

Integrated Economic-Environmental Modeling for Evidence-Based Public Policy  
and Investment Design

# ISIM-IEEM Chile Exercises: Terms of Trade Shocks

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Banco Central de Chile  
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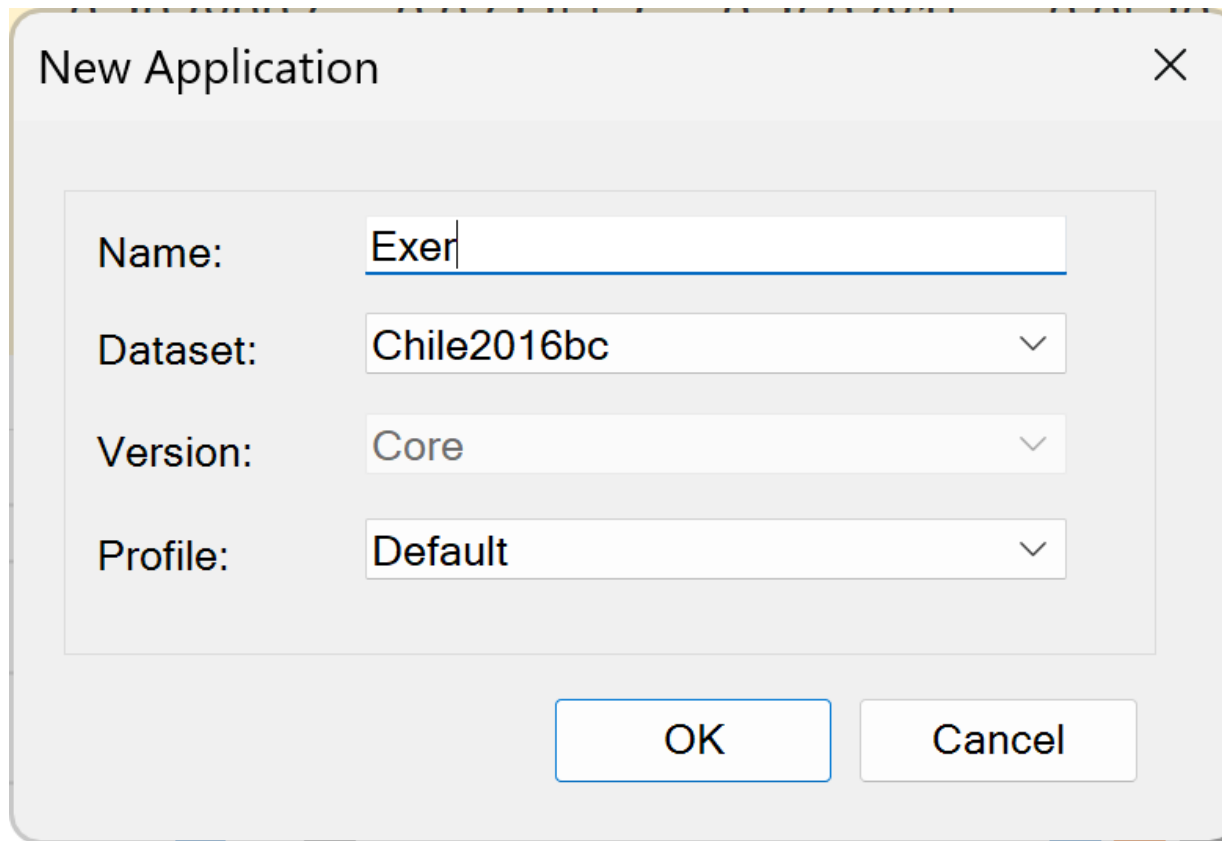
# Contents

- Introduction
- Definition of Scenarios
  - shocks, macro closure, and rules
- Key Base Base-Year Data
- Key Model Equations and Variables
- Results

# Introduction

- In this presentation, we show, step by step, how to perform and analyze IEEM Chile simulations using the ISIM user-friendly interface.
- In order to follow the exercises, you should have successfully installed
  - GAMS with license (gamslice.txt)
  - ISIM
  - IEEM with IEEM Chile 2016 dataset

# New ISIM application



A dialog box titled "New Application" with a close button (X) in the top right corner. It contains four input fields: "Name" with the text "Exer", "Dataset" with a dropdown menu showing "Chile2016bc", "Version" with a dropdown menu showing "Core", and "Profile" with a dropdown menu showing "Default". At the bottom, there are two buttons: "OK" and "Cancel".

New Application

Name:


Dataset:

Version:

Profile:

OK Cancel

# In Period, Select **2030** as Last Simulation Year

6bc) Period:  Setu Paramet

From: 2016 To: 2050

Setup (IEF 01)

✓ <i>fx</i> =E3	2017	
C	2018	
)	2019	E
ops	2020	Export price
estock	2021	20
ning	2022	
od	2023	
	2024	
	2025	
	2026	
t)	2027	
r2	2028	Import price
	2029	20
	2030	
	2031	
	2032	

The image shows a software interface for setting simulation parameters. At the top, the 'Period' is defined from 2016 to 2050. A dropdown menu is open, showing a list of years from 2017 to 2032. The year 2030 is highlighted with a black border, indicating it is the selected last simulation year. The background shows a spreadsheet-like grid with various data points and labels, including 'Export price' and 'Import price' with values of 20.

# In Configuration, Select Period **2022-2030** to Calculate Average Annual Growth Rates

The screenshot shows a 'Configuration' dialog box with three tabs: 'General', 'Reports', and 'Poverty Module'. The 'Reports' tab is active. It contains a checkbox for 'Enable Reports in Excel' which is unchecked. Below this is a 'Period' section with 'From:' set to '2022' and 'To:' set to '2030'. The 'Selected reports' section has a dropdown menu showing 'repmacro'. To the right is a list of report codes: 'bopindic00', 'coststruc00', 'debtgdp', 'demstruc00', 'facdemstruc00', 'fiscalindic00', and 'gdpindic00'. There are 'Add >>' and 'Remove' buttons between the selected reports and the list. A 'Restore defaults' button is at the bottom of the list. At the bottom of the dialog are 'OK' and 'Cancel' buttons.

Configuration

General Reports Poverty Module

Enable Reports in Excel

Period

From: 2022 To: 2030

Selected reports

repmacro

bopindic00  
coststruc00  
debtgdp  
demstruc00  
facdemstruc00  
fiscalindic00  
gdpindic00

Add >> Remove

Restore defaults

OK Cancel

# Scenario Definitions: Shocks

- **pwefood** = increase in world export price of food products; 10pp, 20pp y 30pp relative to base 2023, 2024 y 2025-2030.
- **pwmfood** = increase in world import price of food products; 10pp, 20pp y 30pp relative to base 2023, 2024 y 2025-2030.
- **pwfood** = increase in world (export and import) price of food products; 10pp, 20pp y 30pp relative to base 2023, 2024 y 2025-2030.

