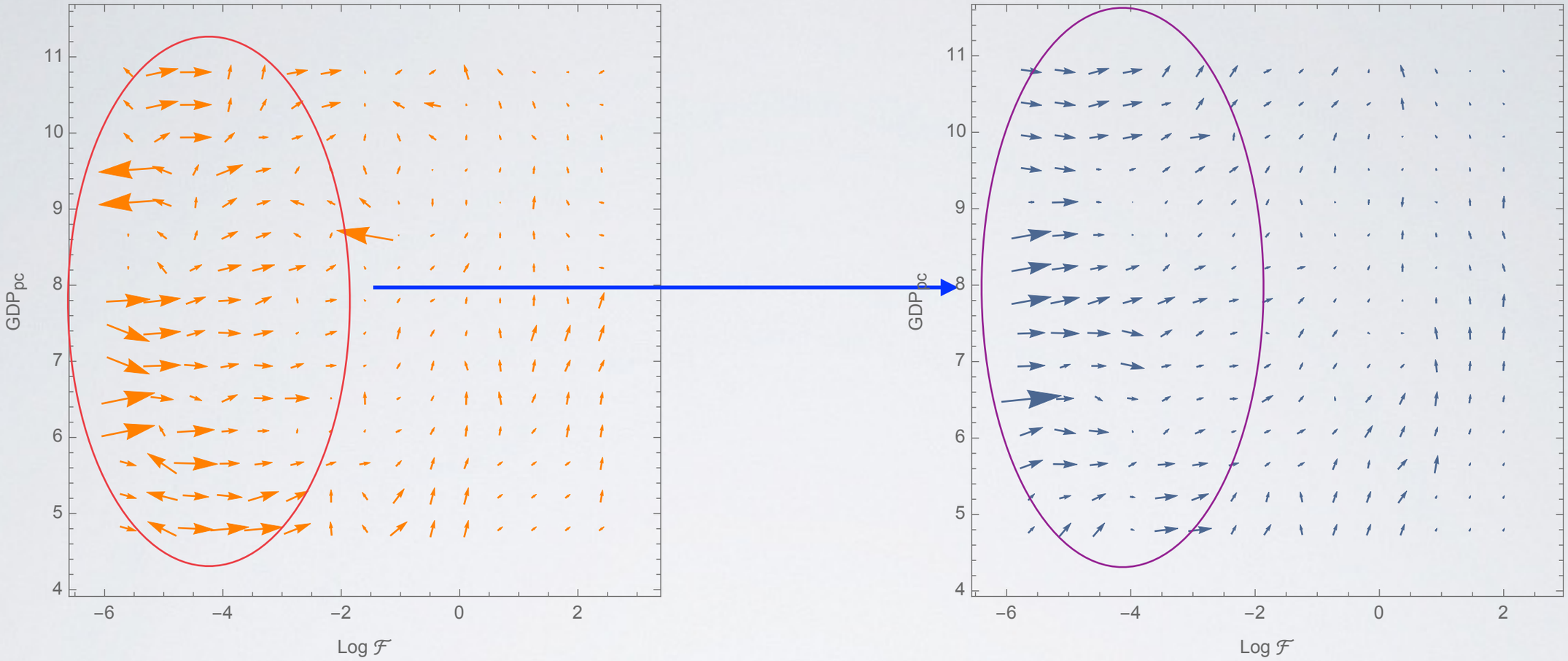

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