Paper proposal for the online workshop

”The Frontiers in Growth Regimes Research: Theoretical Perspectives and Country Cases”

Using Contribution-to-Growth Curves to Measure Growth Models

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The purpose and outline of the paper

- The purpose of our paper is to offer a new method to operationalize the demand component relative contribution to growth (RCGs) in order to trace changes of countries' growth model and to compare growth model.
- We show that the conventional method to measure RCGs is problematic for three key reasons: (1) the results are distorted for zero growth rates; (2) it does not account for spill-over between demand components; and (3) it does account for changes of the economy within the same growth model.
- We offer an alternative method operationalization which overcome these problems.
- We demonstrates the usefulness of our method by measuring the consumption, export and net-export RCGs for six countries (Germany, the US, Sweden, Ireland, Italy and Korea).

Contribution-to-Growth index

Defined as the demand component change rate multiplied by the relative size of the demand component:

$$C \cdot \frac{C}{Y}$$

- Weakness: Cannot be used for comparing different periods or different countries, because of changes in the GDP growth rate.

Relative Contribution to Growth Index (RCG)

Defined by dividing the contribution-to-growth by the GDP growth rate (y)

$$Consumption\ RCG = \frac{c}{y} \cdot \frac{C}{Y} = \frac{\Delta C/C}{\Delta Y/Y} \cdot \frac{C}{Y} = \frac{\Delta C}{\Delta Y}$$

- The problem of zero growth
- The problem of spillover
- The problem of dynamics.

Deducting Demand Components' Relative Contribution-to-growth

$$Y = C + I + G + (EX - IM)$$

(1) $$y = c \cdot \frac{C}{Y} + i \cdot \frac{I}{Y} + g \cdot \frac{G}{Y} + \left[ex \cdot \frac{EX}{Y} - im \cdot \frac{IM}{Y}\right]$$

GDP growth as a sum of the demand components' contribution-to-growth

(2) $$1 = \left(\frac{c}{y} \cdot \frac{C}{Y}\right) + \left(\frac{i}{y} \cdot \frac{I}{Y}\right) + \left(\frac{g}{y} \cdot \frac{G}{Y}\right) + \left[\left(\frac{ex}{y} \cdot \frac{EX}{Y}\right) - \left(\frac{im}{y} \cdot \frac{IM}{Y}\right)\right]$$

Unity is the sum of the demand components' Relative Contribution to growth

(3) $$Consumption\ RCG = \frac{c}{y} \cdot \frac{C}{Y} = \frac{\Delta C/_C}{\Delta Y/_Y} \cdot \frac{C}{Y} = \frac{\Delta C}{\Delta Y}$$

(4) $$Periodic\ average\ of\ Consumption\ RCG = \frac{\sum \frac{\Delta C}{\Delta Y}}{N}$$

Problems Associated with the Relative Contribution-to-growth Index

1. The problem of zero growth

2. The problem of spillovers

3. The problem of dynamism

The Problem of zero growth

$$Y = C + I + G + (EX - IM)$$

$$(1) \quad y = c \cdot \frac{C}{Y} + i \cdot \frac{I}{Y} + g \cdot \frac{G}{Y} + \left[ex \cdot \frac{EX}{Y} - im \cdot \frac{IM}{Y}\right]$$

$$(2) \quad 1 = \left(\frac{c}{y} \cdot \frac{C}{Y}\right) + \left(\frac{i}{y} \cdot \frac{I}{Y}\right) + \left(\frac{g}{y} \cdot \frac{G}{Y}\right) + \left[\left(\frac{ex}{y} \cdot \frac{EX}{Y}\right) - \left(\frac{im}{y} \cdot \frac{IM}{Y}\right)\right]$$

$$(3) \quad Consumption\ RCG = \frac{c}{y} \cdot \frac{C}{Y} = \frac{\Delta C/C}{\Delta Y/Y} \cdot \frac{C}{Y} = \frac{\Delta C}{\Delta Y}$$

$$(4) \quad Periodic\ average\ of\ Consumption\ RCG = \frac{\sum \frac{\Delta C}{\Delta Y}}{N}$$

Moving from eq. (1) to (2) is impossible, if growth rate is zero.
For very small growth rates, the RCG is distorted upward

The Problem of Spillovers

$$Y = C + I + G + (EX - IM)$$

(1) $$y = c \cdot \frac{C}{Y} + i \cdot \frac{I}{Y} + g \cdot \frac{G}{Y} + \left[ex \cdot \frac{EX}{Y} - im \cdot \frac{IM}{Y}\right]$$

(2) $$1 = \left(\frac{c}{y} \cdot \frac{C}{Y}\right) + \left(\frac{i}{y} \cdot \frac{I}{Y}\right) + \left(\frac{g}{y} \cdot \frac{G}{Y}\right) + \left[\left(\frac{ex}{y} \cdot \frac{EX}{Y}\right) - \left(\frac{im}{y} \cdot \frac{IM}{Y}\right)\right]$$

(3) $$Consumption\ RCG = \frac{C}{y} \cdot \frac{\Delta C}{C} = \frac{\Delta C}{Y} \cdot \frac{C}{Y} = \frac{\Delta C}{\Delta Y}$$

(4) $$Periodic\ average\ of\ Consumption\ RCG = \frac{\sum \frac{\Delta C}{\Delta Y}}{N}$$

- Moving from eq. (2) to (3) assumes that there are no spillovers, and the contribution-to-growth of each demand component is channeled to GDP growth directly.
- It also assumes that as GDP growth approaches zero, so the demand component contribution-to-growth approaches zero

The Problem of dynamism

$$Y = C + I + G + (EX - IM)$$

$$(1) \quad y = c \cdot \frac{C}{Y} + i \cdot \frac{I}{Y} + g \cdot \frac{G}{Y} + \left[ex \cdot \frac{EX}{Y} - im \cdot \frac{IM}{Y}\right]$$

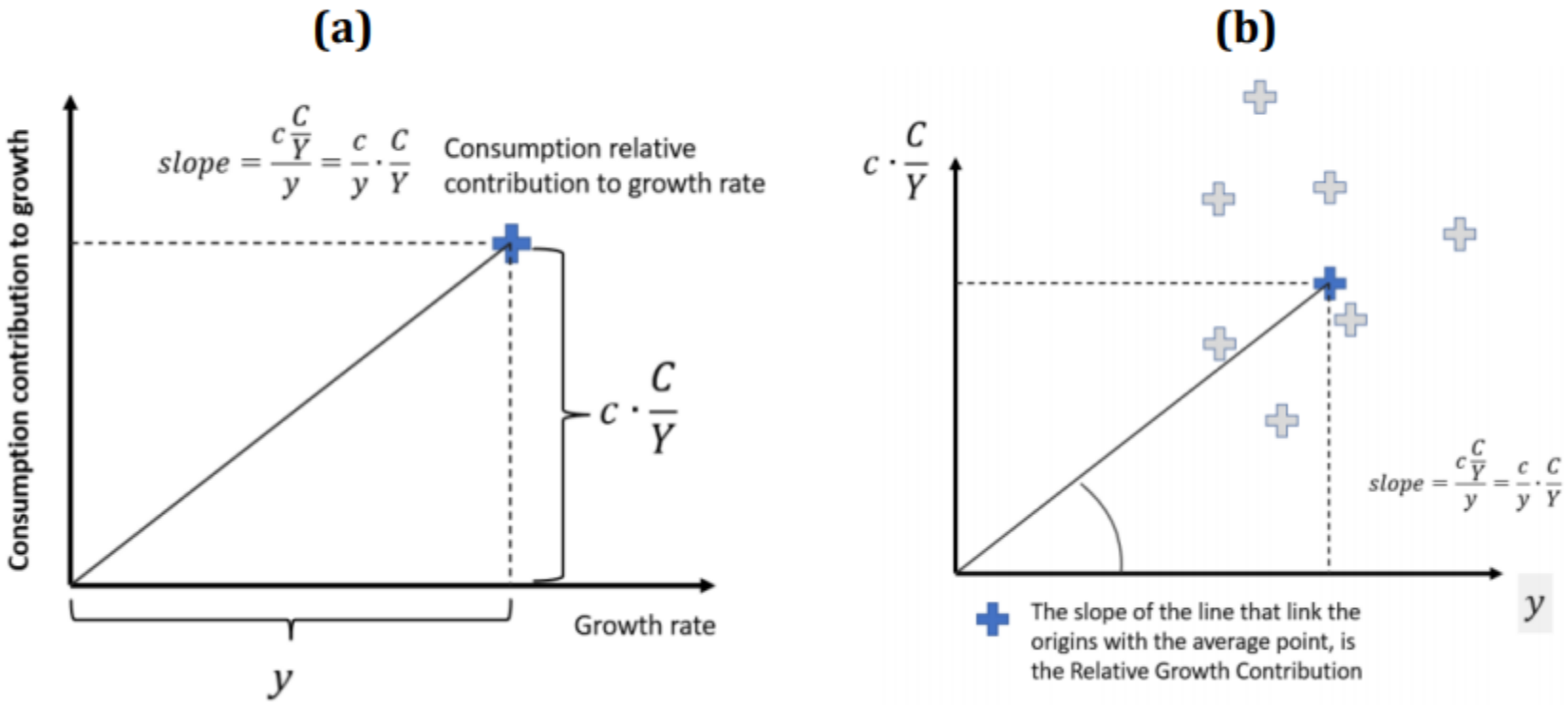
$$(2) \quad 1 = \left(\frac{c}{y} \cdot \frac{C}{Y}\right) + \left(\frac{i}{y} \cdot \frac{I}{Y}\right) + \left(\frac{g}{y} \cdot \frac{G}{Y}\right) + \left[\left(\frac{ex}{y} \cdot \frac{EX}{Y}\right) - \left(\frac{im}{y} \cdot \frac{IM}{Y}\right)\right]$$

$$(3) \quad Consumption\ RCG = \frac{c}{y} \cdot \frac{C}{Y} = \frac{\Delta C/_C}{\Delta Y/_Y} \cdot \frac{C}{Y} = \frac{\Delta C}{\Delta Y}$$

$$(4) \quad Periodic\ average\ of\ Consumption\ RCG = \frac{\sum \frac{\Delta C}{\Delta Y}}{N}$$

- The calculation of periodic average loose information regarding the variation of GDP growth rate and of the demand components' contribution-to-growth

A Graphical Presentation of the conventional definition

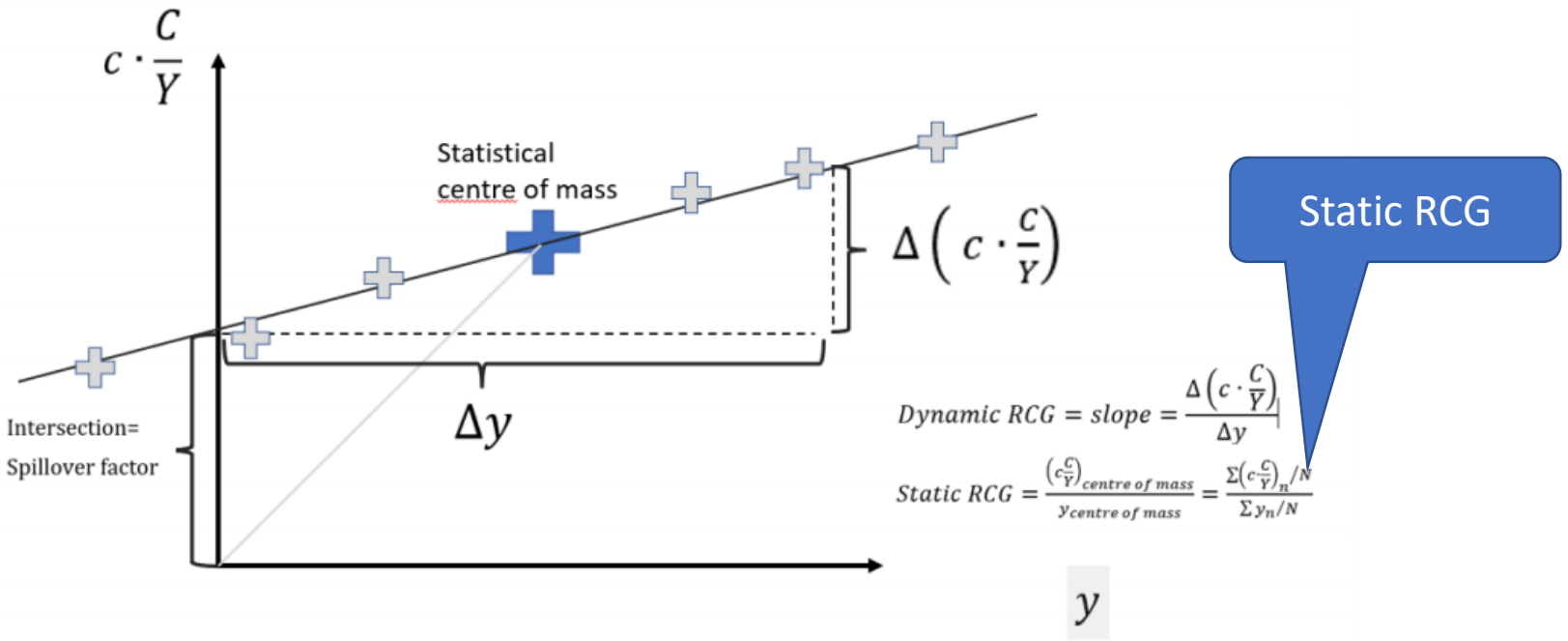


An Alternative Approach: The Contribution-to-Growth Curves

$$\left(c\frac{C}{Y}\right) = A \cdot y + B$$

Dynamic RCG

Spillover factor



Static RCG

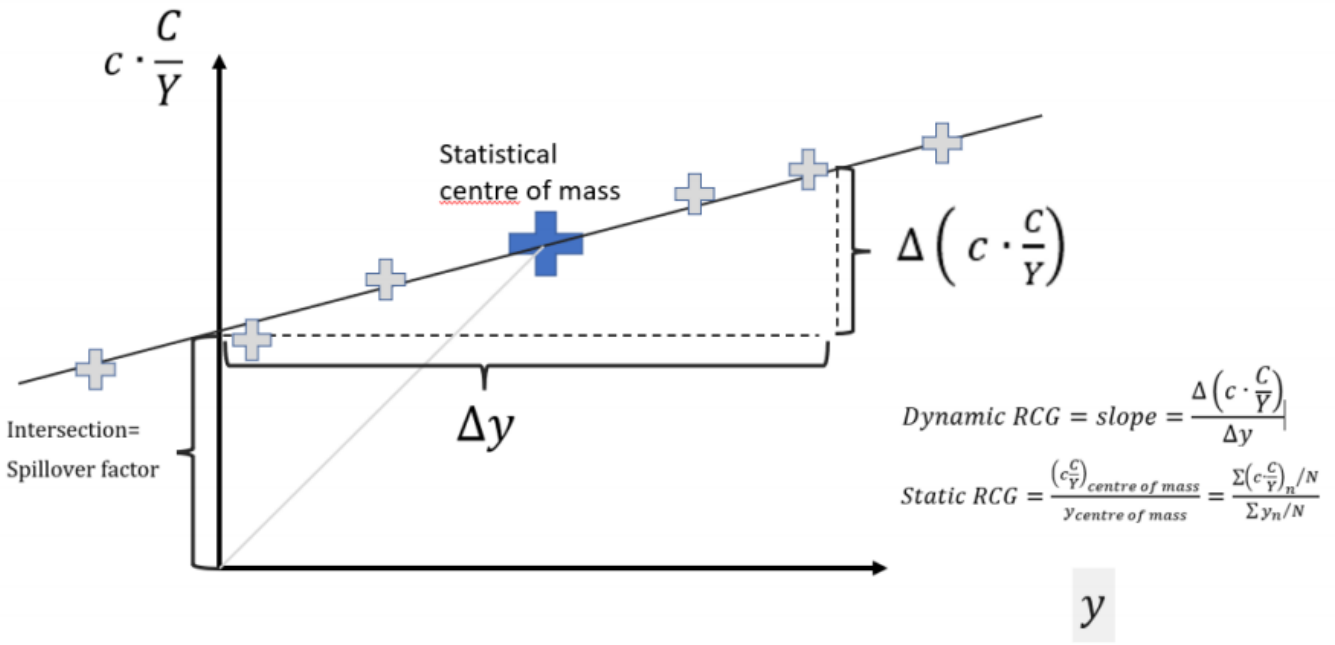
$$Dynamic\ RCG = slope = \frac{\Delta\left(c \cdot \frac{C}{Y}\right)}{\Delta y}$$

$$Static\ RCG = \frac{\left(c\frac{C}{Y}\right)_{centre\ of\ mass}}{y_{centre\ of\ mass}} = \frac{\Sigma\left(c\frac{C}{Y}\right)_n/N}{\Sigma y_n/N}$$

