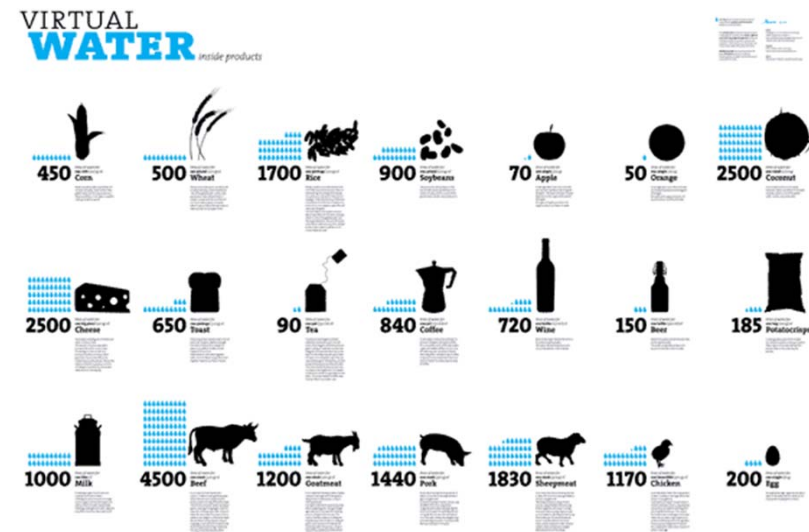


Virtual water and trade

What economists say



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Motivation

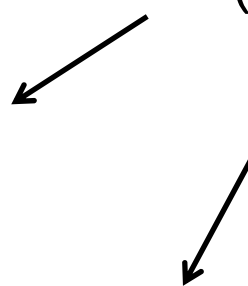
- **Concepts** of Virtual Water (VW) and Water Footprints (WF) are **widely linked to trade issues**
- **Normative criteria** (implicit or explicit) how trade patterns should look like w.r.t. water scarcity/endowment
- **Trade is subject to either expectations (water savings, water use efficiency) or concerns (fairness, participation)** – in either case it is suggested that **trade should be (re-) organised according to water availability**
- **Consequently, trade-restricting instruments are suggested (border taxes, tradable WF permits)**
("from accounting to global water governance")

Normative framework to evaluate consumption and trade in the VW literature

(Resource) Efficiency

- VWA reveals efficiency gains through virtual water trading (global savings) and uncovers efficiency deficits in current trade patterns
- Strengthening of VW trade and alignment to a “global water use efficiency” (equalisation of water distribution) (Allan 1997; HOEKSTRA/HUNG 2003)