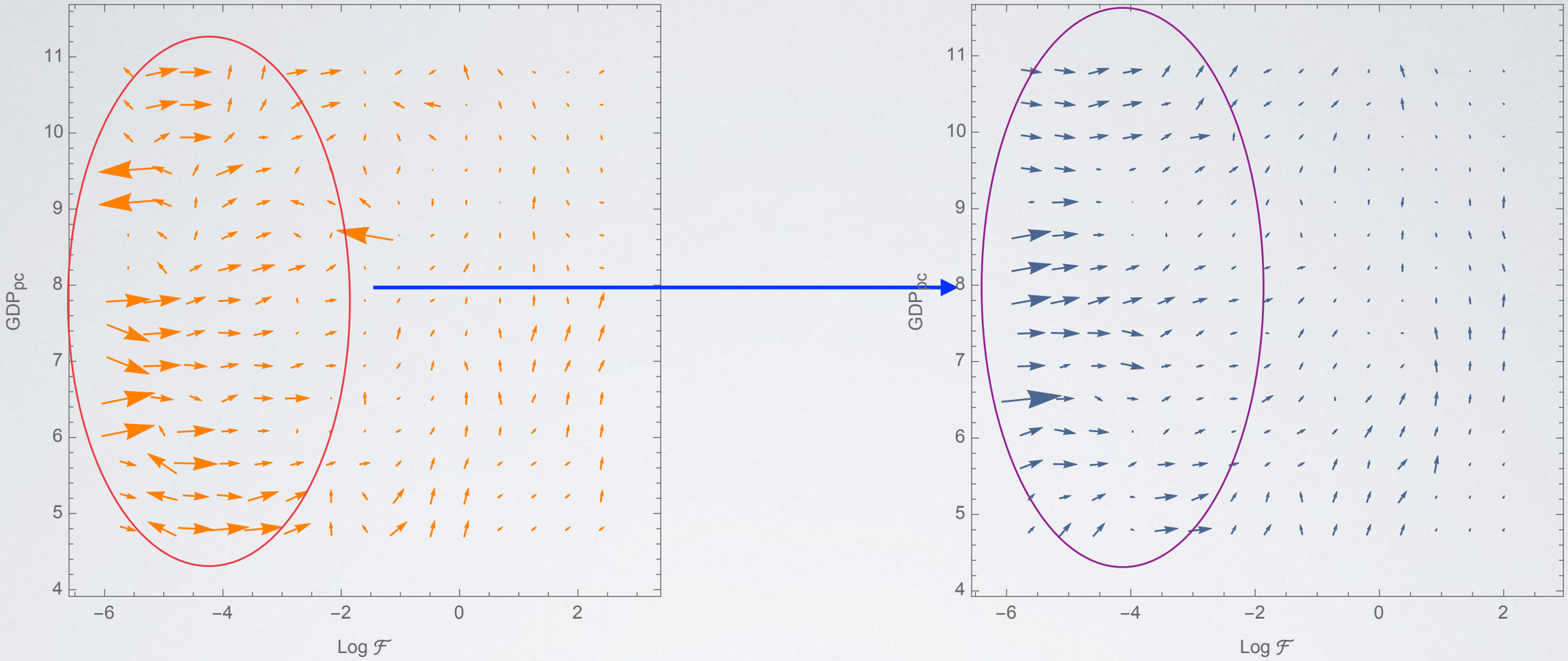
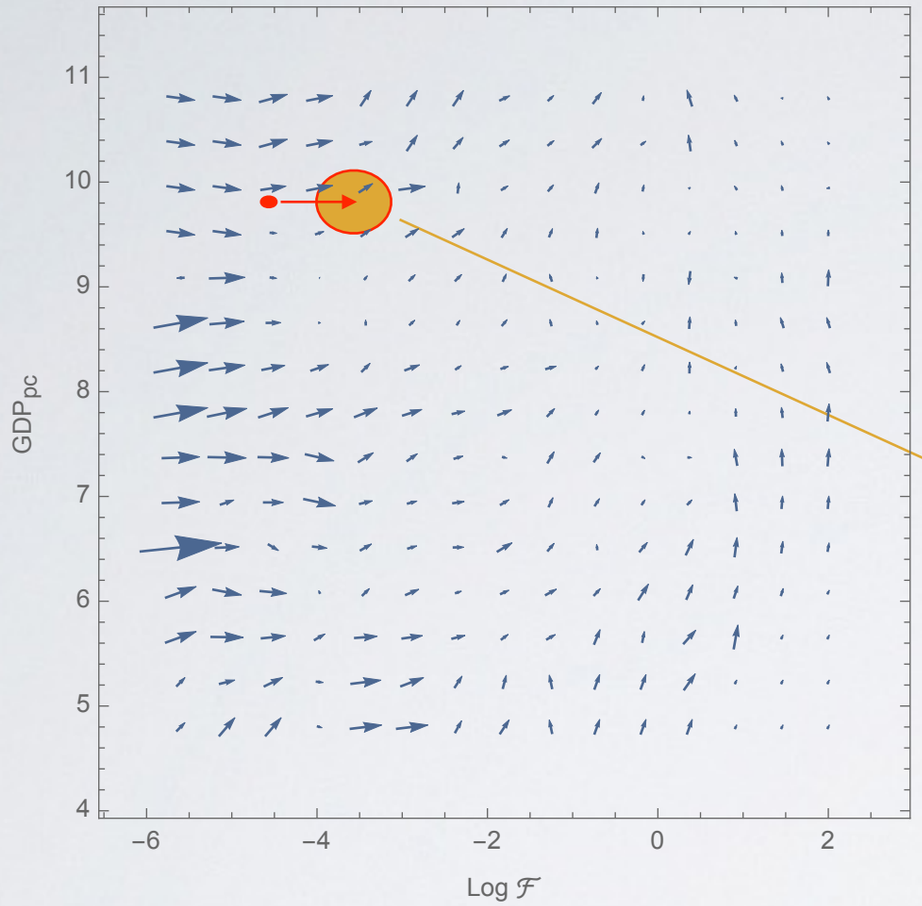
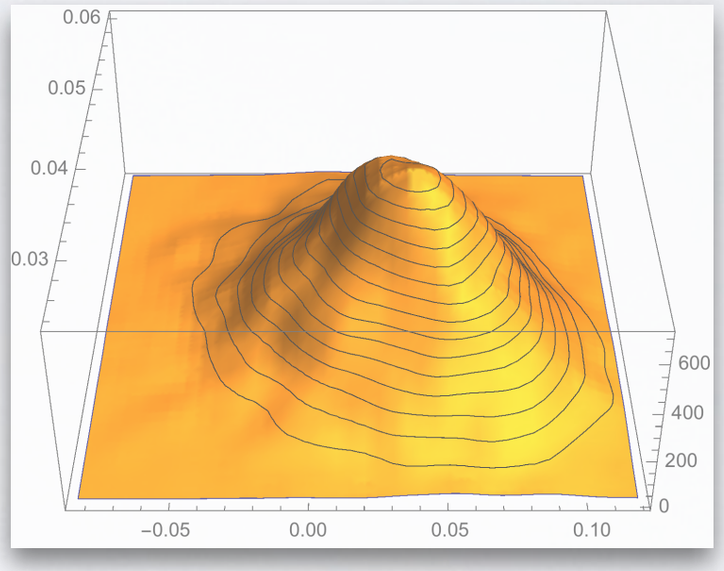