Dynamic (periodic) Relative Contribution to Growth

$$Dynamic\ RCG = \frac{\Delta\left(c \cdot \frac{C}{Y}\right)}{\Delta y}$$

The ratio between the portion of consumption contribution-to-growth that actually contributed to growth and GDP growth rate



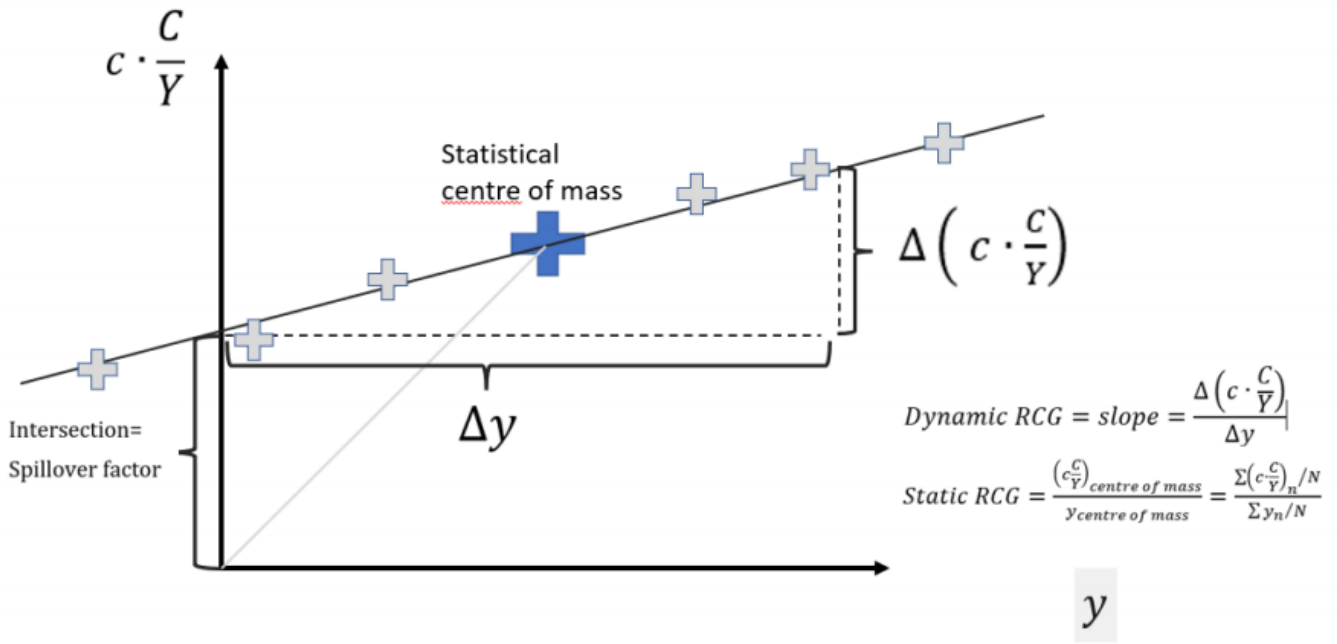
$$Dynamic\ RCG = slope = \frac{\Delta\left(c \cdot \frac{C}{Y}\right)}{\Delta y}$$

$$Static\ RCG = \frac{\left(c\frac{C}{Y}\right)_{centre\ of\ mass}}{y_{centre\ of\ mass}} = \frac{\Sigma\left(c\frac{C}{Y}\right)_n/N}{\Sigma y_n/N}$$

The Spillover Factor

$$Spillover\ Factor = \left(c \cdot \frac{C}{Y}\right)_{y=0}$$

The portion of a demand component' RCG, that spills to other demand components rather than to GDP growth



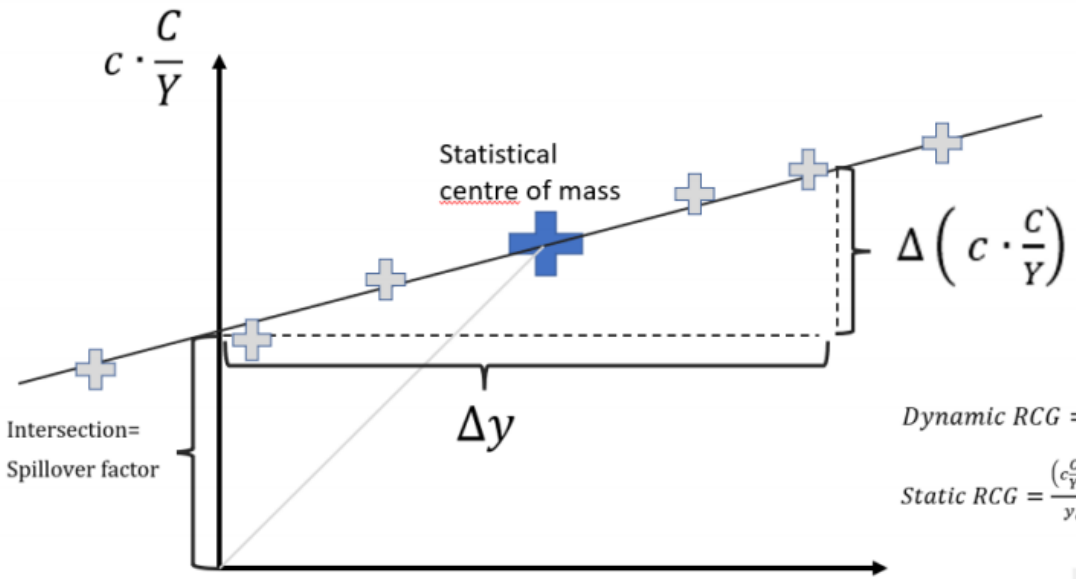
$$Dynamic\ RCG = slope = \frac{\Delta\left(c \cdot \frac{C}{Y}\right)}{\Delta y}$$

$$Static\ RCG = \frac{\left(c\frac{C}{Y}\right)_{centre\ of\ mass}}{y_{centre\ of\ mass}} = \frac{\Sigma\left(c\frac{C}{Y}\right)_n/N}{\Sigma y_n/N}$$

Static Relative Contribution to Growth

$$Static\ RCG = \frac{\left(c\frac{C}{Y}\right)_{centre\ of\ mass}}{y_{centre\ of\ mass}} = \frac{\sum\left(c\cdot\frac{C}{Y}\right)_n/N}{\sum y_n/N}$$

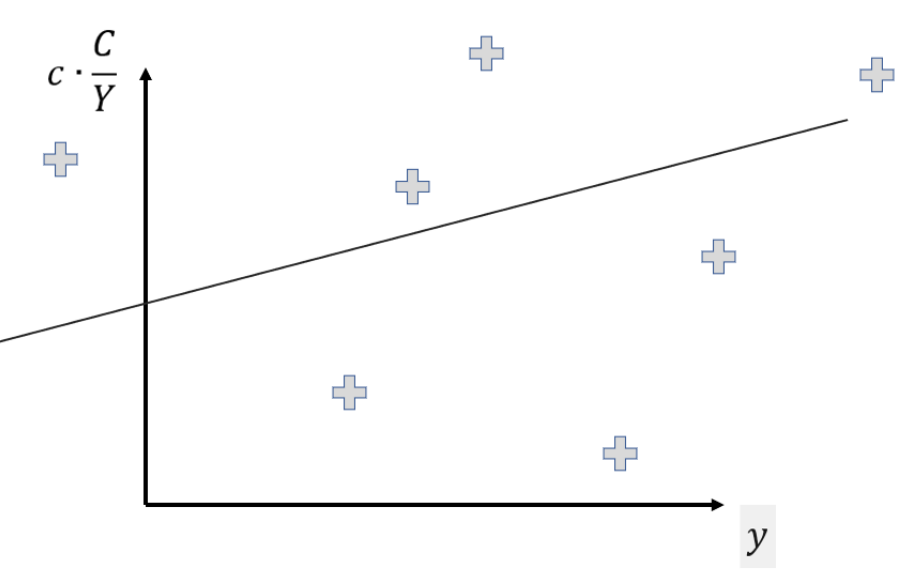
The ratio between the average demand component's contribution to growth and the average growth rate



$$Dynamic\ RCG = slope = \frac{\Delta\left(c\cdot\frac{C}{Y}\right)}{\Delta y}$$

$$Static\ RCG = \frac{\left(c\frac{C}{Y}\right)_{centre\ of\ mass}}{y_{centre\ of\ mass}} = \frac{\sum\left(c\cdot\frac{C}{Y}\right)_n/N}{\sum y_n/N}$$

Significance Indices: R-square and p-value



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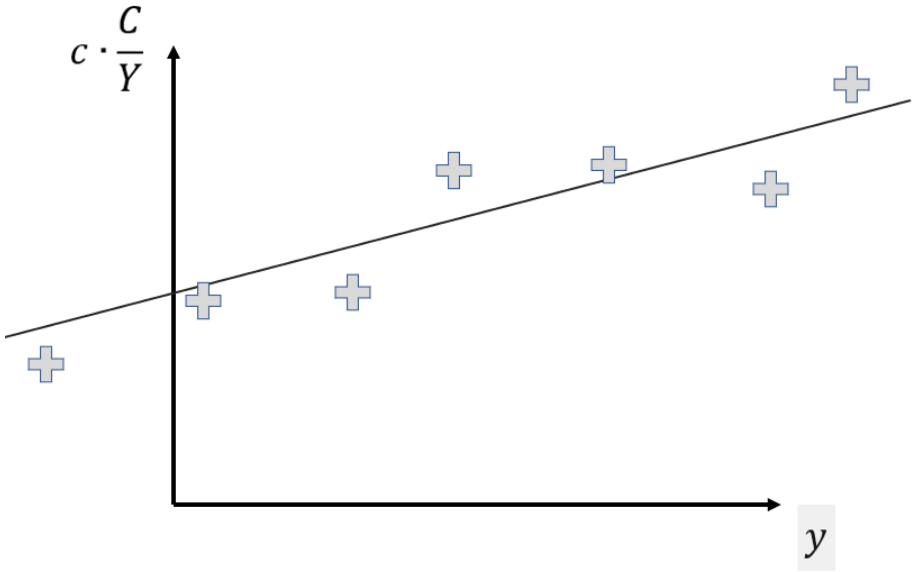