trade should be
(re-) organised
acc. to water
issues



Fairness

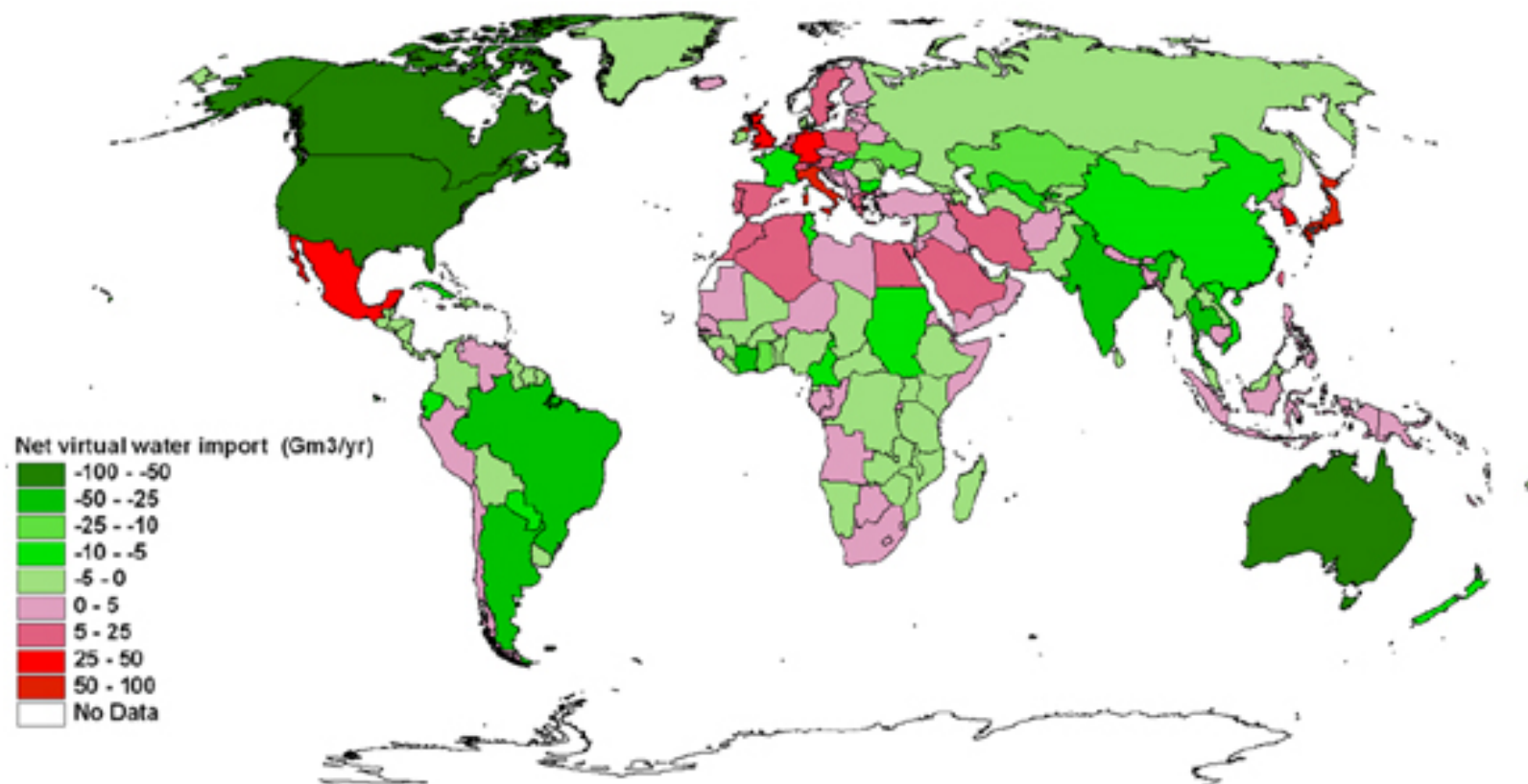
- VWA reveals fairness deficits in both consumption and trade patterns
- Restriction of VW trade and alignment to fairness norms (“virtual water for all” – ZEHNDER 2010)

Research Questions

- **What can VWA tell us about the “right direction” or the “right volume” of foreign trade?**
- **Is there a need for a global water governance reorganising trade w.r.t. water availability?**



Empirical findings: net exporters / net importers



www.waterfootprint.org

Water scarcity and import dependency

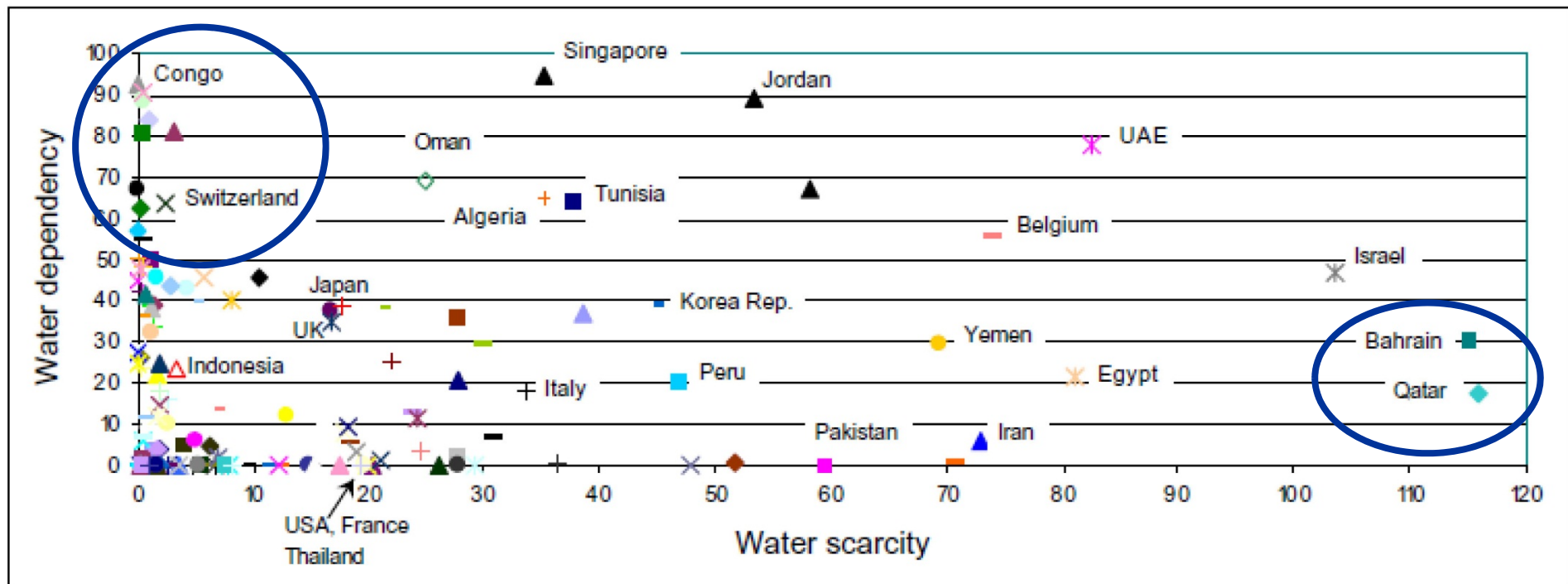
– do they correlate?