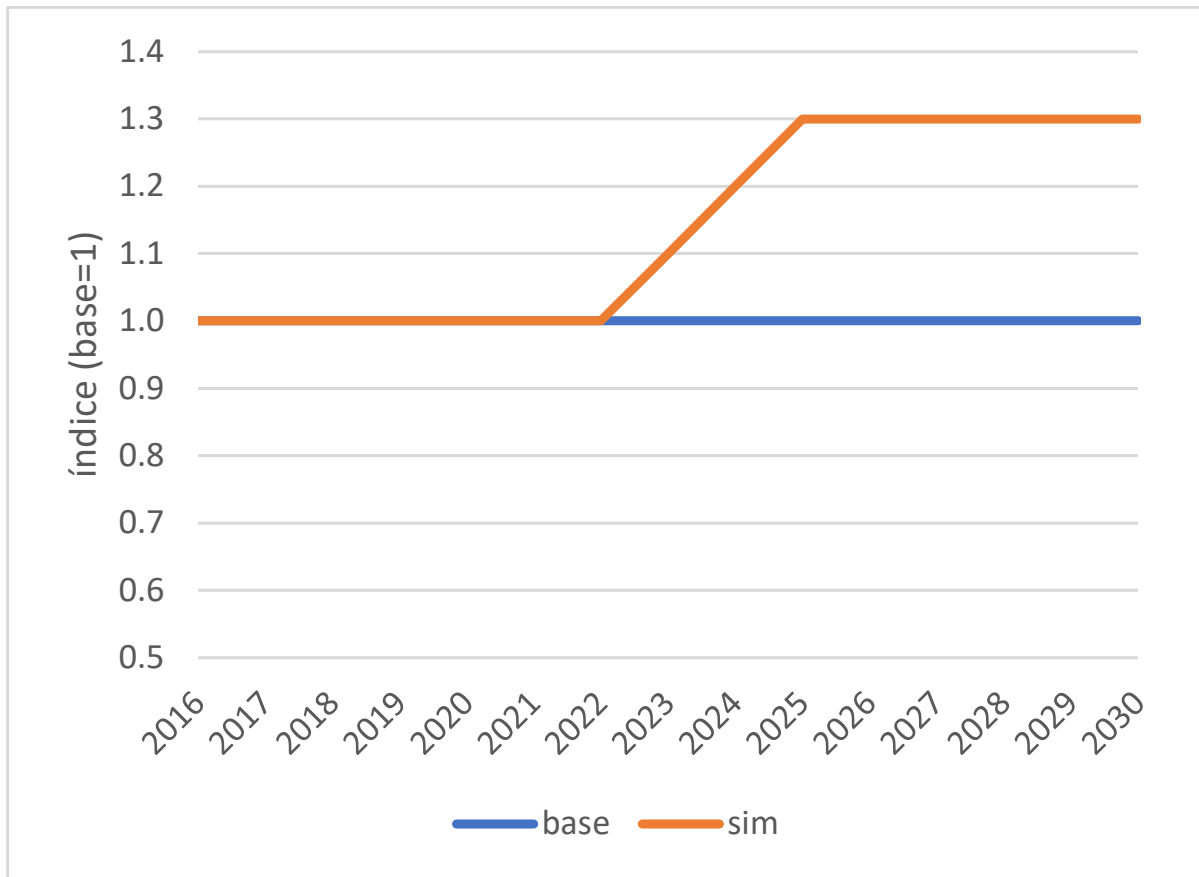
# Selected Products in Non-Base Scenarios

- The food products are
  - c-crops
  - c-livestock
  - c-fishing
  - c-food



# Scenario Definitions: Shocks – cont.

## pw for food products



In pwesim and pwmsim, 1 in 2016 and 1.3 in 2025 means 30% deviation relative to the base-year in 2025.

# Scenario Definitions: Shocks – cont.

pwesim(sim,call,r2,t)			export price for c (foreign currency)														
sim	call	r2	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
X pwefood	c-crops	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3
X pwefood	c-livestock	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3
X pwefood	c-fishing	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3
X pwefood	c-food	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3
X																	
X pwfood	c-crops	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3
X pwfood	c-livestock	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3
X pwfood	c-fishing	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3
X pwfood	c-food	row	1	1	1	1	1	1	1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3

[Add row](#)

# Scenario Definitions: Factor Markets

- Labor
  - all categories (1) = unemployment with wage curve
- Capital
  - all categories (1) = fixed employment; once installed, sector-specific
- Natural Resources
  - f-land-crops = fixed employment; sector-specific, exog supply and function of deforestation
  - f-land-livestock = fixed employment; sector-specific, exog supply
  - f-land-for = fixed employment; sector-specific, exog supply
  - f-fish = fixed employment; sector-specific, exog supply
  - f-nrpetgas = fixed employment; sector-specific, exog supply
  - f-nrcopper = fixed employment; sector-specific, exog supply
  - f-nrothmin = fixed employment; sector-specific, exog supply

# Closure Rule Factor Markets; $f_{acclos0}$ and $f_{acclossim}$

#	<b>workings of factor markets</b>
1	full employment (fixed UERAT); mobile factor
2	full employment (fixed UERAT); specific factor
3	unemployment assuming exogenous (constant) real wage; mobile factor
4	unemployment assuming wage curve (i.e., negative relation bt real wage and UERAT); mobile factor

# Scenario Definitions: Macro Closure

- Government (**govclossim**) = **direct tax** rate is the clearing variable for the government budget ( $SURPG = YG - EG - INVVALG$ ).
- Savings-Investment (**siclossim**) = **non-government investment** is the clearing variable (i.e., exog MPS).
- External Sector (BoP) (**rowclossim**) = the real exchange rate adjusts endogenously to balance foreign currency inflows and outflows.

# Alternative Closures for Government (govclos0 y govclassim)

#	variable that clears the government budget
1	direct (income) tax rate
2	domestic financing
3	foreign financing
4	government (current) consumption
5	government investment
6	transfers from rest of the world
7	transfers to domestic non-gov inst
8	commodity subsidies
9	commodity tax
10	activity tax
11	value added tax

# Alternative Closures for Non-Government Savings-Investment Balance (siclos0 y siclossim)

#	variable that clears the savings-investment balance
1	investment
2	savings rate of domestic non-gov inst
3	foreign savings
4	government domestic financing

# Alternative Closures for BoP (rowclos0 y rowcrossim)

#	BoP
1	real exchange rate



# Rules for Government: Expenditures and Incomes

– not selected in `govclos0/govclossim`

- It is necessary to select them for government expenditures and incomes that are not used to balance the government budget.
  - expenditures are specified under **`govspndrule0/govspndrulesim`**
  - incomes (or receipts) are specified under **`govrecrule0/govrecrulesim`**
- ISIM makes default selection for `govspndrulesim` and `govrecrulesim` (see below).

# Rules for Government Receipts (govrecrulesim)

#	rule	control param	default
1	exog rate (for taxes) / growth rate; quantity is exog (other items)	taxrate0/taxratesim / govrecgrw0/govrecgrwsim	baseyr / gdpgrw
2	GDP share	govrecgdp0/govrecgdpsim	baseyr

Note: For taxes, 1 implies exogenous tax rates.