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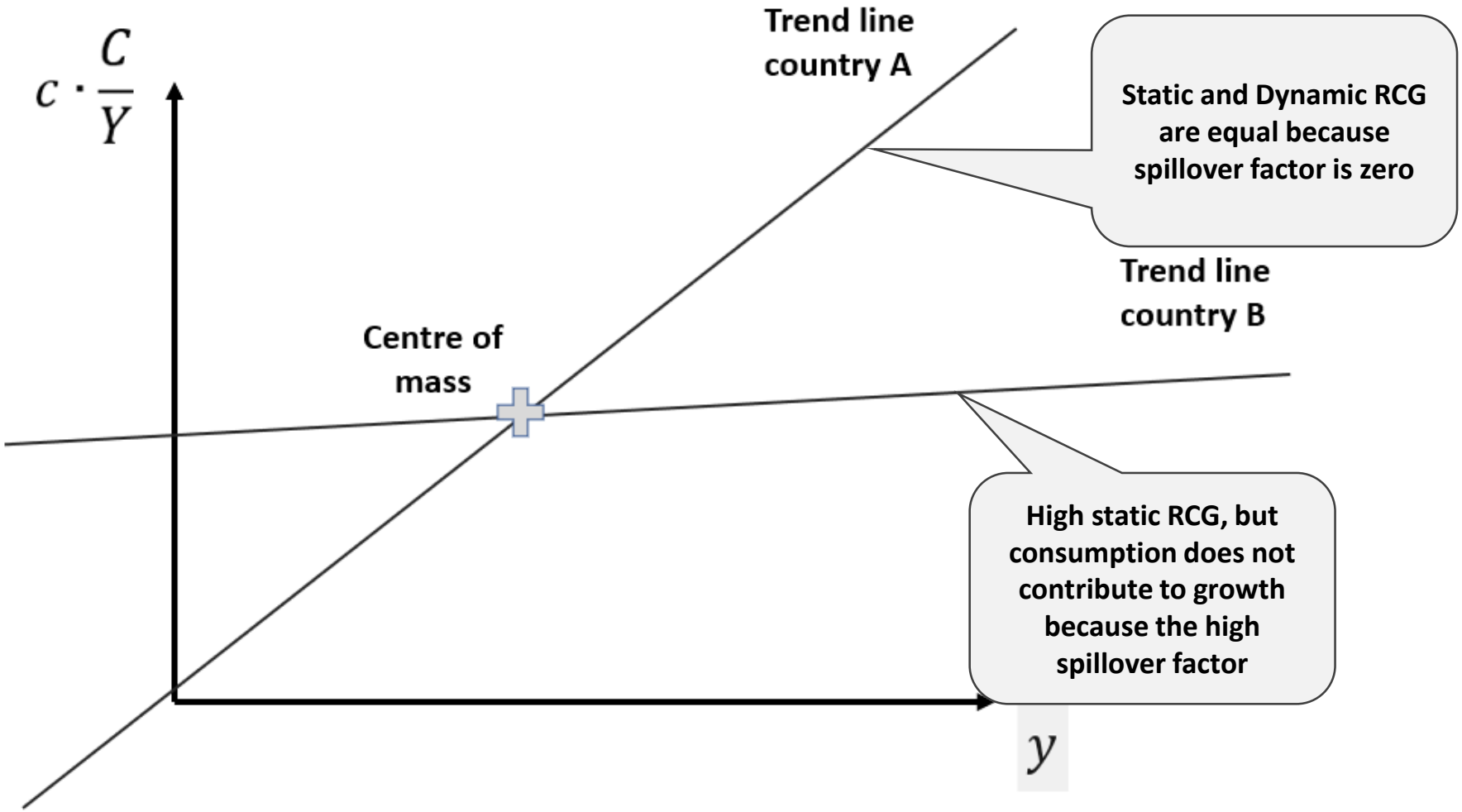
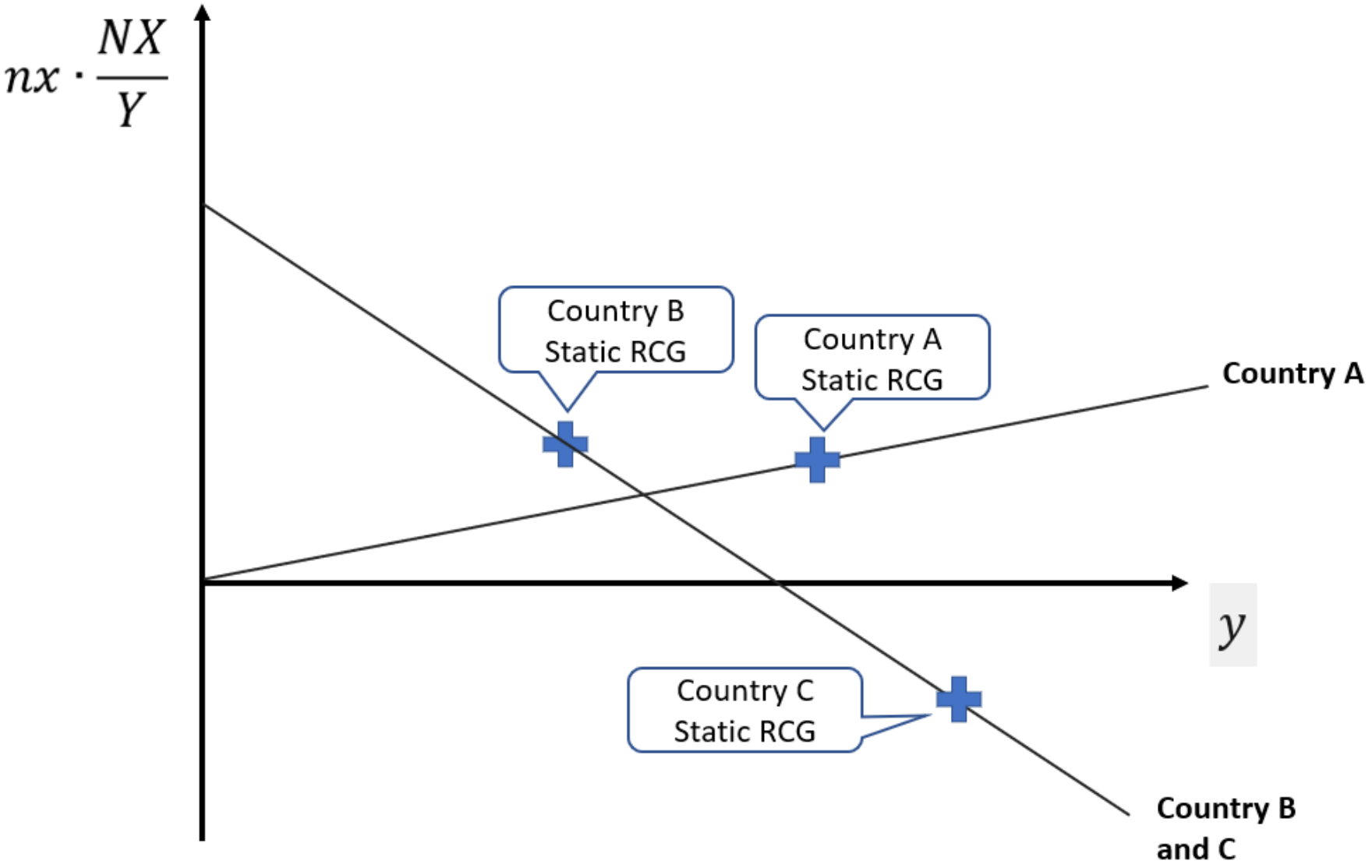
Significance Indices: R-square and p-value

Table 1: Four indicators for Characterizing Growth models and Strategy		
Name of indicator	**Meaning**	**Operationalization**
Periodic Dynamic RCG	Captures the expected increase of the Contribution-to-growth of demand component X, for each 1 percent increase of GDP growth during a defined period.	The slope of the trending line that represent the points in the *CG/GDP-Growth* space
Periodic Static RCG	Captures the position of the economy in the *CG/GDP-Growth*: the ratio between actual CG of demand component X and GDP Growth.	The slope of the line the link the origins and the "center of mass" of the points in the *CG/GDP-Growth* space
Spill over Factor	Captures the estimated spill over between demand component X and the other demand components.	The intersection point of the trend line with the CG axis (When GDP growth is zero)
R-square and p-value	Capture the robustness of the linear relationship between CG of demand component X and GDP growth	NA

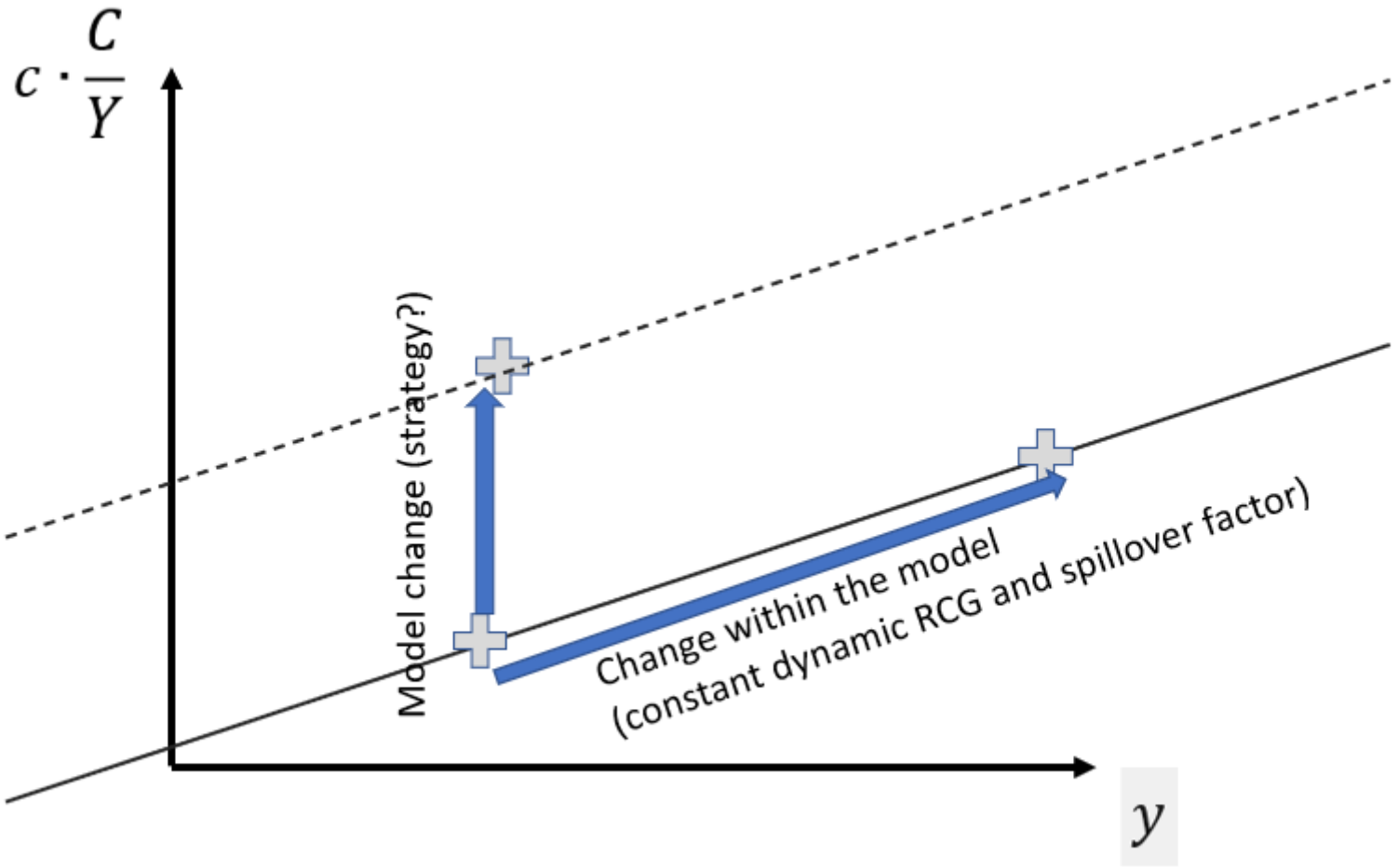
Interpreting the Contribution-to-Growth Curves- Example 1



Interpreting the Consumption-to-Growth Curves- Example 2



Change within a Model vs. Model Change



Case selection and indicators

Cases:

- Germany,
- the United States,
- Sweden,
- Ireland,
- Korea
- Italy.

- **Periods:**
  - Pre-crisis/post-crisis
- **Indicators:**

	Dynamic RCG	Spillover factor	Static RCG	R-square	P-value
Consumption					
Export					
Net-Export					

Empirical Findings

Table 8: Summary of Findings										
		Consumption			Export			Net Export		
	Period (before/after crisis)	Dynamic RCG	Spill over factor	Static RCG	Dynamic RCG	Spill over factor	Static RCG	Dynamic RCG	Spill over factor	Static RCG
Germany	Before	0.18	0.26	0.34	0.66	1.00	1.30	0.11	0.35	0.32
	After	0.024	0.71	0.38	0.99	0.07	1.02	0.27	0.33	0.10
United States	Before	0.47	0.81	0.72	0.21	0.17	0.16	-0.17	0.22	-0.10
	After	0.47	0.45	0.67	0.078	0.27	0.20	-0.42	0.77	-0.08
Sweden	Before	0.30	0.21	0.35	0.94	-0.61	0.76	0.00	0.5	0.14
	After	0.27	0.38	0.40	0.61	0.33	0.76	0.02	0.00	0.04
Ireland	Before	0.25	0.86	0.37	1.00	1.2	1.13	0.35	-1.6	0.11
	After	0.051	0.32	0.10	1.60	1.3	1.72	0.76	-3.8	0.14
Korea	Before	0.88	-2.40	0.48	0.013	2.9	0.49	-0.67	4.4	0.06
	After	0.29	0.3	0.38	0.96	-1.2	0.59	-0.26	1.0	0.05
Italy	Before	0.36	0.36	0.58	0.86	0.44	0.59	0.26	0.54	-0.07
	After	0.68	0.13	0.19	0.30	0.91	3.60	-0.51	0.51	1.34