Water Scarcity (in %)

= domestic use / water availability

Water Dependency (in %)

= $NVWI / (DU + NVWI)$, if $NVWI > 0$
„import quota“



HOEKSTRA/HUNG (2003); KUMAR/SINGH (2005)

Empirical evidence

KUMAR/SINGH (2005): 131 countries

- **Water availability without clear impact on trade volumes or trade flows**
- **More significant impact by availability of (arable) land:**

often: trade **flow from “water-scarce, but land-abundant” countries to “water-abundant, but land-scarce” countries**



Empirical evidence

KUMAR/SINGH (2005)

- **The Netherlands:**
water-abundant,
but land-scarce:
net importer



- **Kazakhstan:**
water-scarce, but land-
abundant: **net exporter**



From empirical evidence to economic theory

- **Theoretically, these findings are hardly surprising:** water is just one single trade determining production factor – besides land, labour, capital and knowledge/production technology!
- It can be shown in a simple **Heckscher-Ohlin-model** that
 - ... **relative endowment of water is not decisive for trade direction,**
 - ... **relative endowment should not be relevant either for reasons of welfare**

Heckscher-Ohlin-Theorem and virtual water trading

HO-Theorem: 2-goods-2-factors(W,K)-2-countries-model

A country turns out to be an exporter of the very good that is using the relative abundant factor more intensively.

→ water-abundant countries as net exporters?