Automatically, ISIM selects option 1 for all elements.

By default, for non-setup scenarios  
ISIM makes the following selection for  
elements in govrecrulesim

- `trgovrow` = real values setup scenario
- `trgovngov` = real values setup scenario
- `netforfingov` = real values setup scenario
- `netdomfin` = real values setup scenario
- `'tax-act'` = tax rates setup scenario
- `'tax-imp'` = tax rates setup scenario
- `'tax-com'` = tax rates setup scenario
- `'tax-dir'` = tax rates setup scenario

# Rules for Government Spending (govspndrulesim)

#	rule	control param	default
1	growth rate; quantity is exog	govspndgrw0/govspndgrwsim	gdpgrw
2	GDP share	govspndgdp0/govspndgdpsim	baseyr

Automatically, ISIM selects option 1 for all elements.

By default, for non-setup scenarios  
ISIM makes the following selection for  
elements in govspndrulesim

- trngovgov = real values setup scenario
- trrowgov = real values setup scenario
- congov = real values setup scenario
- 'f-capg' = real values setup scenario

# Rules for Non-Government Payments (ngovpayrulesim)

#	rule	control param	default
1	growth rate; quantity is exog	ngovpaygrw0/ngovpaygrwsim	gdpgrw
2	GDP share	ngovpaygdp0/ngovpaygdpsim	baseyr

Automatically, ISIM selects option 1 for all elements.

By default, for non-setup scenarios ISIM makes the following selection for elements in `ngovpayrulesim`

- `trngovrow` = real values setup scenario
- `trrowngov` = real values setup scenario
- `savngov` = real values setup scenario
- `trfacrow` = real values setup scenario
- `trrowfac` = real values setup scenario
- `netforfinngov` = real values setup scenario
- `fdi` = real values setup scenario
- `'f-cap'` = real values setup scenario

# Alternatively, Selection of Defaults Using "BASE"

- The base scenario can be used to impose defaults on the other simulations.
  - if no choice is made for the base scenario, it is identical to the pre-programmed reference scenario
  - in our case, selection of values for baseline scenario simplifies scenario definition
    - according to SAM, government consumes/provides public administration and other services



# Scenario Definitions: Rules for Government Receipts (**govrecrulesim**)

- `trgovrow` = real values setup scenario
- `trgovngov` = real values setup scenario
- `netforfingov` = real values setup scenario
- `netdomfin` = real values setup scenario
- 'tax-act' = tax rates setup scenario
- 'tax-imp' = tax rates setup scenario
- 'tax-com' = tax rates setup scenario
- 'tax-dir' = endogenous – see `govclossim` (!)
- **Question: do we need to introduce any change?**

# Scenario Definitions: Rules for Government Spending (govspndrulesim)

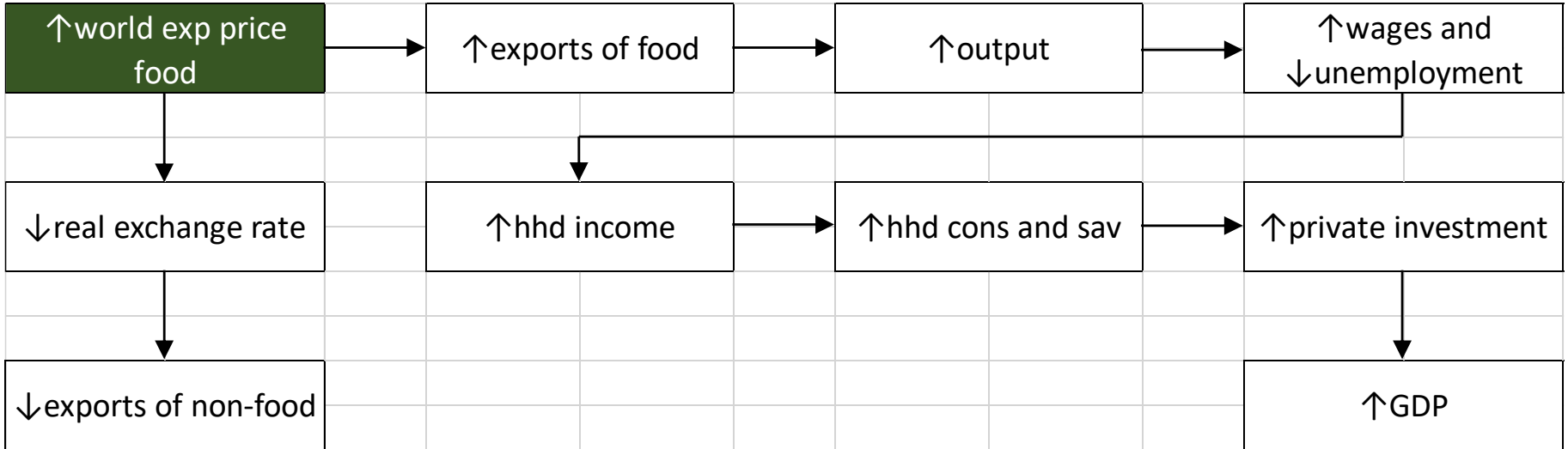
- trngovgov = real values setup scenario
- trrowgov = real values setup scenario
- congov = real values setup scenario
- 'f-capg' = real values setup scenario
- Question: do we need to introduce any change?

# Scenario Definitions: Rules for Non-Government Payments

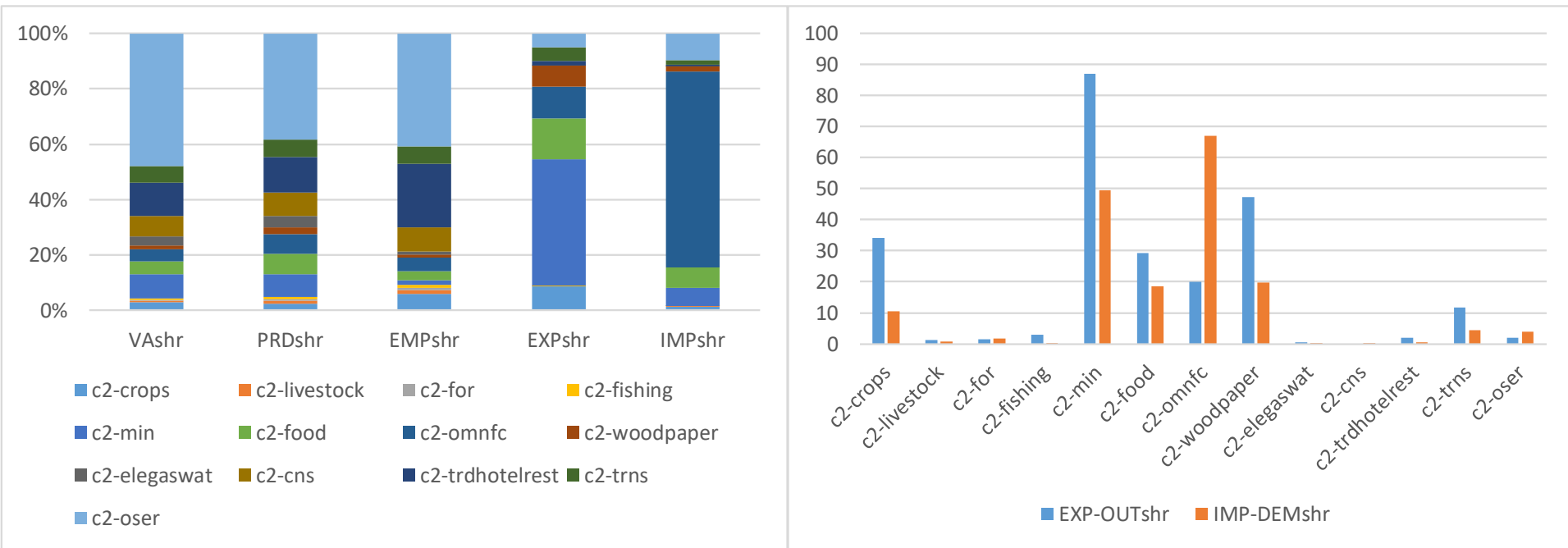
## (ngovpayrulesim)