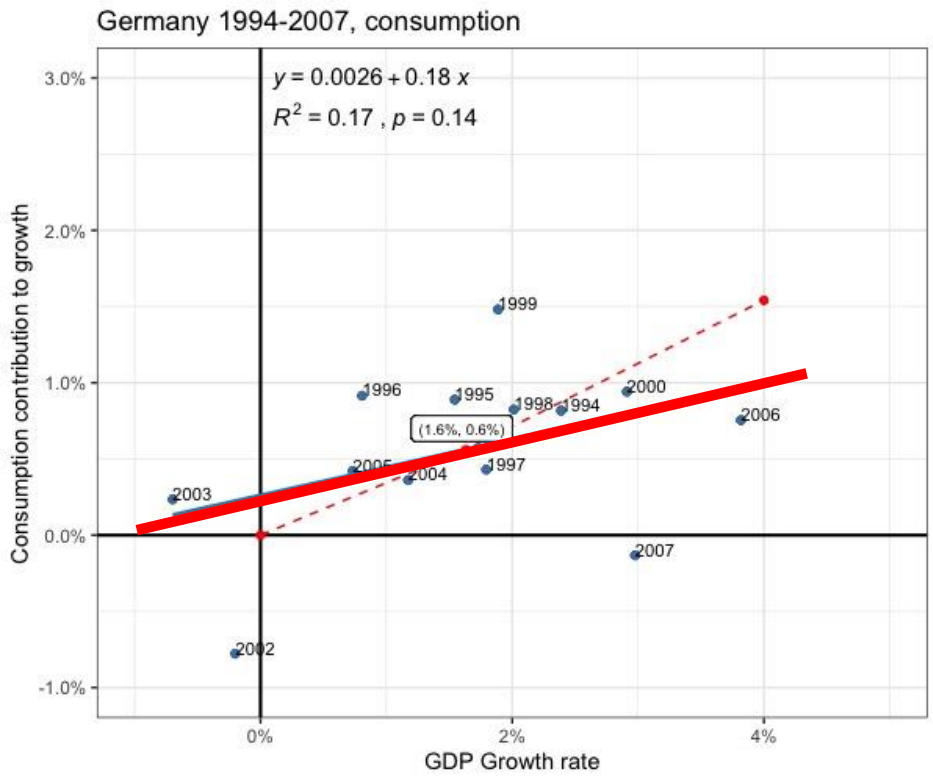
Key Empirical Findings

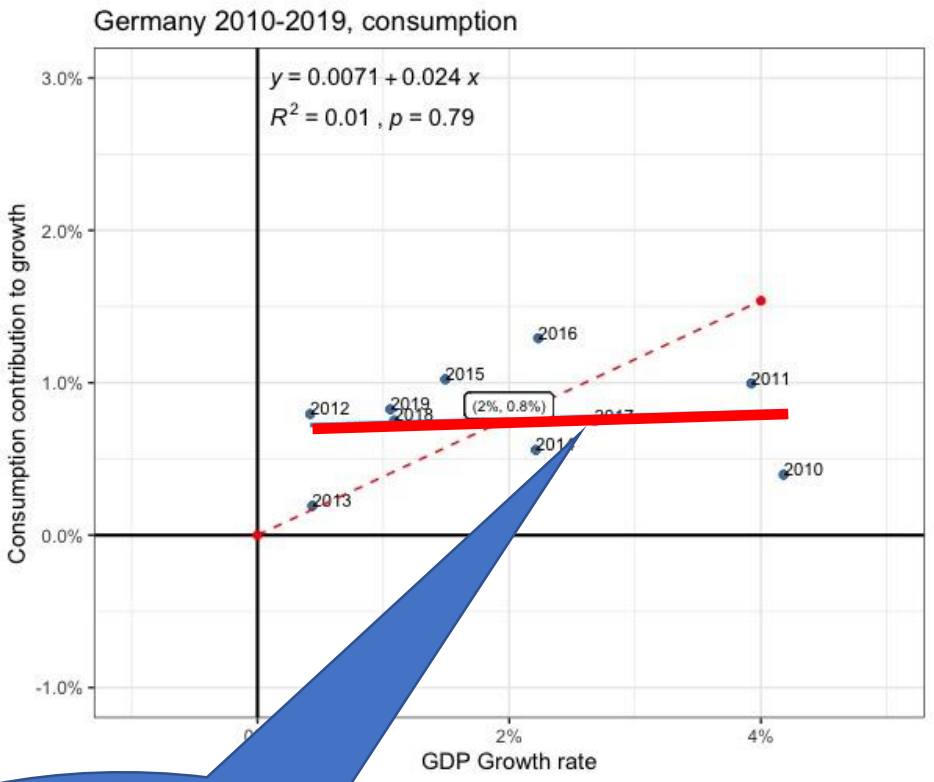
Germany

Table 2: Germany

	1994-2007							2010-2019						
	Dynamic RCG	*Spill over Factor* (%)	Centre of mass: CG Periodic average (%)	Centre of mass: GDP Growth periodic average (%)	*Static RCG*	R-Square	p-value	*Dynamic RCG*	*Spill over Factor* ($x10^{-2}$)	Centre of mass: CG Periodic average (%)	Centre of mass: GDP Growth periodic average (%)	*Static RCG*	R-Square	p-value
Consumption	0.18	0.26	0.6	1.6	0.34	0.17	0.14	0.024	0.71	0.8	2	0.38	0.01	0.79
Export	0.66	1.0	2.1		1.3	0.49	<0.01	0.99	0.066	2.0		1.02	0.76	<0.01
Net Export	0.11	0.35	0.5		0.32	0.02	0.59	0.27	0.33	0.2		0.10	0.23	0.16

Germany: Consumption

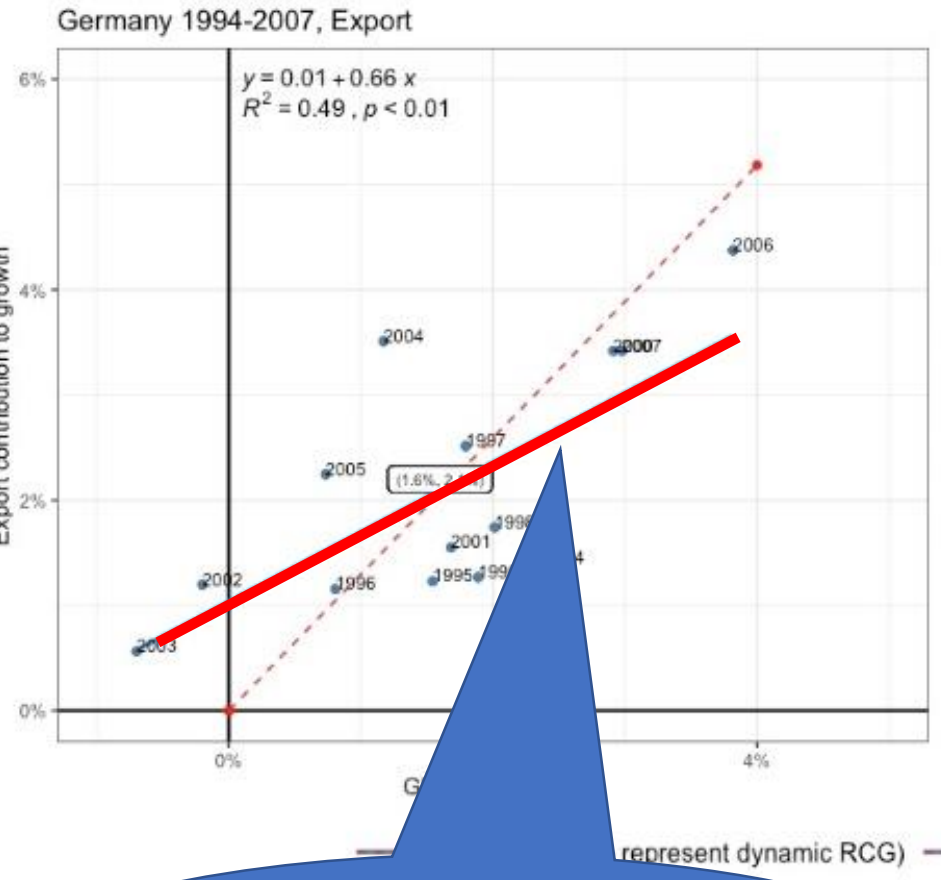


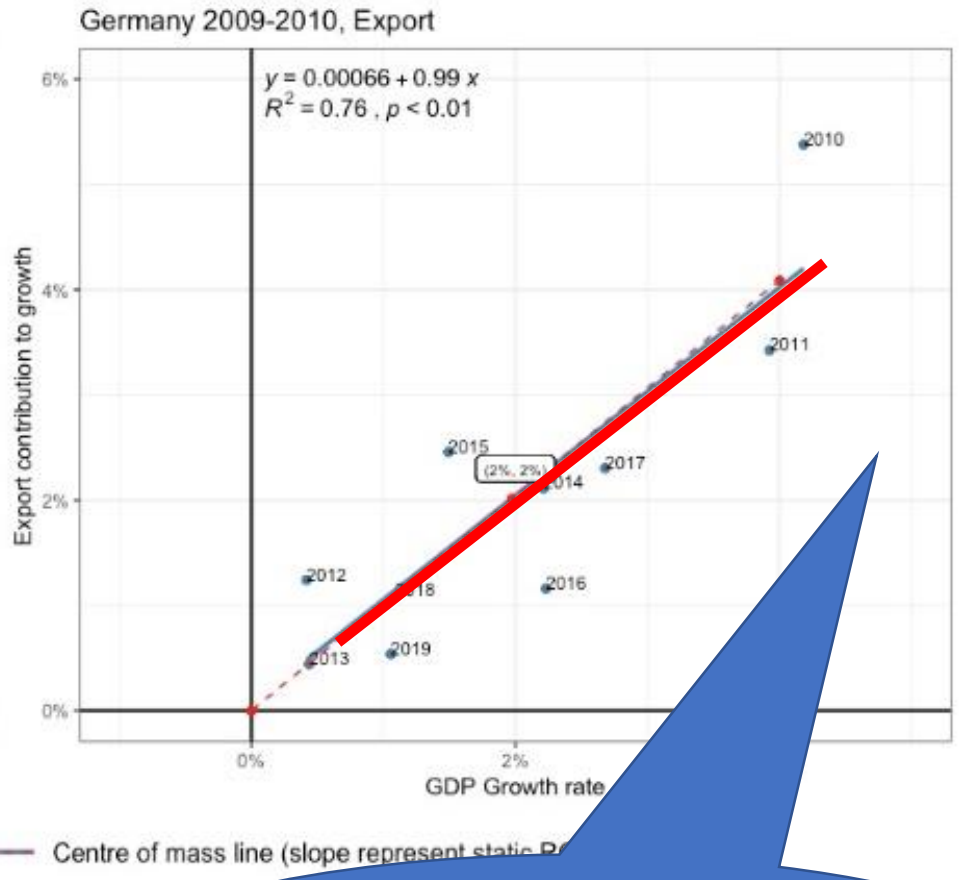


Trend line (slope represent dynam… …resent static RCG)

Positive spillover factor, zero Consumption dynamic RCG

Germany: Export



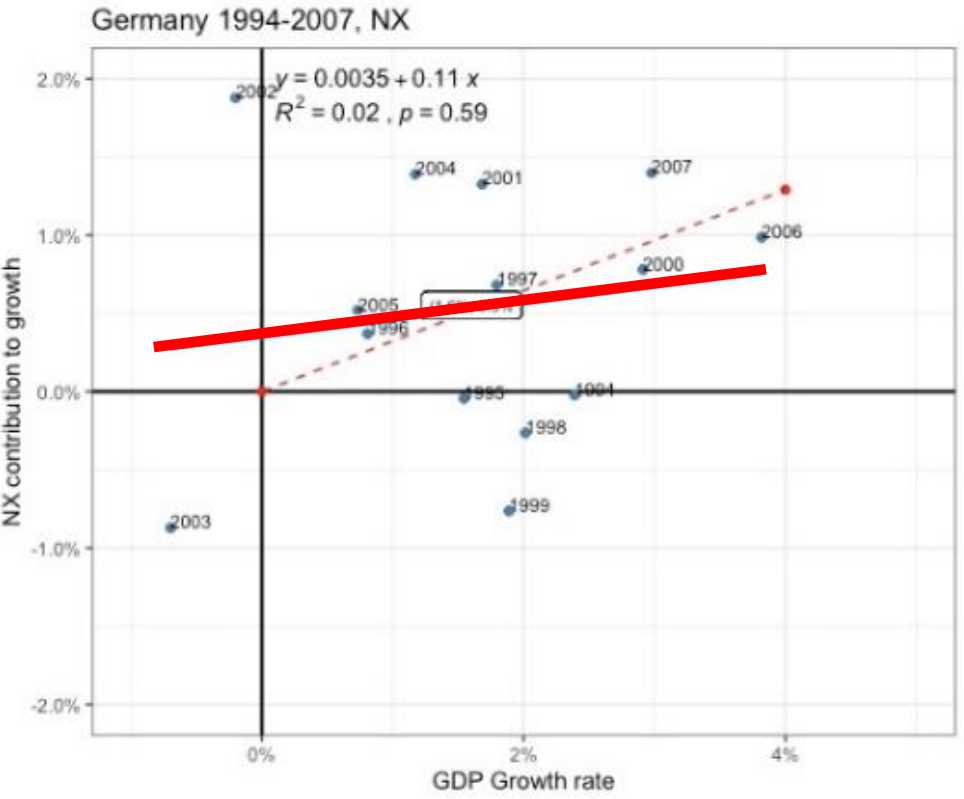


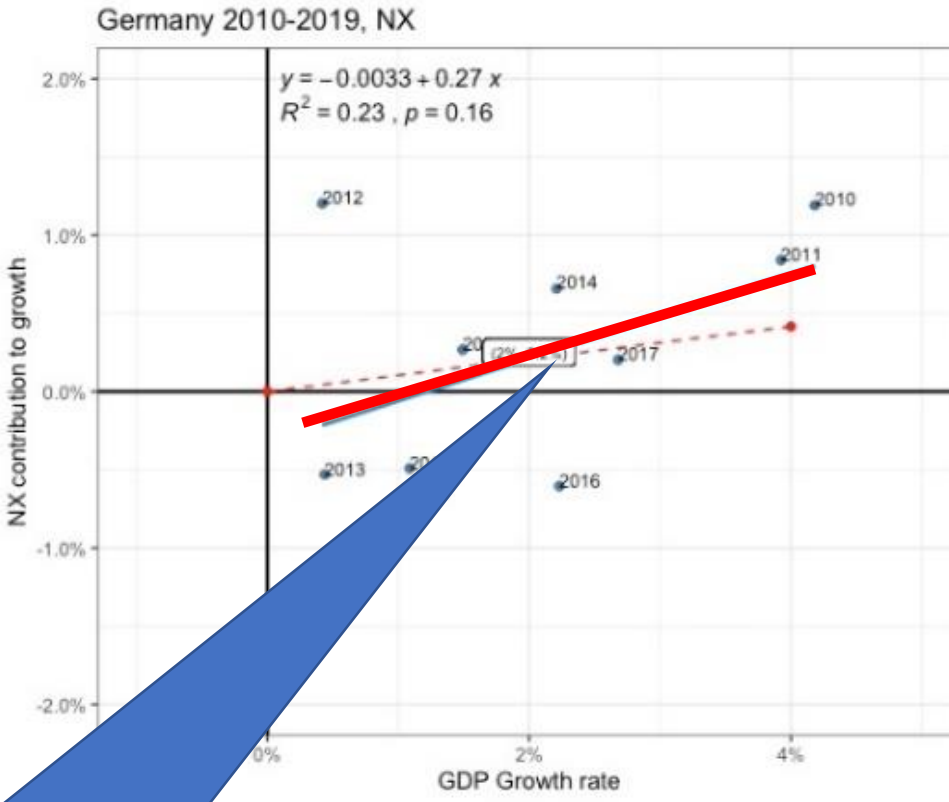
represent dynamic RCG) — Centre of mass line (slope represent static R

Mid-level dynamic export RCG;
Positive spillover;
Robust model

Very high dynamic export RCG;
No spillover;
Robust model

Germany: Net-Export





Trend line (slope represent dynamic RCG

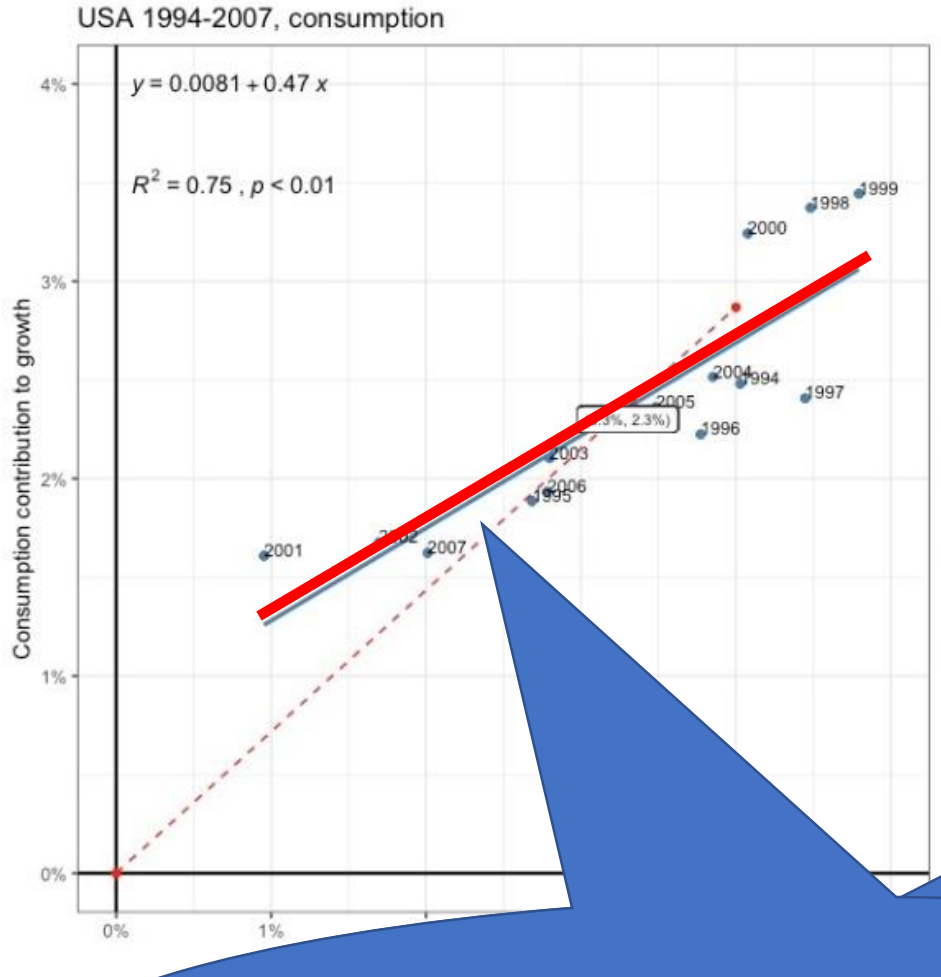
ass line (slope represent static RCG)