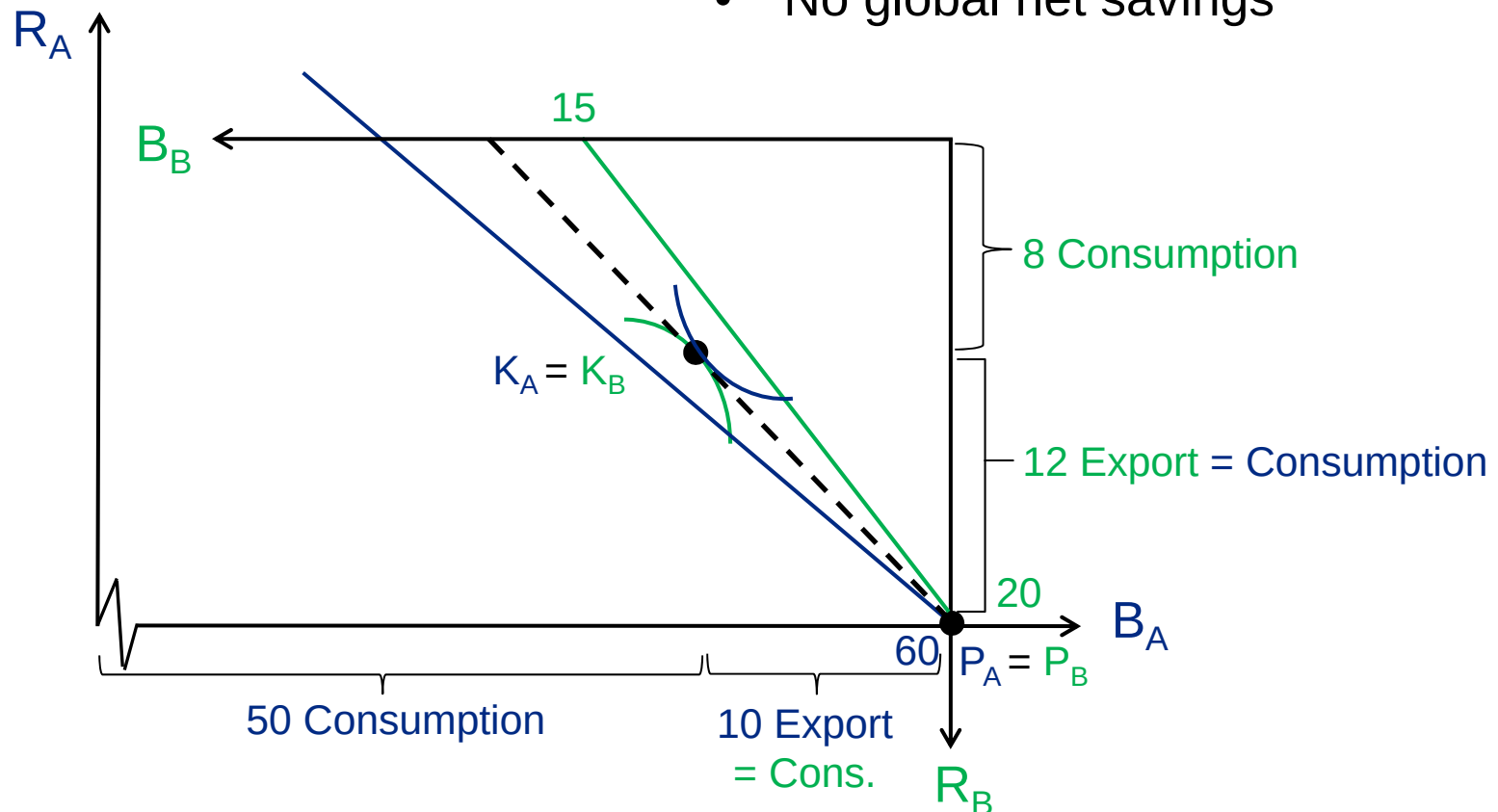
Not necessarily! HO-Theorem is based on **relative abundance** ($W_1/C_1 > W_2/C_2$) between countries, not on absolute factor scarcity.

Therefore, a relatively water-rich country ($W_1 > W_2$) may be at the same time a net importer of VW (ANSINK 2010).

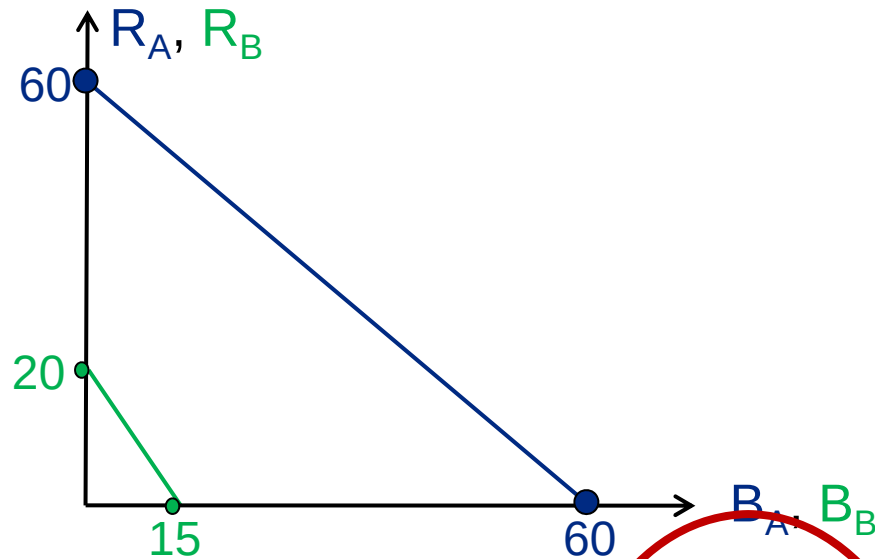
H-O-Model

Trade Equilibrium

- Water-abundant country A imports water-intensive cotton
- No global net savings