- trngovrow = real values setup scenario
- trrowngov = real values setup scenario
- savngov = real values setup scenario
- trfacrow = real values setup scenario
- trrowfac = real values setup scenario
- netforfinngov = real values setup scenario
- fdi = real values setup scenario
- 'f-cap' = endogenous – see siclossim (!)
- Question: do we need to introduce any change?

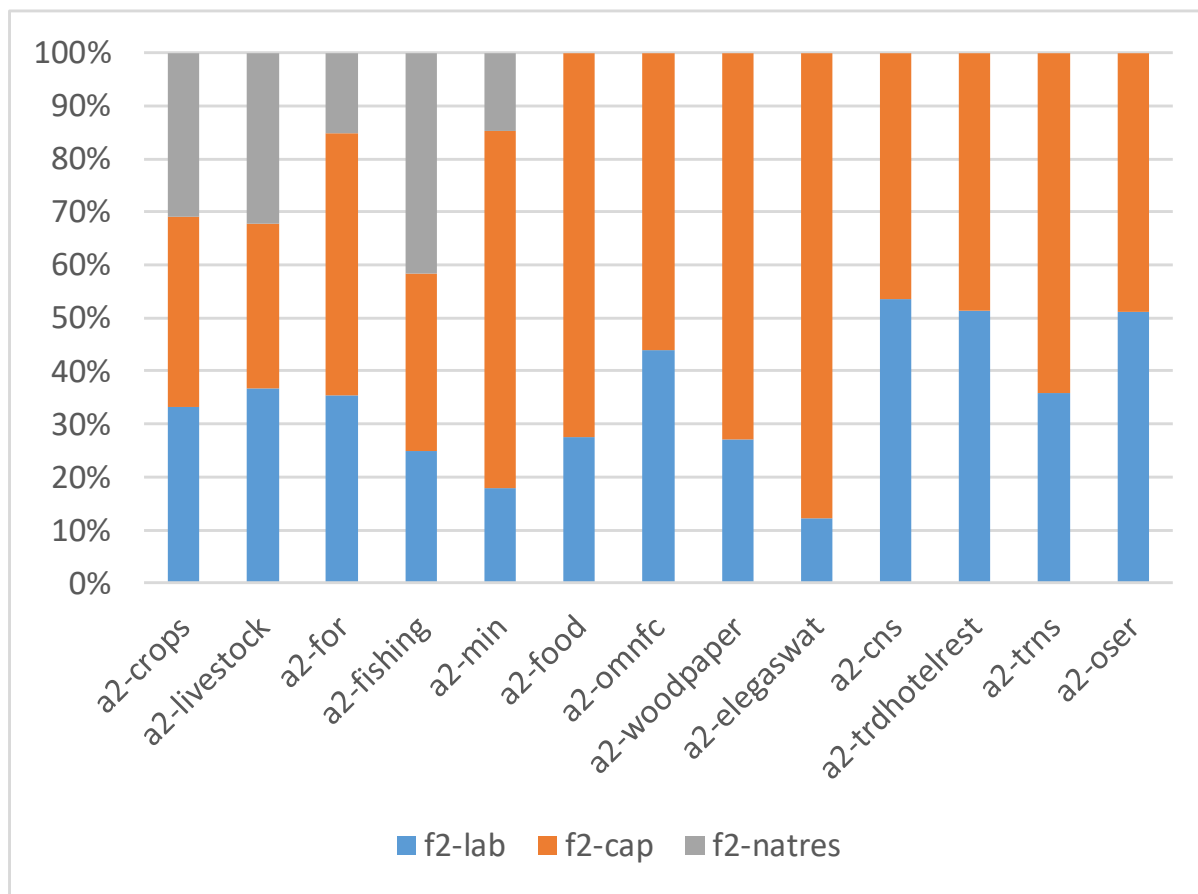
# Transmission Channels pwefood



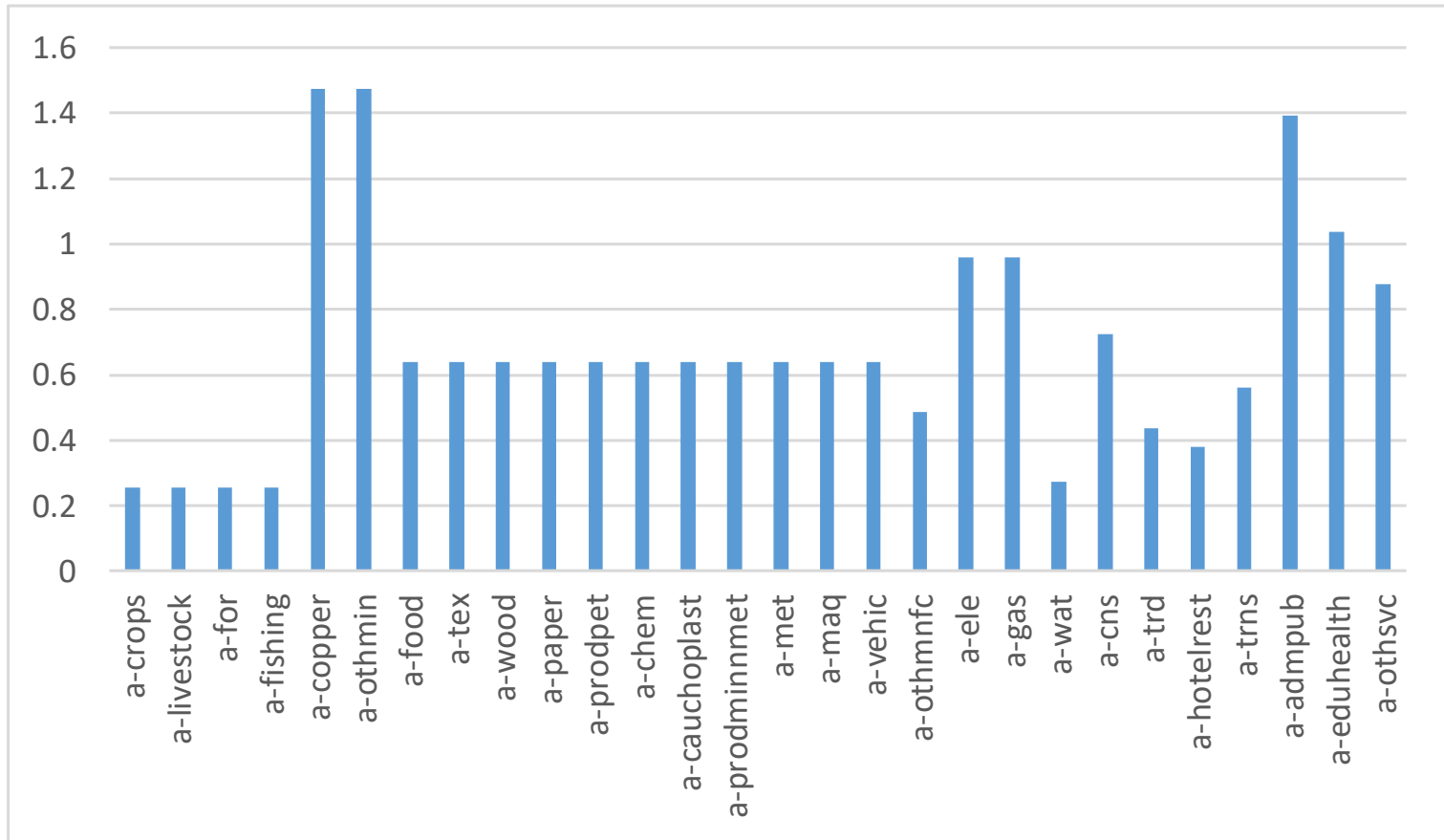
# Key Base-Year Data: Sectoral Structure (%)