The chaotic region of the plane has low fitness, that means a stronger sensibility to noise due to the lower number of products exported.

enhancing the selective predictability scheme



For each point we can construct a distribution for the annualized growth using the bootstrap method (spsb)

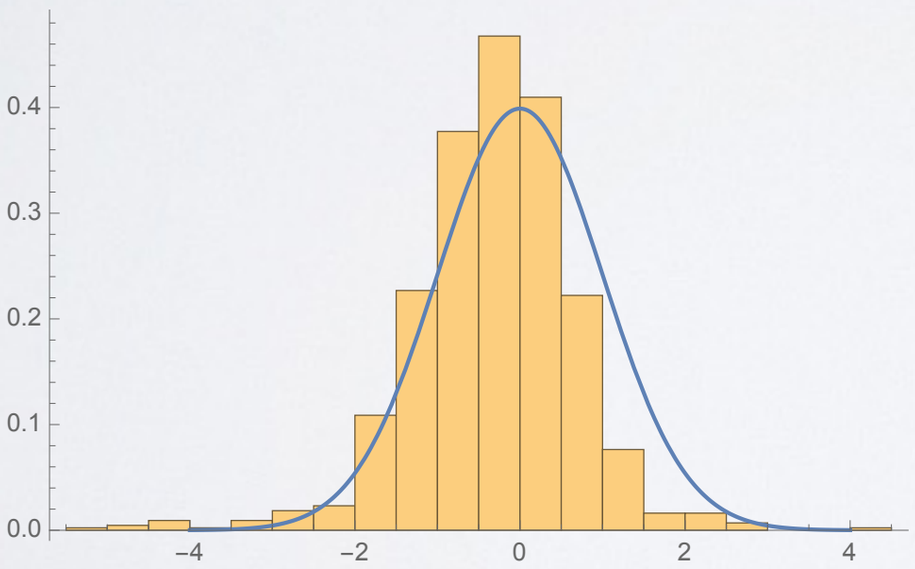


These distributions contain the information of the trajectories of the entire plane weighed by the distance from the starting point

enhancing the selective predictability scheme

How reliable are these distributions?

- Each single distribution has only one experimental point
- To compare errors in the entire dataset we standardize each point with its associated distribution
- We compare the resulting histogram with a Normal (0,1)



$\mu = -0.3$

$\sigma = 0.98$

The spsb is quite reliable in the errors estimation

COMPARISON BETWEEN METHODS

Annualized growth in the years 2005-2010

	MAE	RMSE
IMF*	2.03	3.05
SPS*	2.01 1%	2.64 13%
SPSB	1.99 2%	2.57 16%
SPSB+HMM	1.92 5%	2.48 19%

*Cristelli, M., Tacchella, A., Cader, M., Roster, K., & Pietronero, L. (2017). On the predictability of growth.