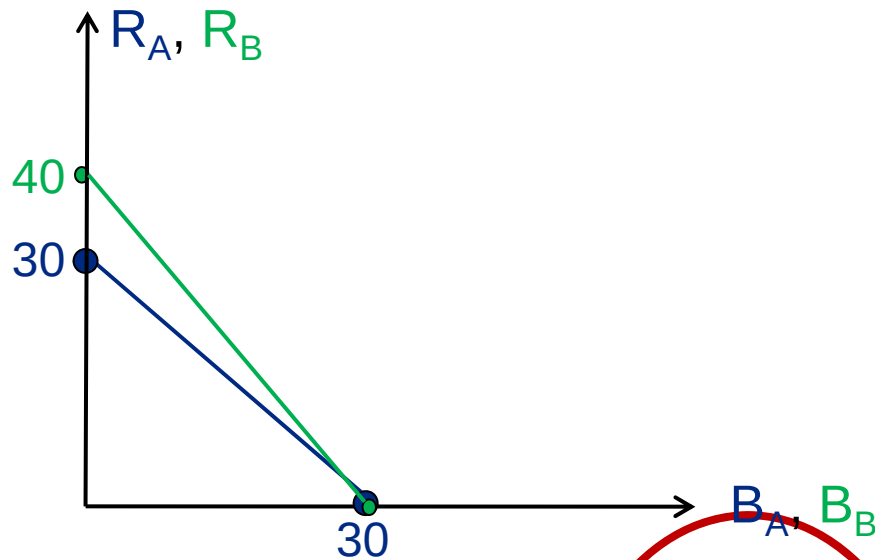
H-O-Model



What happens if the water endowment is inverted?
(„impoverish the haves,
enrich the have-nots“)

Country	Product	Yield (t/ha)	Water Availability (1.000 m³)	Water Demand (1.000 m³/t)	Area (ha)	Maximal Production (t)
A	Rice	6	180	3	40	60
	Cotton	2				60
B	Rice	4	90	4,5	40	20
	Cotton	1		6		15

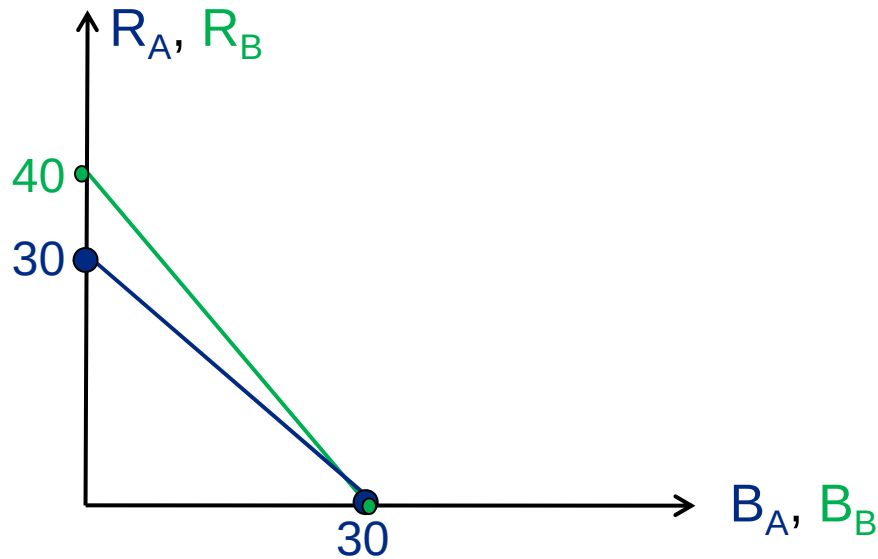
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B	Rice	4	180	4,5	40	40
	Cotton	1		6		30

H-O-Model



Opportunity costs and comp. advantages unchanged!