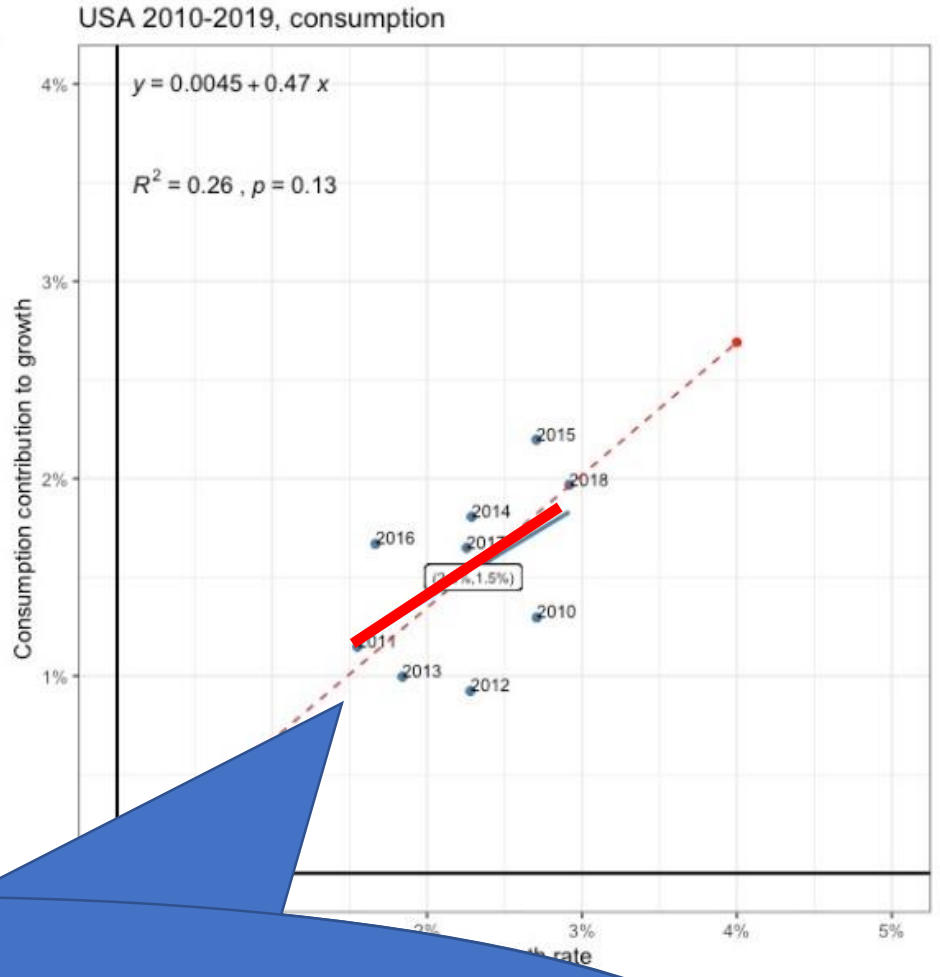
Higher dynamic NX RCG after GFC;
Zero spillover factor (below 1%)

Table 3: United states

	1994-200							2010-2019						
	Dynamic RCG	*Spill over Factor* (%)	Centre of mass: RCG Periodic average (%)	Centre of mass: GDP Growth periodic average (%)	*Static RCG*	R-Square	p-value	*Dynamic RCG*	*Spill over Factor* (%)	Centre of mass: RCG Periodic average (%)	Centre of mass: GDP Growth periodic average (%)	*Static RCG*	R-Square	p-value
Consumption	0.47	0.81	2.3	3.3	0.80	0.75	<0.01	0.47	0.45	1.5	2.3	0.68	0.26	0.13
Export	0.21	0.17	0.5		0.13	0.29	0.04	0.078	0.27	0.4		0.20	0.01	0.81
Net Export	-0.17	0.22	-0.3		-0.10	0.24	0.07	-0.42	0.77	-0.2		-0.06	0.47	0.03

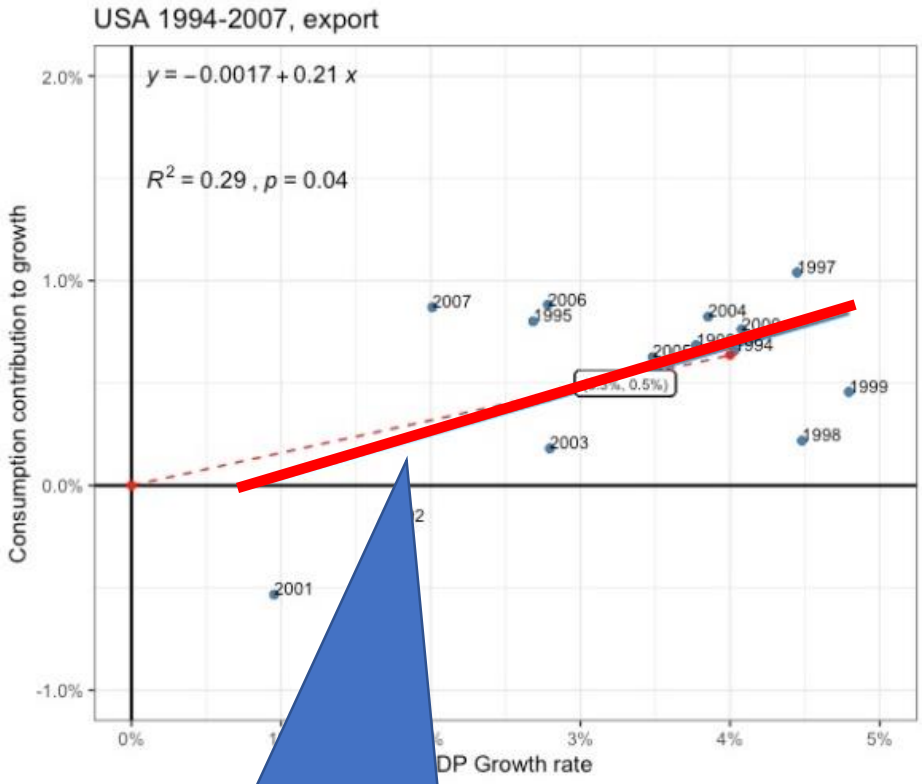
US: Consumption

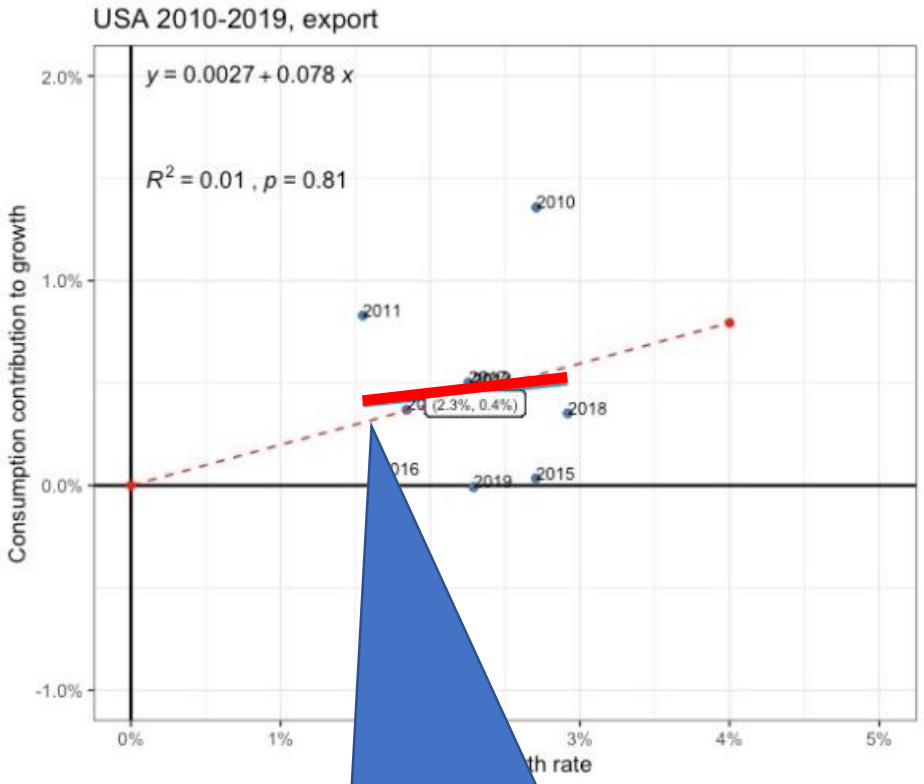




Dynamic consumption RCGs were high before after the GFC; but after the crisis the model is less coherent (low R-S high p-value)

US: Export



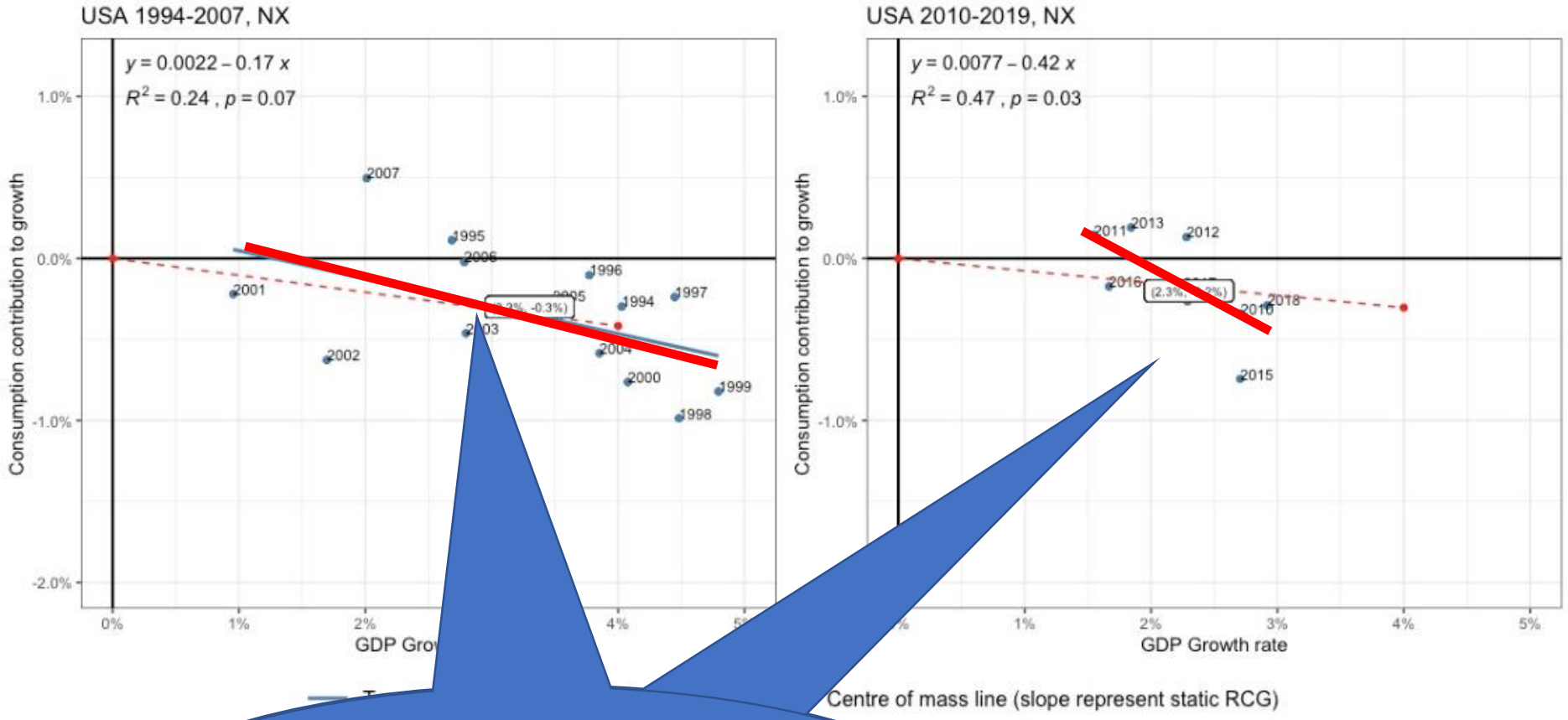


rend line (slope represent dynamic RCG) — Centre of mass line (slope r G)

Low export dynamic RCG but strategy was coherent

Lowwer export dynamic RCG and less coherency

US: Net Export



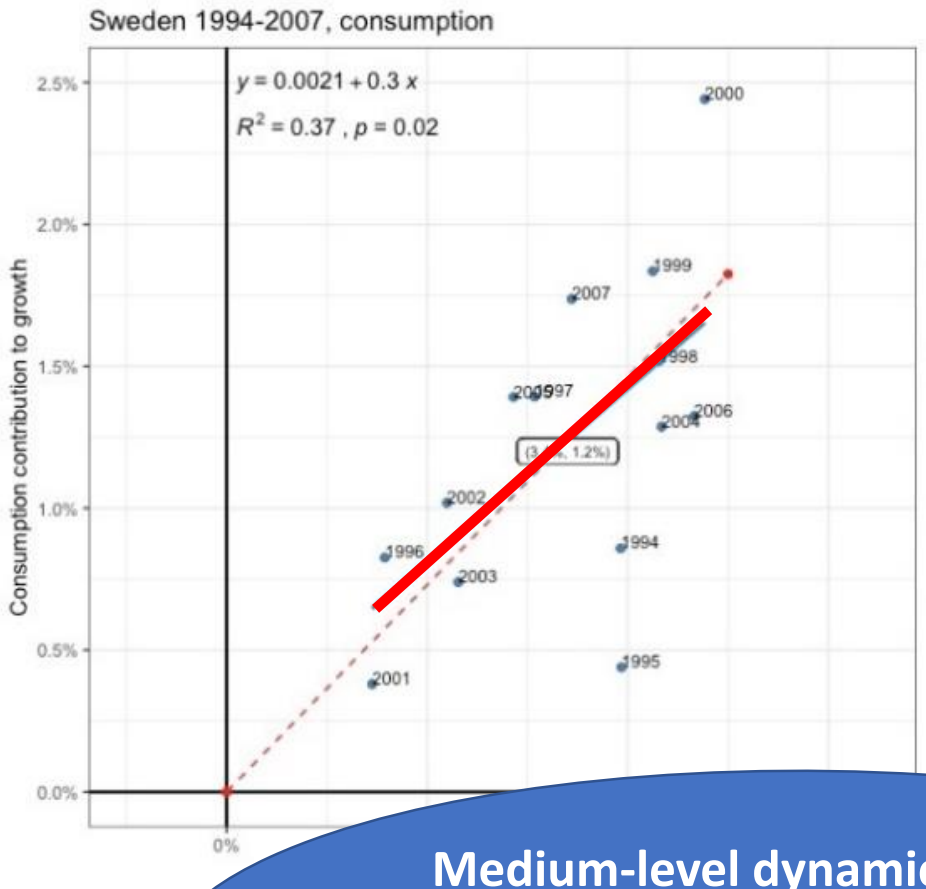
Negative net-export dynamic RCG: trade-off between GDP growth and higher NX contribution to growth