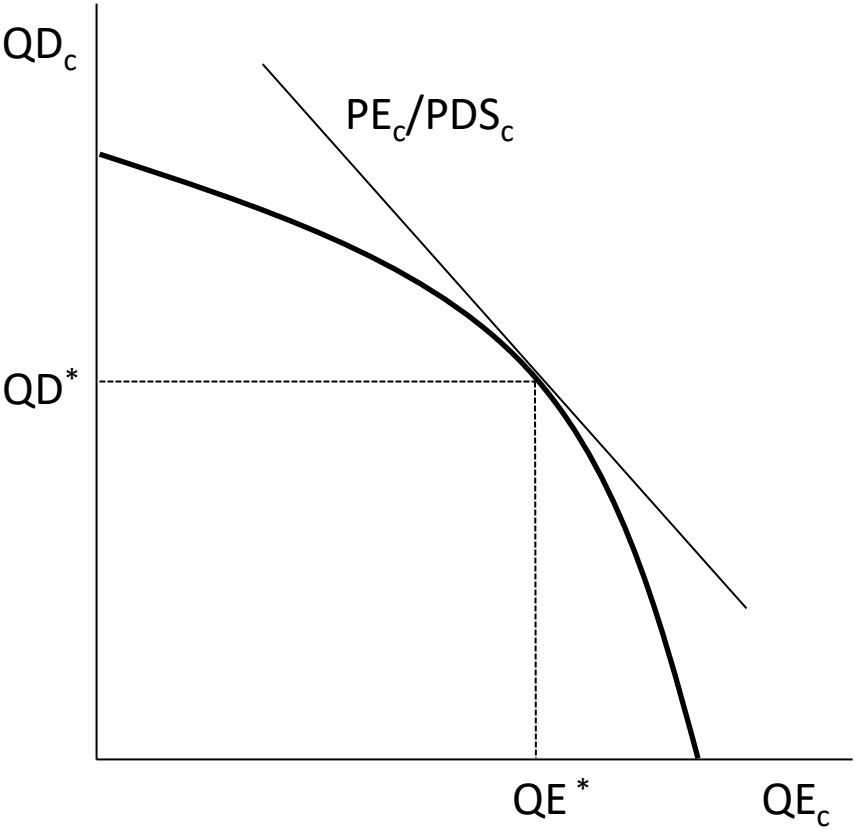
# Key Base-Year Data: Sectoral Value Added Composition (%)



# Key Base-Year Data: Real Wages

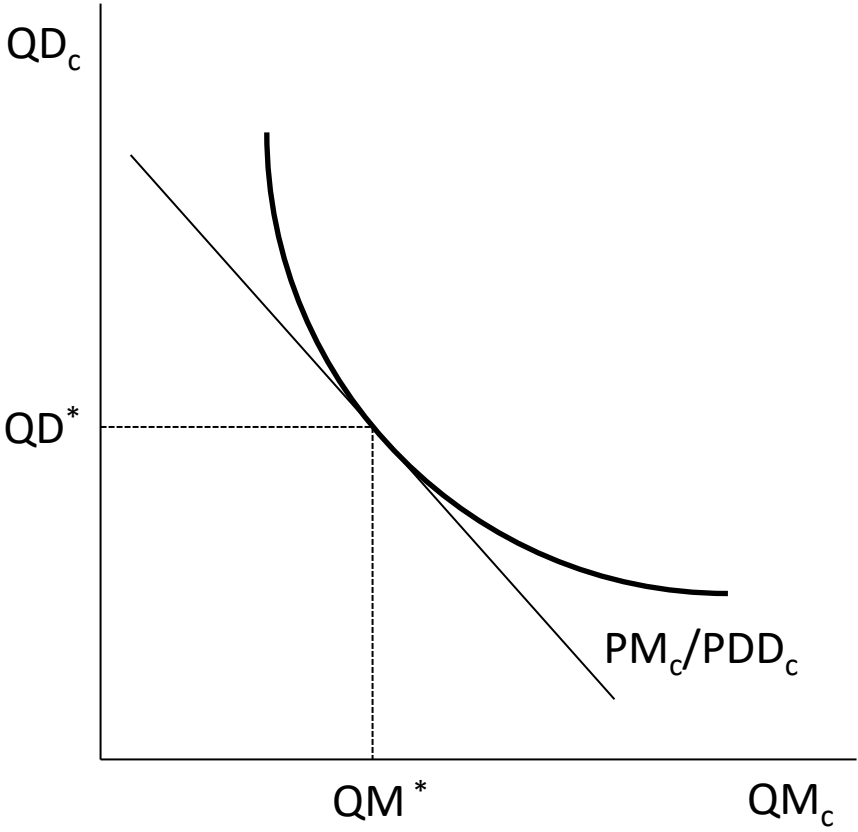


# Domestic Sales vs. Exports





# Domestic Purchases vs. Imports



# Key Equations and Variables: Export and Import Prices

$$PE_{c,t} = (1 - te_{c,t})EXR_t \cdot pwe_{c,t} - \sum_{c' \in CT} PQ_{c',t} \cdot ice_{c',c} \quad \begin{array}{l} c \in C \\ t \in T \end{array}$$

$$\frac{QE_{c,t}}{QD_{c,t}} = \left( \frac{PE_{c,t}}{PDS_{c,t}} \cdot \frac{\delta_c^{ds}}{\delta_c^e} \right)^{\sigma_c^x} \quad \begin{array}{l} c \in C \\ t \in T \end{array}$$

$$PM_{c,t} = (1 + tm_{c,t})EXR_t \cdot pwm_{c,t} + \sum_{c' \in CT} PQ_{c',t} \cdot icm_{c',c} \quad \begin{array}{l} c \in C \\ t \in T \end{array}$$

$$\frac{QM_{c,t}}{QD_{c,t}} = \left( \frac{PDD_{c,t}}{PM_{c,t}} \cdot \frac{\delta_c^m}{\delta_c^{dd}} \right)^{\sigma_c^q} \quad \begin{array}{l} c \in C \\ t \in T \end{array}$$