Country	Product	Yield (t/ha)	Water availability (1.000 m³)	Max. Production (t)	Opportunity Costs (per t)	Comparative Cost Advantage
A	Reis	6	90	30	1 (t cotton)	
	Baumwolle	2		30	1 (t rice)	X
B	Reis	4	180	40	0,75 (t cotton)	X
	Baumwolle	1		30	1,33 (t rice)	

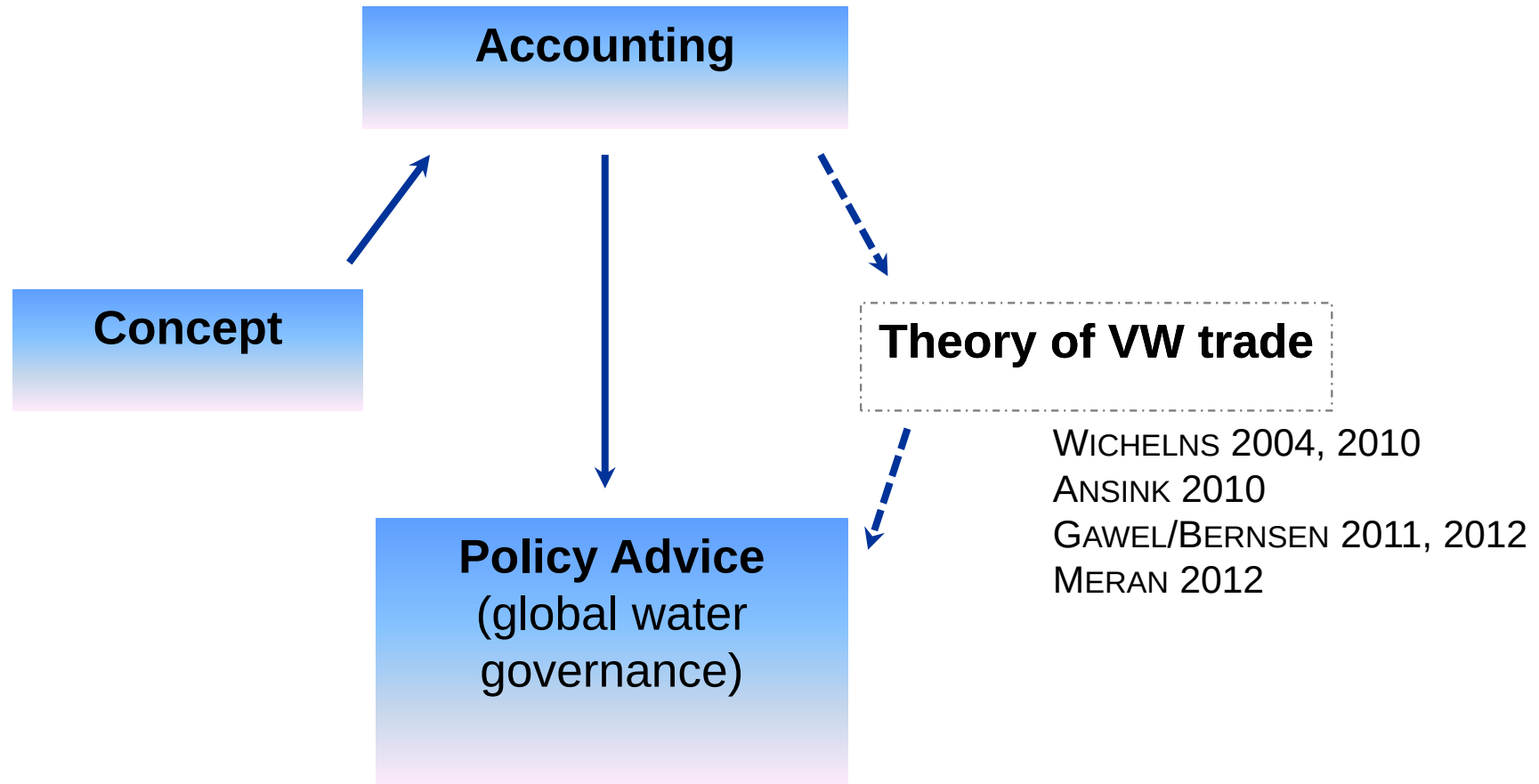
H-O-Model

Overall Findings:

- **No distinct relation between** water availability and trade position
- **Reorganising trade flows according to “water efficiency” causes welfare losses**
- Foreign trade may result in **global water savings but doesn't have to!**



The missing link: economic theory



Water Footprint vs. Carbon Footprint

Carbon Footprint



aggregates **homogeneous impacts**;
comparability of impacts: yes!

But: Still no economic decision can be made on where to mitigate! Information on heterogeneous abatement costs missing!

Water Footprint



aggregates **heterogeneous uses**;
comparability of impacts: no!