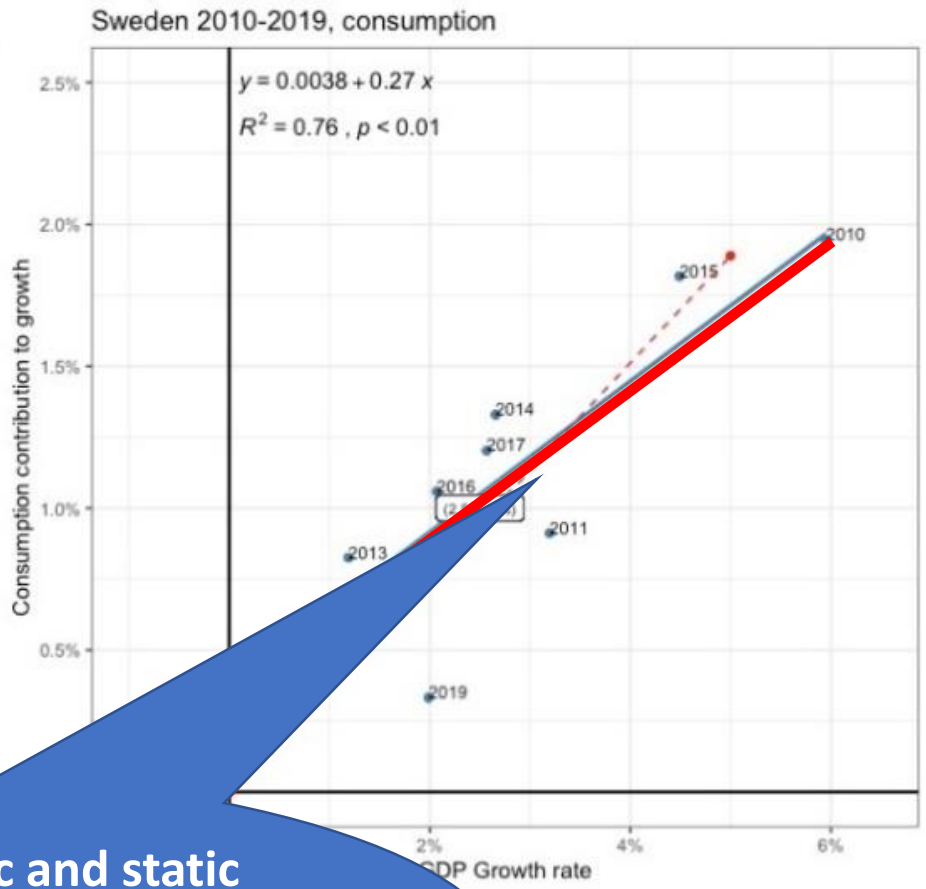
Sweden

Table 4: Sweden

	1994-2007							2010-2019						
	Dynamic RCG	*Spill over Factor* (%)	Centre of mass: CG Periodic average (%)	Centre of mass: GDP Growth periodic average (%)	*Static RCG*	R-Square	p-value	*Dynamic RCG*	*Spill over Factor* (%)	Centre of mass: CG Periodic average (%)	Centre of mass: GDP Growth periodic average (%)	*Static RCG*	R-Square	p-value
Consumption	0.30	0.21	1.2		0.35	0.37	0.14	0.27	0.38	1.0		0.4	0.76	<0.01
Export	0.94	-0.6	2.6	3.4	0.76	0.68	<0.01	0.61	0.33	1.9	2.5	0.76	0.67	<0.01
Net Export	0.00	0.5	0.5		0.14	0	0.59	0.02	0.00	0.1		0.04	0.0	0.9

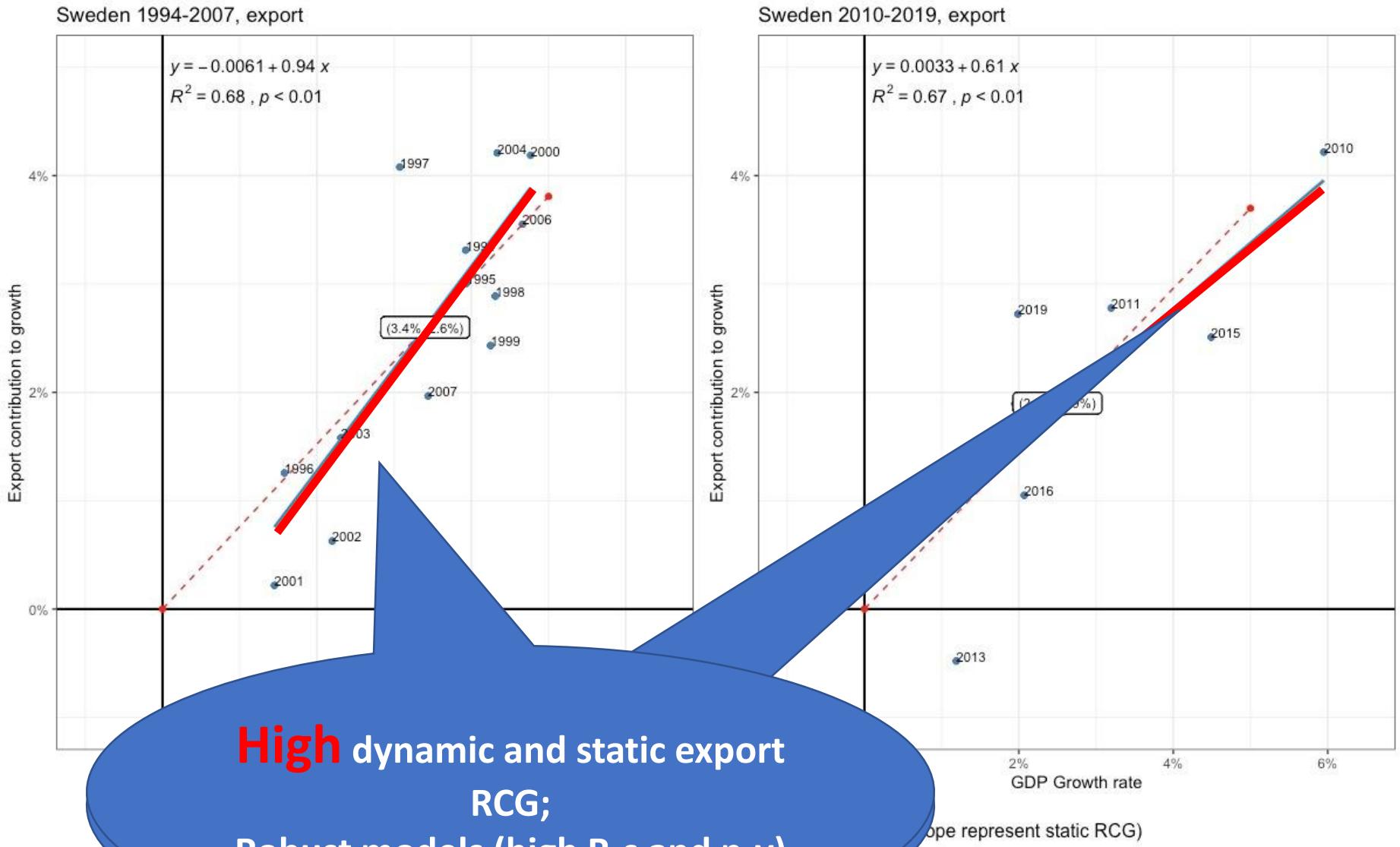
Sweden: Consumption





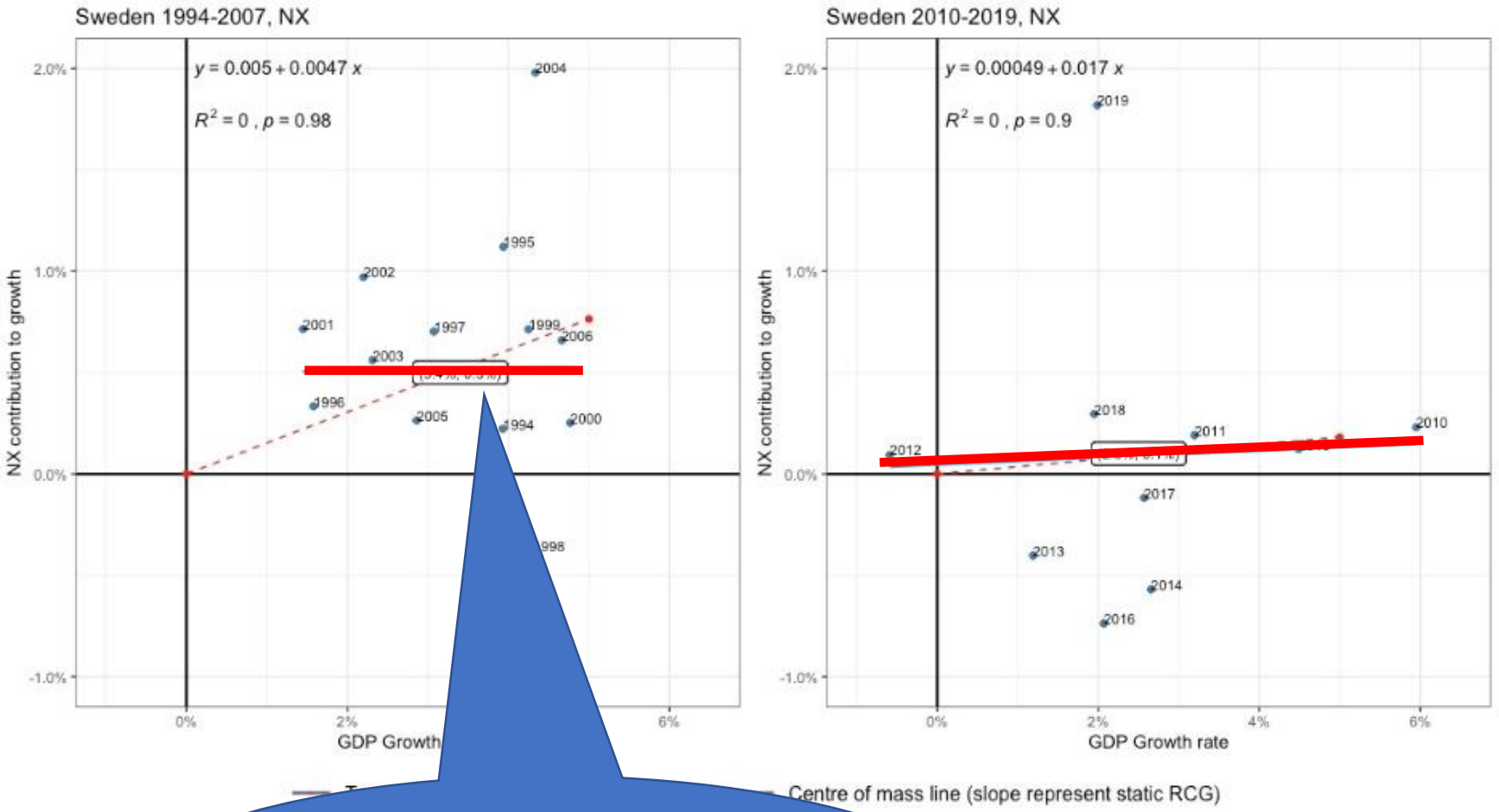
Medium-level dynamic and static consumption RCG;
Low spillovers;
Coherent model

Sweden: Export



High dynamic and static export RCG;
Robust models (high R-s and p-v)

Sweden: Net Export



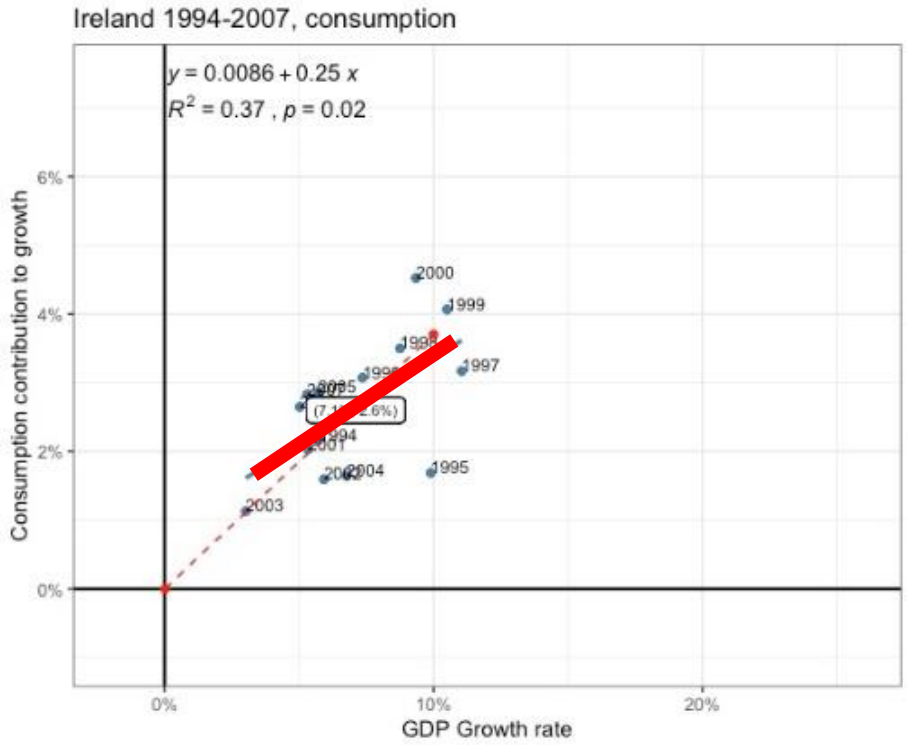
Zero dynamic NX RCG;
High p-v >> indifferent to NX