# Key Equations and Variables: Balance of Payments (FCU)

$$\begin{aligned}
 & \sum_{c \in C} pwe_{c,t} \cdot QE_{c,t} + \sum_{i \in INSD} trnsfr_{i,row,t} + \sum_{f \in F} trnsfr_{f,row,t} + SAVF_t \\
 & = \sum_{c \in C} pwm_{c,t} \cdot QM_{c,t} + trnsfr_{row,gov,t} + \frac{\sum_{i \in INSDNG} TRII_{row,i,t}}{EXR_t} \\
 & + \sum_{f \in F} trnsfr_{row,f,t}
 \end{aligned}
 \qquad t \in T$$

In words, outflows of foreign exchange (left) = inflows of foreign exchange (right).

# Key Equations and Variables: Activity and Commodity Prices

$$PX_{c,t} \cdot QX_{c,t} = PDS_{c,t} \cdot QD_{c,t} + PE_{c,t} \cdot QE_{c,t} \quad \begin{array}{l} c \in C \\ t \in T \end{array}$$

$$PA_{a,t} = \sum_{c \in C} \theta_{a,c} \cdot PX_{c,t} \quad \begin{array}{l} a \in A \\ t \in T \end{array}$$

$$PVA_{a,t} = PA_{a,t} (1 - ta_{a,t}) - \sum_{c \in C} PQ_{c,t} \cdot ica_{c,a} \quad \begin{array}{l} a \in A \\ t \in T \end{array}$$

# Key Equations and Variables: Factor Demand and Output

$$Q_{F_{f,a,t}} = \left( \frac{PVA_{a,t}}{WF_{f,t} \cdot WFDIST_{f,a,t}} \right)^{\sigma_a^{va}} (\delta_{f,a}^{va})^{\sigma_a^{va}} (TFP_{a,t} \cdot \varphi_a^{va})^{\sigma_a^{va}-1} \cdot QA_{a,t}$$

$f \in FVA$   
 $a \in A$   
 $t \in T$

$$WFDIST_{f,a,t} = wfdistb_{f,a}$$

$f \in FVA$   
 $f \in FMOB$   
 $t \in T$

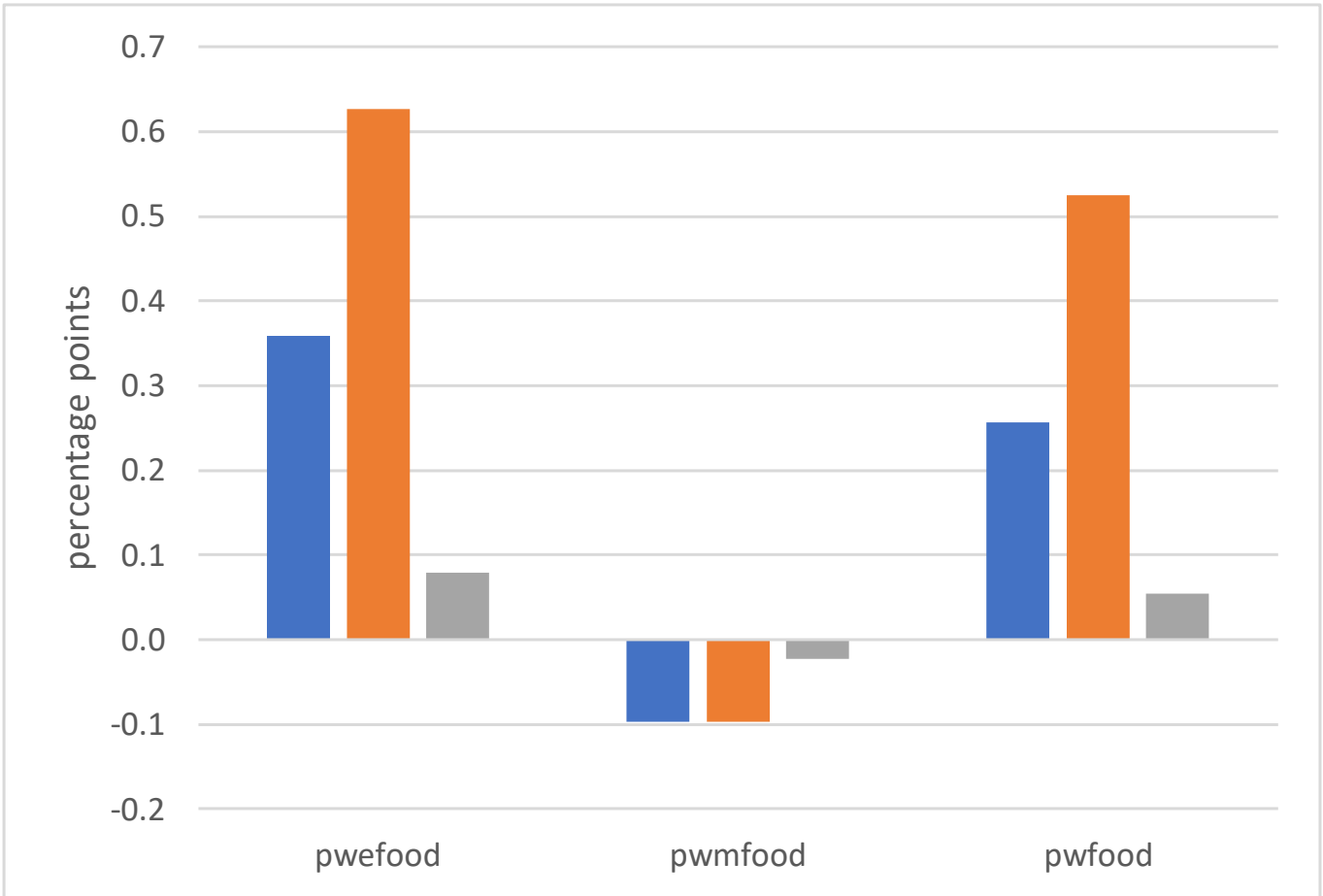
$$WF_{f,t} = wfb_f$$

$f \in FVA$   
 $f \in FNMOb$   
 $t \in T$

$$QA_{a,t} = TFP_{a,t} \cdot \varphi_a^{va} \left( \sum_{f \in F} \delta_{f,a}^{va} \cdot Q_{F_{f,a,t}}^{-\rho_a^{va}} \right)^{\frac{-1}{\rho_a^{va}}}$$