Additionally: no information on heterogeneous opportunity costs of water use and of preferences: **no economic decision can be made**

Alternative approach: fairness of VW flows

- Recent literature turns towards fairness issues:
VW trading becomes subject to manifold critique
- No consensus on fairness norms:
“everything is problematic”

Fairness of VW flows

Problems:

- **Ambiguity / arbitrariness of distribution norms**
- **Implications of “fair share” approach for resource endowments remains unclear**



May refinements of the concept overcome the flaws?

- Green, blue und gray water (FALKENMARK 2003)
 - Weighting with shadow prices (BIEWALD ET AL. 2011)
 - Non-sustainable vW (SCHUBERT 2011)
-
- ➔ Confession of the flaws of basic concept
 - ➔ Fragmentation of approaches
 - ➔ Still no solution of fundamental problems



May refinements of the concept overcome the flaws?

- Is green water really irrelevant?
(= blue water as indicator of opp. costs?)

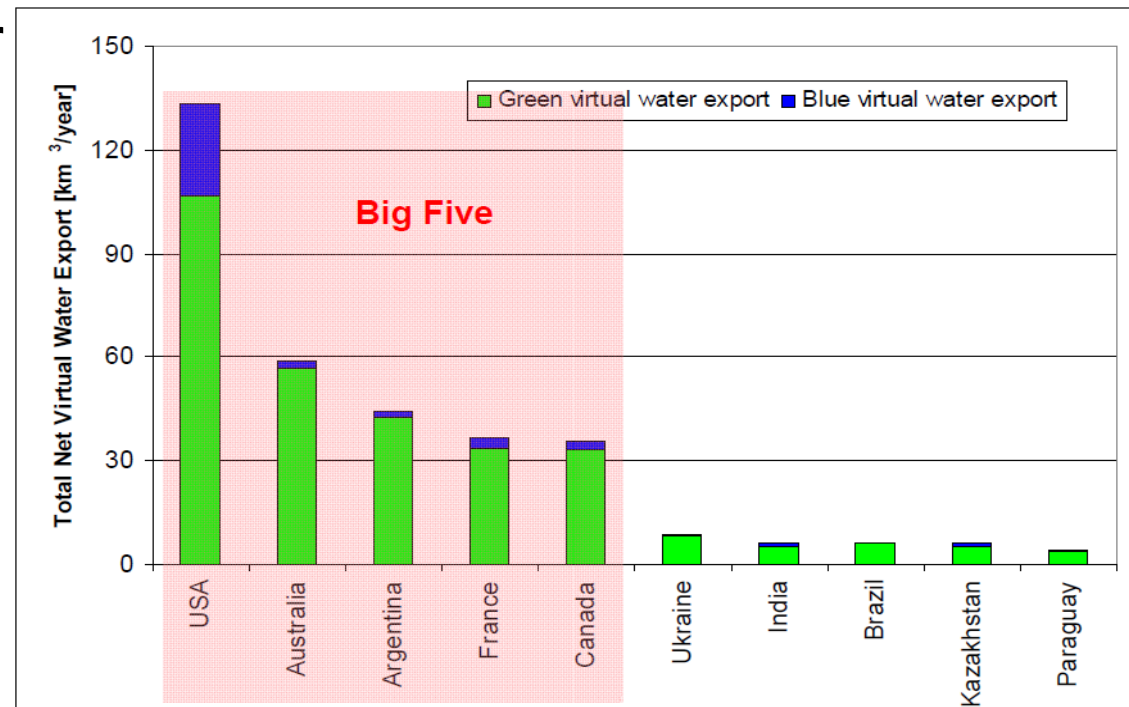
➔ About 94% of VW in agrarian trade is „green“

LIU ET AL. 2009

➔ Distinction not clear

➔ Green water is not free of opportunity cost!

➔ Blue water with variable opp. costs



Conclusions

- **Trade restrictions or „reorganisations“ should not be based on VW accountings only**
- **Solution of water- and trade-related problems preferably in the respective arenas, not crabwise**
(„Don't kill the messenger“ LEVERNOY/MESSERLIN 2011)
- **Merely quantitative-based global interventions don't solve the genuine problems, but create new ones (distortions)**
- **International environmental and trade policy should not be oriented to (contradictory) policy recommendations based on VWA.**



Conclusions

- **Mere quantitative accounting** (neglecting costs and preferences) **do not provide appropriate information for economic or political decision-making** on water resources use or on (global) water governance



Thank you for your attention!

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