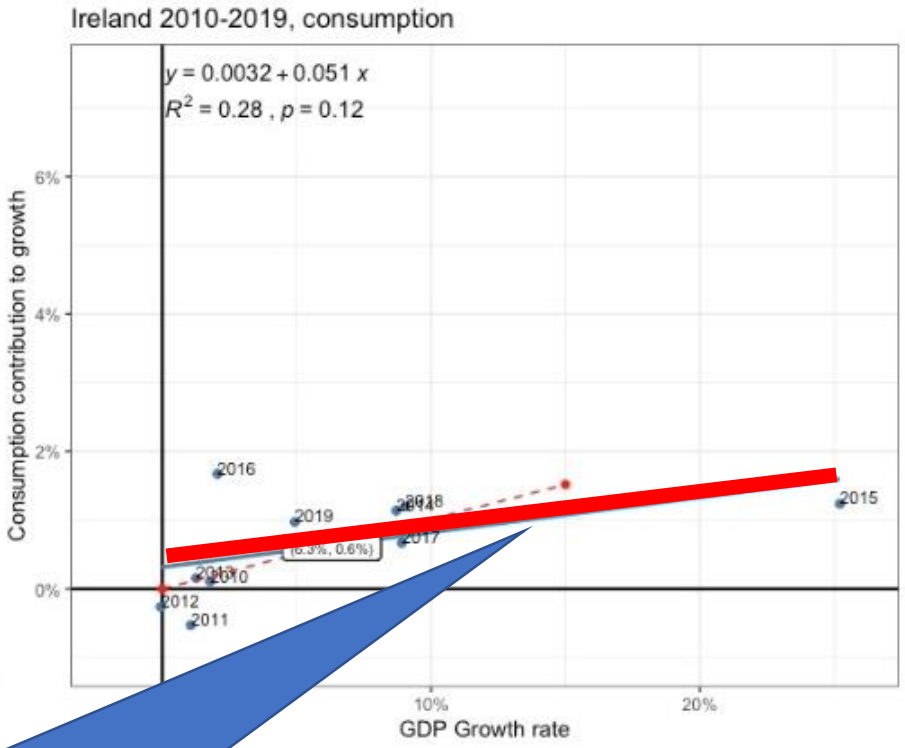
Ireland

Table 5: Ireland

	1994-2007							2010-2019						
	Dynamic RCG	*Spill over Factor (%)*	Centre of mass		*Static RCG*	R-Square	p-value	*Dynamic RCG*	*Spill over Factor (%)*	Centre of mass		*Static RCG*	R-Square	p-value
			CG Periodic average (%)	GDP Growth periodic average (%)						CG Periodic average (%)	GDP Growth periodic average (%)			
Consumption	0.25	0.86	2.6	7.1%	0.37	0.37	0.02	0.051	0.32	0.06	6.3%	0. 1	0.28	0.12
Export	1.30	-1.4	8.1		1.13	0.55	<0.01	1.60	1.3	10.8		1.72	0.97	<0.01
Net Export	0.35	-1.6	0.8		0.11	0.16	0.16	0.76	-3.8	0.9		015	0.22	0.17

Ireland: Consumption

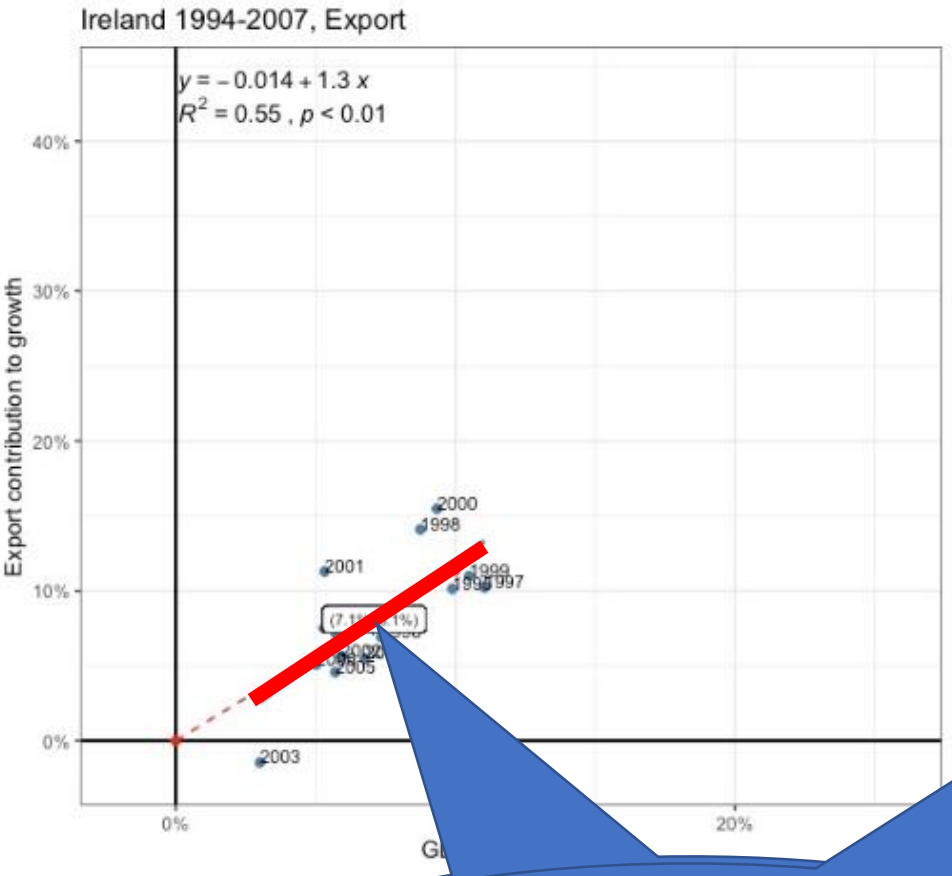


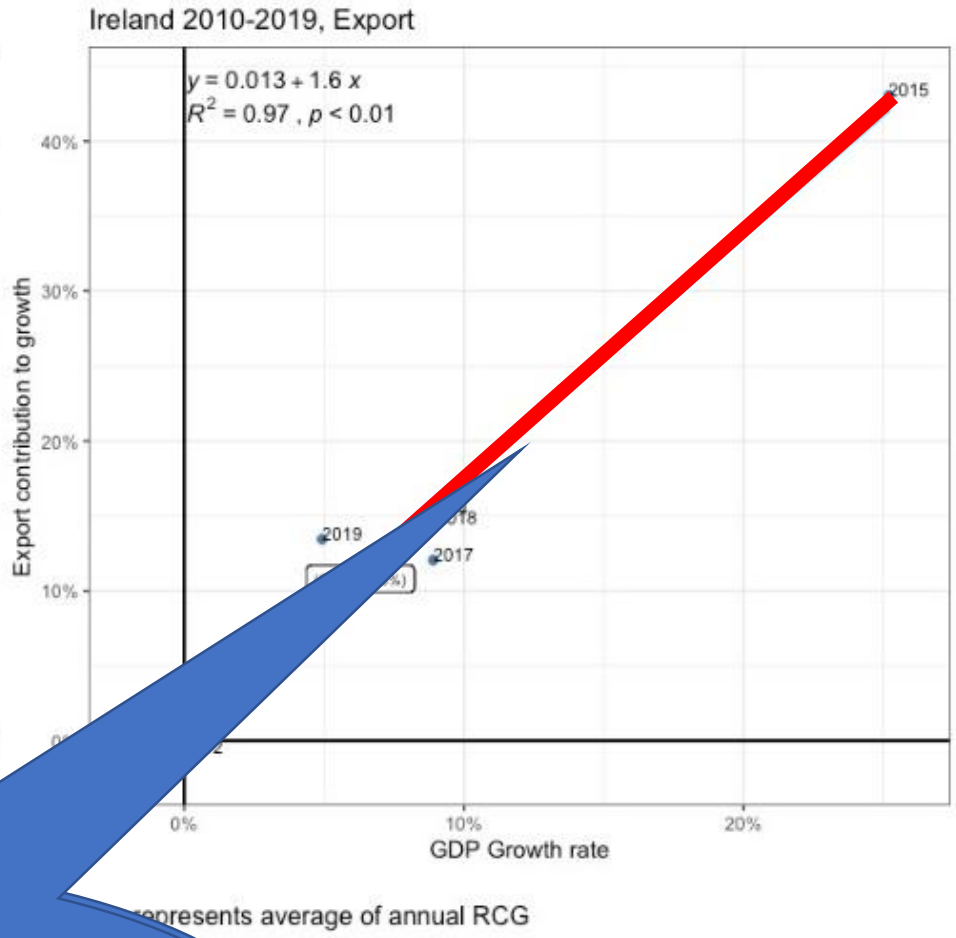


ass line (slope represent static RCG)

Dynamic and statis consumption RCG very low after the crisis;

Ireland: Export

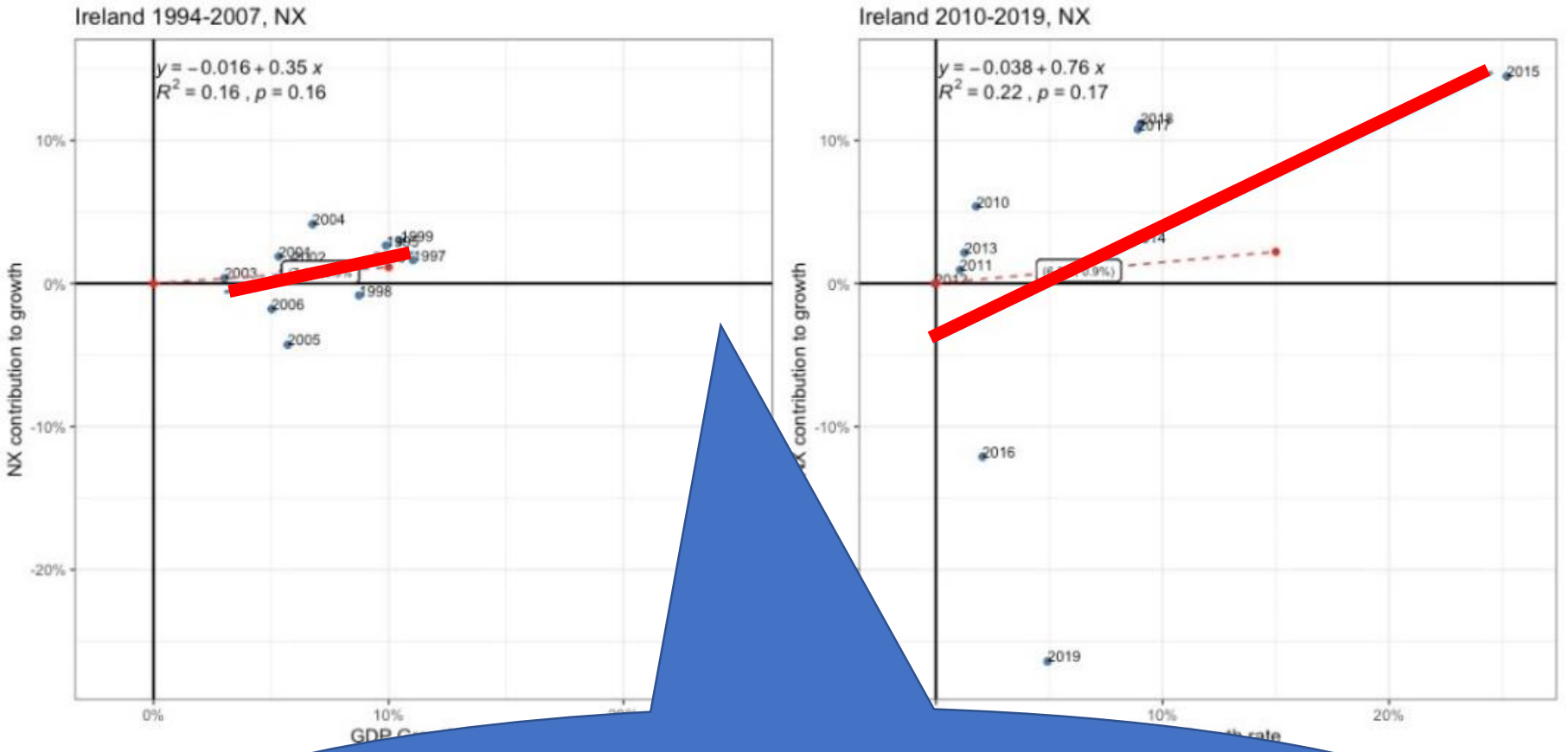




represents average of annual RCG

Extremely high dynamic and static export RCG; Robust model (High R-s and low p-v)

Ireland: Net-Export



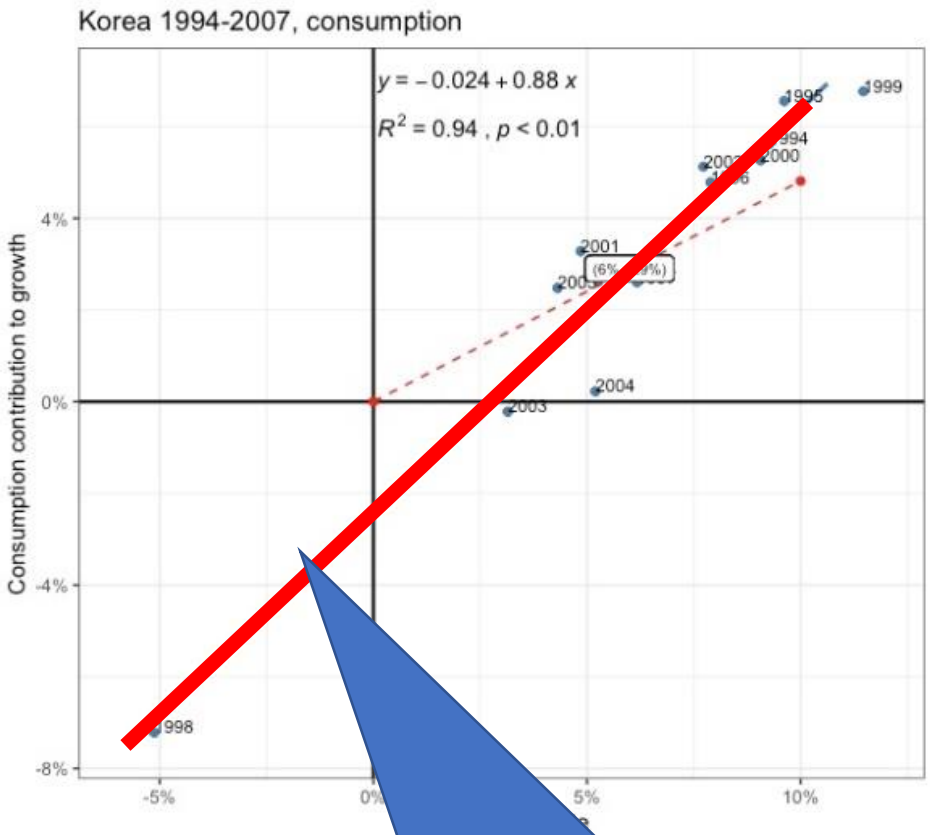
High and positive dynamic export RCG;
Negative spillover factor (3.8%)(“sucking” demand from others component);