$a \in A$   
 $t \in T$

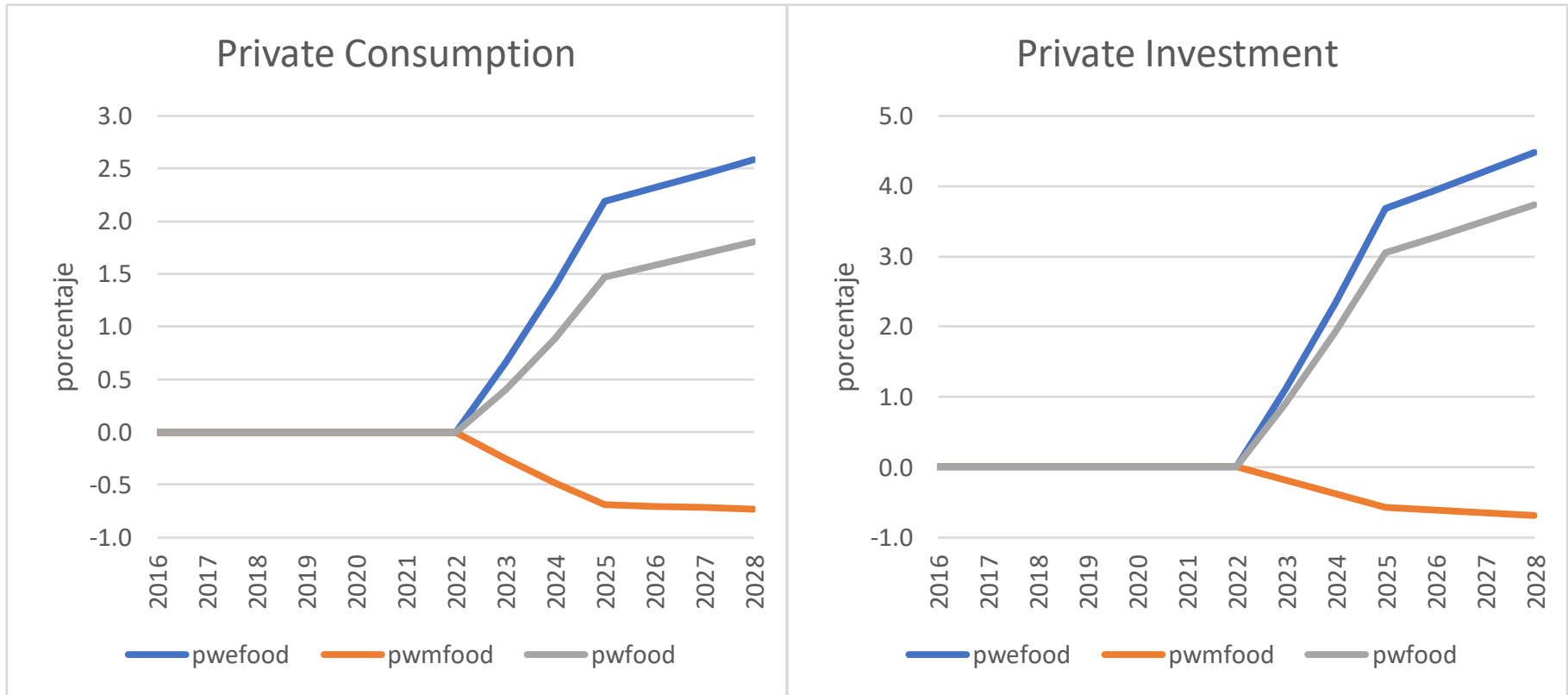
# Private Consumption (average growth rate 2023-2030 pp deviation from base)



# Macro Results; average growth rate 2023-2030 (%)

	baseyr	base	pwefood	pwmfood	pwfood
Absorption	167,937.01	1.83	2.18	1.75	2.10
PrvCon	107,066.79	1.84	2.19	1.74	2.09
GovCon	23,361.94	1.88	1.88	1.88	1.88
FixInv	38,208.32	1.77	2.33	1.68	2.24
PrvFixInv	34,262.23	1.77	2.39	1.67	2.29
GovFixInv	3,946.09	1.77	1.77	1.77	1.77
StockChange	-700.05	1.88	1.88	1.88	1.88
Exports	46,023.58	1.74	1.65	1.68	1.59
Imports	45,306.07	1.60	2.53	1.38	2.28
GDPMP	168,654.51	1.86	1.95	1.82	1.91
NetIndTax	18,715.58	1.58	1.90	1.50	1.81
GDPFC	151,048.16	1.88	1.96	1.86	1.94
REXR	1.00	0.66	-0.78	0.65	-0.77
Wage	1.00	1.23	1.63	1.05	1.43
CapRet	1.00	1.00	1.04	0.84	0.86
UnempRat	6.51	5.98	5.74	6.07	5.84

# Real Private Consumption and Investment (% level deviation from base)





# Sectoral Exports; average growth rate

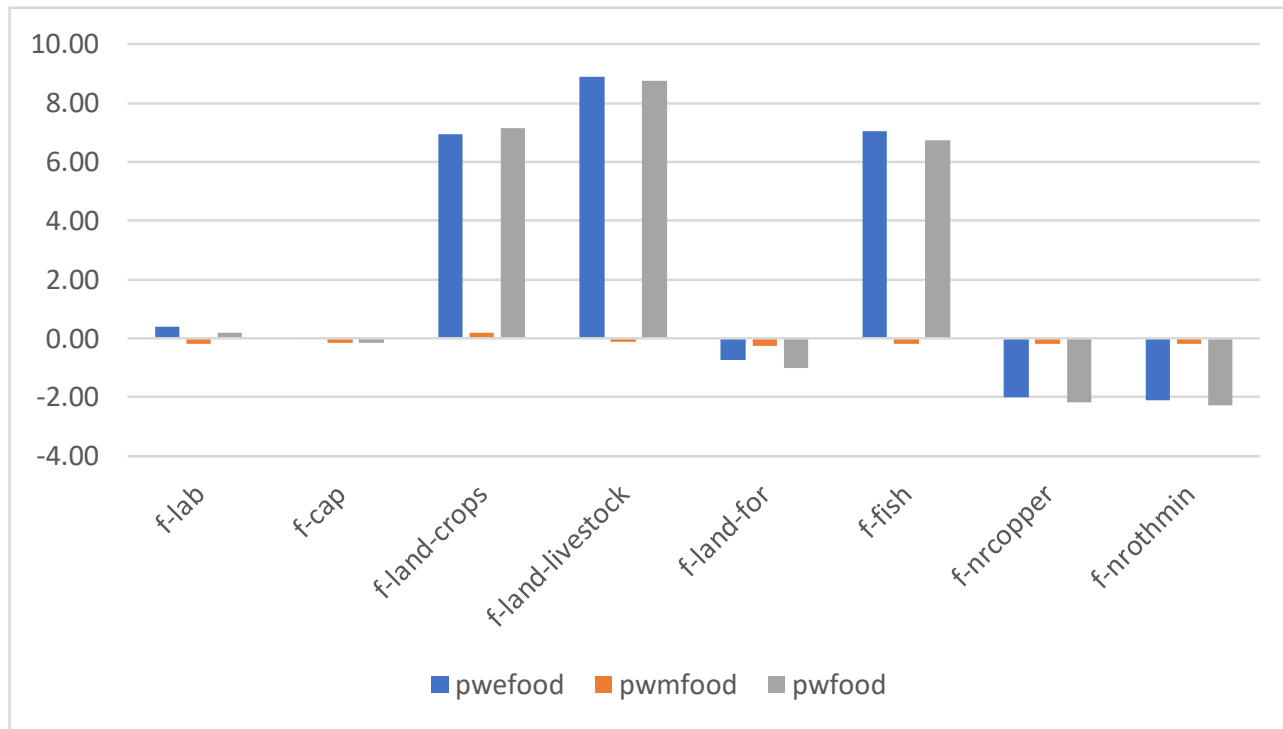
## 2023-2030 (%)