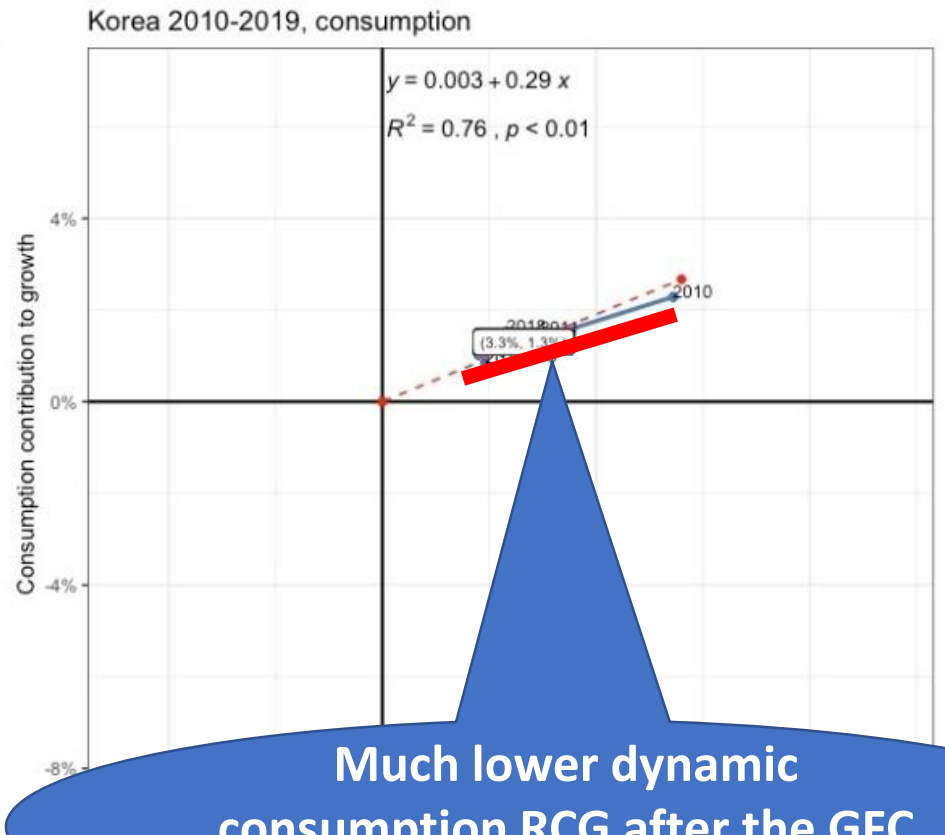
Korea

Table 6: Korea

	1994-2007							2010-2019						
	Dynamic RCG (x10^{-2})	*Spill over Factor* (x10^{-2})	Centre of mass: CG Periodic average	Centre of mass: GDP Growth periodic average	*Static RCG*	R-Square	p-value	*Dynamic RCG*	*Spill over Factor* (x10^{-2})	Centre of mass: CG Periodic average	Centre of mass: GDP Growth periodic average	*Static RCG*	R-Square	p-value
Consumption	0.88	-2.4	2.9		0.48	0.94	<0.01	0.29	0.3	1.3		0.38	0.76	<0.01
Export	0.013	2.9	3	6	0.49	0	0.9	0.90	-1.2	2	3.3	0.59	0.41	0.04
Net Export	-0.67	4.4	0.4		0.06	0.02	0.59	-0.26	1	0.2		0.05	0.08	0.42

Korea: Consumption

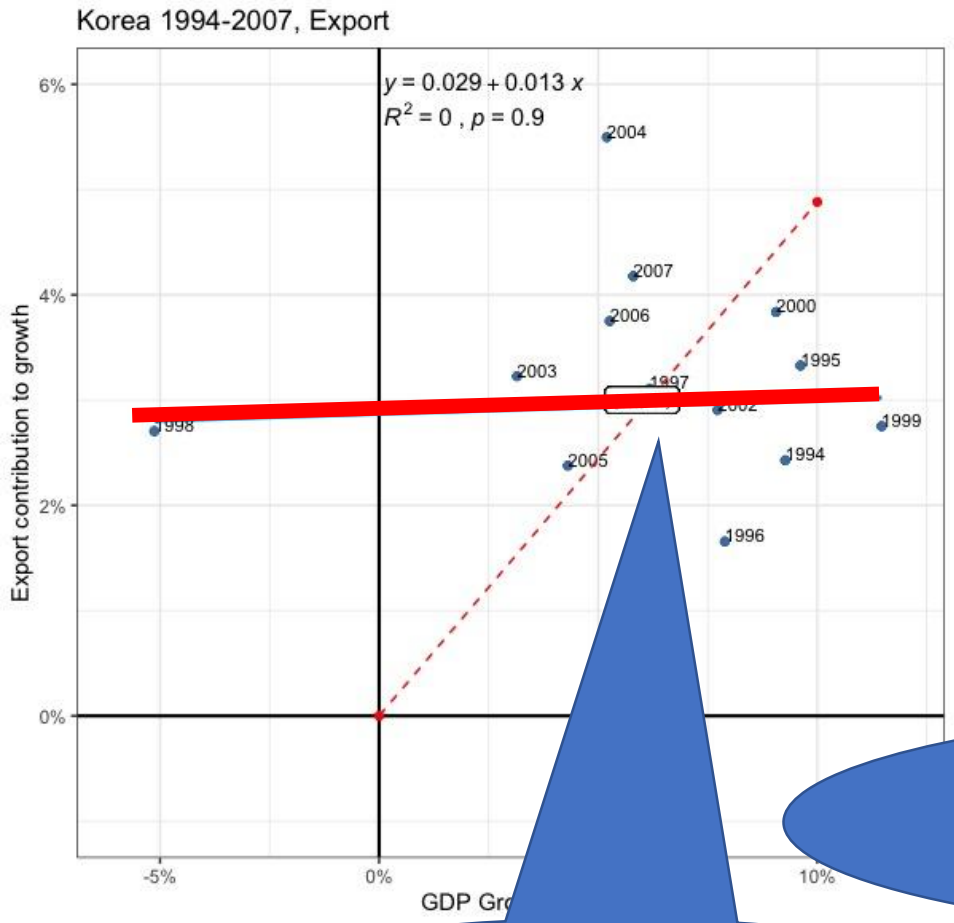


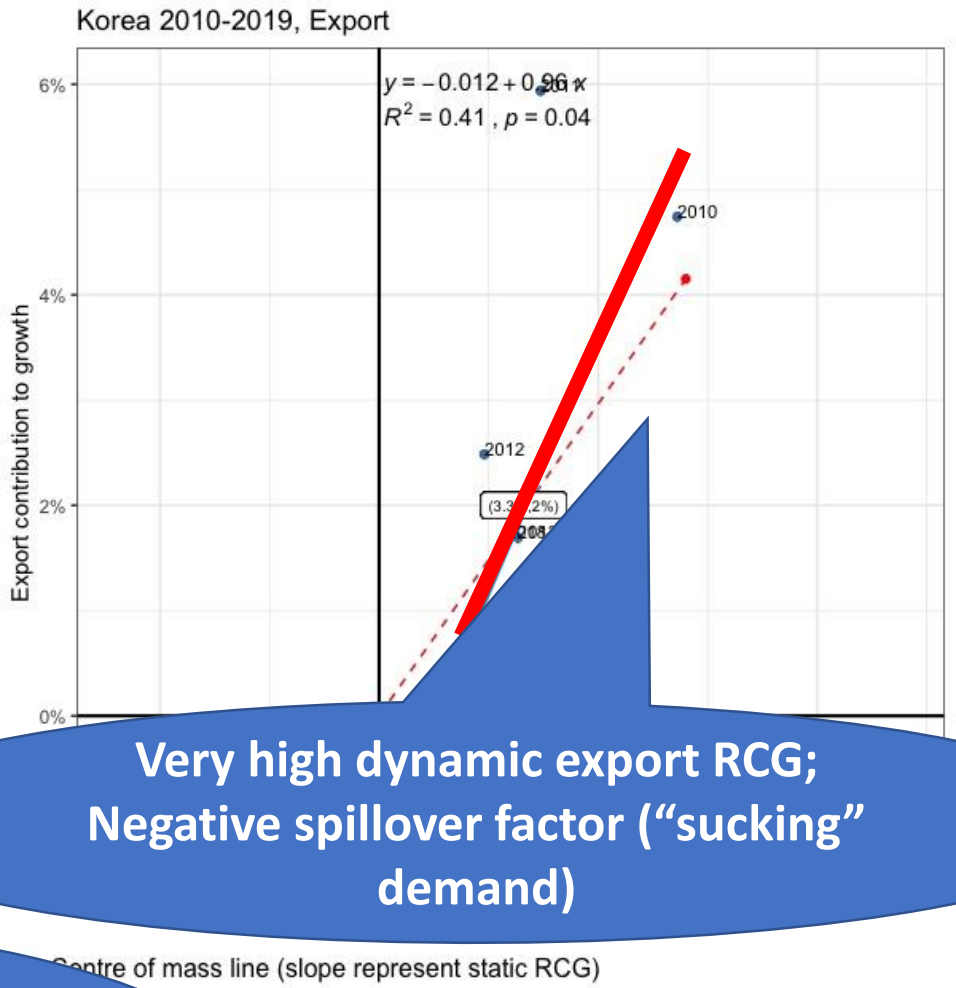


Much lower dynamic consumption RCG after the GFC

Very high dynamic consumption RCG and a negative spillover factor (robust model) prior to the crisis;

Korea's Export



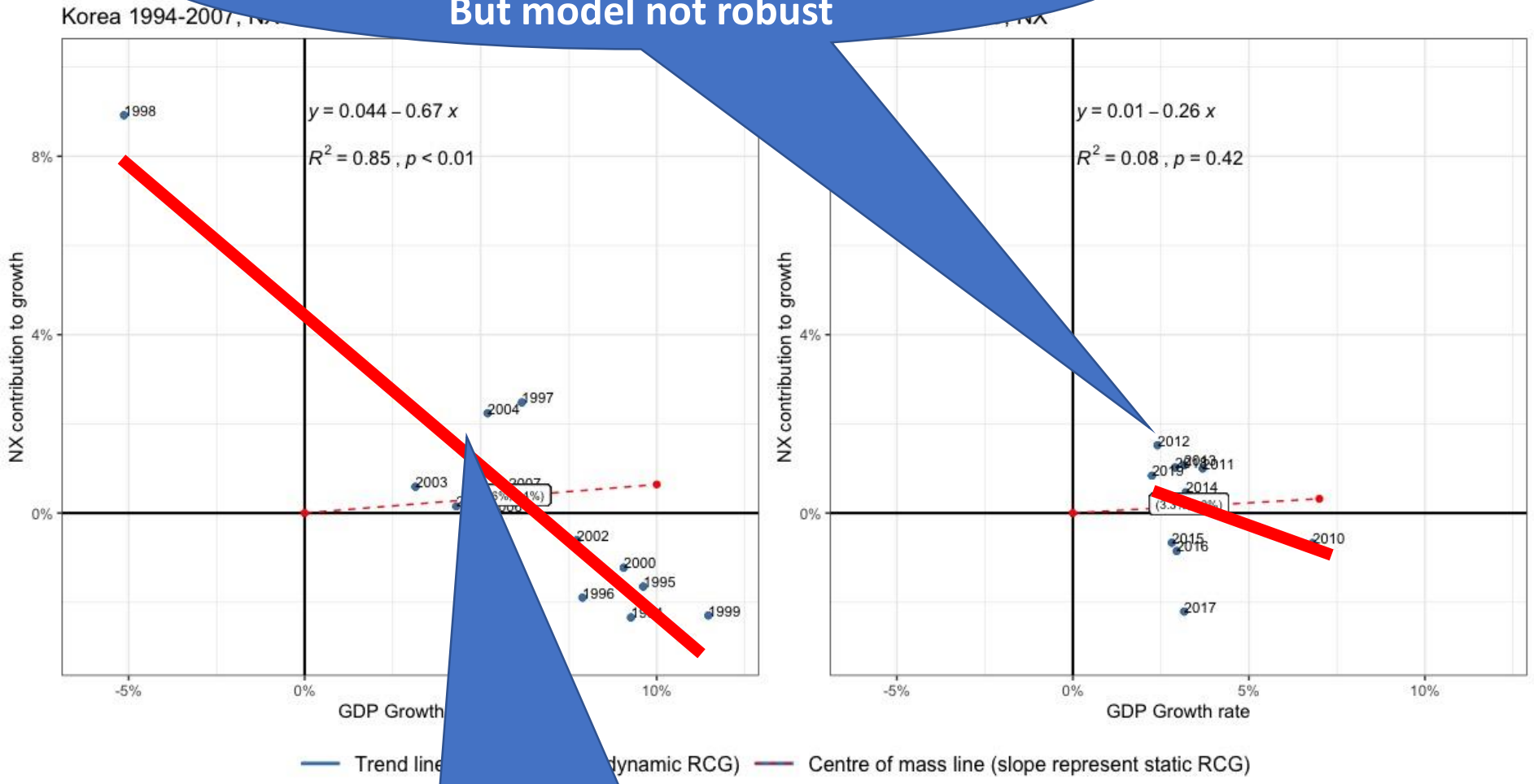


Very high dynamic export RCG; Negative spillover factor ("sucking" demand)

Zero dynamic export RCG; High spillover factor (export contribution-togrowth does not contribution to growth

Korea's Net-Export

Negative dynamic NX RCG;
Zero static NX RCG;
But model not robust



High and negative dynamic NX RCG;
Zero static NX RCG;

Advantages of the Contribution-to-Growth curves approach

- Distinguishing between the dynamic and static element of the growth models.
- Distinguishing between change within the model (similar dynamic RCG but change of static RCG) and change of the model (movement of the Contribution-to-Growth curves).
- Conceptualizing, operationalization and measurement of the interaction between the demand components (spillover factors).
- Distinguishing between types consumption-led models: high dynamic Consumption RCG vs. horizontal Consumption RCG curve.
- Distinguishing between types of export-led growth models: positive vs. negative dynamic NX RCGs.
- Estimation of the coherency/robustness of the model.
- Simplicity

Open questions

- Theocratization of the descriptive models.
- Explaining variation based on Post-Keynesian economic models.
- The role of growth drivers?
- Where is the “model” and where is the “strategy” in the curves?

Thank you for your attention