	baseyr	base	pwefood	pwmfood	pwfood
c-crops	4,585.24	2.53	4.34	2.30	4.12
c-livestock	51.29	-1.33	-0.46	-1.81	-0.87
c-for	18.60	2.99	2.54	2.87	2.42
c-fishing	109.24	-0.71	1.34	-1.11	1.04
c-copper	18,804.17	0.94	0.56	0.93	0.55
c-otrmin	1,848.58	0.93	0.28	0.93	0.29
c-food	7,471.48	1.11	3.72	0.85	3.49
c-tex	421.19	4.71	0.67	4.75	0.78
c-wood	1,461.96	2.32	0.51	2.32	0.54
c-paper	1,857.86	2.28	0.73	2.28	0.75
c-prodpet	228.78	2.11	0.88	2.11	0.91
c-chem	1,959.57	2.66	0.81	2.66	0.84
c-cauchoplast	408.49	3.49	1.09	3.51	1.15
c-prodminmet	52.66	2.71	0.96	2.71	0.99
c-met	639.89	3.26	1.11	3.28	1.16
c-maq	613.20	3.49	1.28	3.52	1.34
c-vehic	297.14	4.74	1.52	4.81	1.64
c-othmnc	170.99	4.59	0.45	4.67	0.62
c-ele	7.54	1.16	0.29	1.14	0.28
c-gas	59.80	1.38	0.92	1.37	0.91
c-trd	663.22	2.72	1.59	2.70	1.59
c-hotelrest	11.48	2.91	1.56	2.67	1.33
c-trns	2,090.12	2.33	1.17	2.33	1.19
c-othsvc	2,191.10	2.63	1.37	2.63	1.38
total	46,023.58	1.74	1.65	1.68	1.59

# Sectoral VA; average growth rate 2023-2030 (%)

	baseyr	base	pwefood	pwmfood	pwfood
c-crops	4,068.53	2.05	2.85	2.09	2.88
c-livestock	829.69	1.08	1.90	1.08	1.90
c-for	564.11	1.99	1.75	1.96	1.72
c-fishing	820.50	1.11	2.21	1.10	2.20
c-copper	11,131.14	0.96	0.57	0.94	0.56
c-otrmin	1,846.45	1.17	0.71	1.16	0.71
c-food	6,166.34	1.26	2.39	1.26	2.37
c-tex	286.61	3.36	1.59	3.38	1.62
c-wood	879.88	2.13	1.22	2.11	1.21
c-paper	1,351.17	2.05	1.37	2.04	1.37
c-prodpet	567.76	1.72	1.75	1.71	1.74
c-chem	1,761.05	2.19	1.39	2.19	1.40
c-cauchoplast	534.20	2.52	1.73	2.52	1.74
c-prodminmet	552.98	1.93	1.99	1.89	1.94
c-met	1,227.40	2.48	1.69	2.46	1.68
c-maq	731.38	2.69	1.78	2.69	1.79
c-vehic	171.03	3.83	1.84	3.87	1.90
c-othmnc	859.19	2.32	2.08	2.32	2.09
c-ele	3,703.54	1.43	1.47	1.41	1.45
c-gas	284.69	1.53	1.64	1.51	1.62
c-wat	711.98	1.44	1.58	1.43	1.56
c-cns	11,154.02	1.80	2.28	1.72	2.20
c-trd	14,363.08	1.91	2.22	1.84	2.14
c-hotelrest	3,817.91	2.11	2.14	1.98	2.02
c-trns	9,103.58	1.89	1.84	1.88	1.82
c-admpub	7,586.39	1.90	1.90	1.90	1.90
c-eduhealth	15,568.48	2.35	2.38	2.35	2.38
c-othsvc	50,405.09	1.96	1.98	1.94	1.97
total	151,048.16	1.88	1.96	1.86	1.94

# Real Wages (rents) by Factor (% level deviation from base in 2030)



Question: why does the natural resource used in copper extraction lose in the pwefood scenario? hint: analyze the sectoral structure in sectorstruc00.

# Additional Exercises

- Now, run the same set of simulations with alternative (higher) trade elasticities:
  - Armington elasticity [ $\sigma_q$ ] = 8 for all commodities (instead of 2, 1.5 and 0.9)
  - CET elasticities [ $\sigma_x$ ] = 8 for all commodities (instead of 2, 1.5 and 0.9)
- In this case, it is necessary to re-calibrate the model; it is not necessary to re-define the simulation scenarios.
- In addition, analyze sensitivity results to other model elasticities.

# Macro Results with SigmaQ and SigmaX

## = 8

	baseyr	base	pwefood	pwmfood	pwfood
Absorption	167927.01	1.83	2.29	1.79	2.17
PrvCon	106818.37	1.84	2.29	1.78	2.16
GovCon	23361.94	1.88	1.88	1.88	1.88
FixInv	38446.75	1.80	2.50	1.76	2.37
PrvFixInv	34476.03	1.80	2.58	1.75	2.43
GovFixInv	3970.71	1.80	1.80	1.80	1.80
StockChange	-700.05	1.88	1.88	1.88	1.88
Exports	47561.46	1.72	2.63	1.30	1.81
Imports	46825.42	1.57	4.00	1.09	2.80
GDPMP	168663.05	1.87	1.89	1.84	1.89
NetIndTax	18536.31	1.67	2.03	1.63	1.86
GDPFC	151048.16	1.88	1.94	1.87	1.91
REXR	1.00	0.27	-0.68	0.23	-0.70
Wage	1.00	1.39	1.60	1.26	1.23
CapRet	1.00	0.95	0.92	0.83	0.59
UnempRat	6.59	5.89	5.72	5.96	5.90

# Sensitivity Analysis wrt SigmaQ and SigmaX

## Scenario pwefood (average growth rate 2023-2030 pp deviation from base)

