

Asymmetric Armington Model: Method and Application

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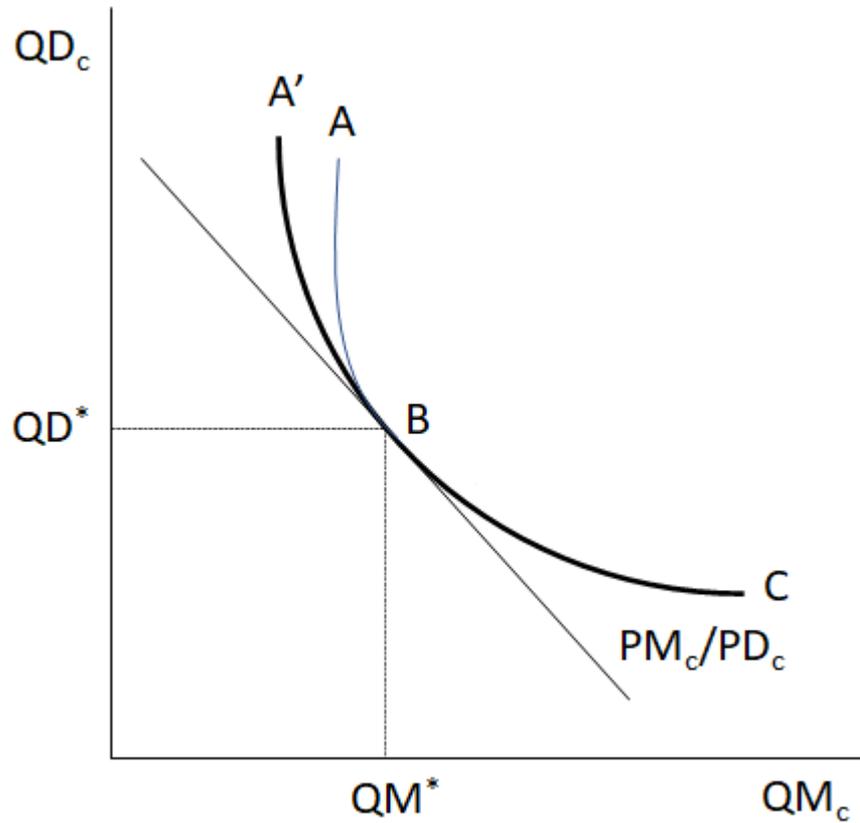
Motivation

- For any country, it may often be easier to find a close substitute for domestic products abroad than to find a close substitute for imports among domestic products.
- In this paper, we extend the Armington treatment by distinguishing between responses to increases and decreases in the price of imports relative to domestic products
 - demand substitution possibilities are asymmetric

Motivation – cont.

- Empirically, this innovation may be important since the size and direction of real exchange rate adjustments and/or changes in balance of payments deficits caused by terms of trade or other shocks in part depend on these substitution elasticities.
- Certainly, whether imports and domestic products are gross complements ($\sigma < 1$) or substitutes ($\sigma > 1$) in the context of a terms-of-trade (or other) shock is crucial for determining its impact.

Asymmetric Armington



Symmetric Armington = $A'BC$
Asymmetric Armington = ABC

Literature review

- CES functions with variable elasticities are not new to the literature – see Revankar (1971), Lovell (1973), Antony (2010), and Growiec and Mućk (2015)
- However, those approaches are different, only indirectly linked to relative input prices
- De La Grandville (1989) and Rutherford (1995) presents the calibrated share form of the CES – we use it since it simplifies model code.

Notation

- To simplify, we omit the commodity index
- QQ : quantity of goods supplied domestically (composite supply)
- QM : quantity of imports
- QD : quantity sold domestically of domestic output
- PQ : composite demand price
- PM : import price (domestic currency)
- PD : price for commodity produced and sold domestically

The CES relationships (using the calibrated share form)

$$QQ = QQ^0 \cdot \left[\theta^m \cdot \left(\frac{PM}{PM^0} \right)^{\rho^q} + \theta^{dd} \cdot \left(\frac{PD}{PD^0} \right)^{\rho^q} \right]^{\frac{1}{\rho^q}} \quad \rho^q = \frac{\sigma^q - 1}{\sigma^q}$$

$$\theta^m = \frac{PM^0 \cdot QM^0}{PM^0 \cdot QM^0 + PD^0 \cdot QD^0} \quad \theta^{dd} = \frac{PD^0 \cdot QD^0}{PM^0 \cdot QM^0 + PD^0 \cdot QD^0}$$

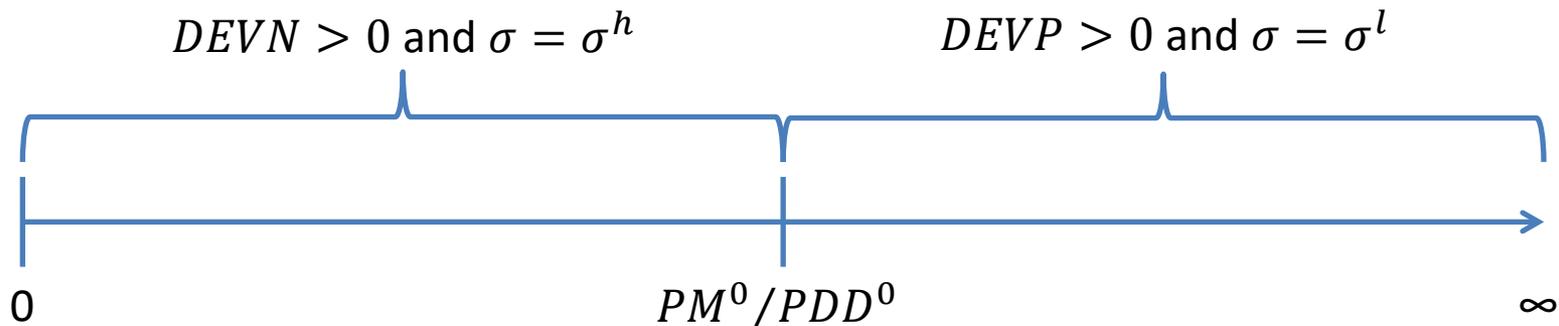
$$PQ = PQ^0 \cdot \left[\theta^m \cdot \left(\frac{PM}{PM^0} \right)^{1-\sigma^q} + \theta^{dd} \cdot \left(\frac{PD}{PD^0} \right)^{1-\sigma^q} \right]^{\frac{-1}{1-\sigma^q}}$$

Method: Key equations

$$\frac{PM}{PD} - \frac{PM^0}{PD^0} = DEVP - DEVN$$

$$DEVP \cdot (SIGMA^Q - \sigma^{ql}) = 0 \quad DEVP \geq 0 \quad SIGMA^Q \geq \sigma^{ql}$$

$$DEVN \cdot (SIGMA^Q - \sigma^{qh}) = 0 \quad DEVN \geq 0 \quad SIGMA^Q \leq \sigma^{qh}$$



Method: Key equations – cont.

$$QM = QM^0 \cdot \frac{QQ}{QQ_0} \cdot \left(\frac{PM^0}{PM} \cdot \frac{PQ}{PD^0} \right)^{SIGMA^Q}$$

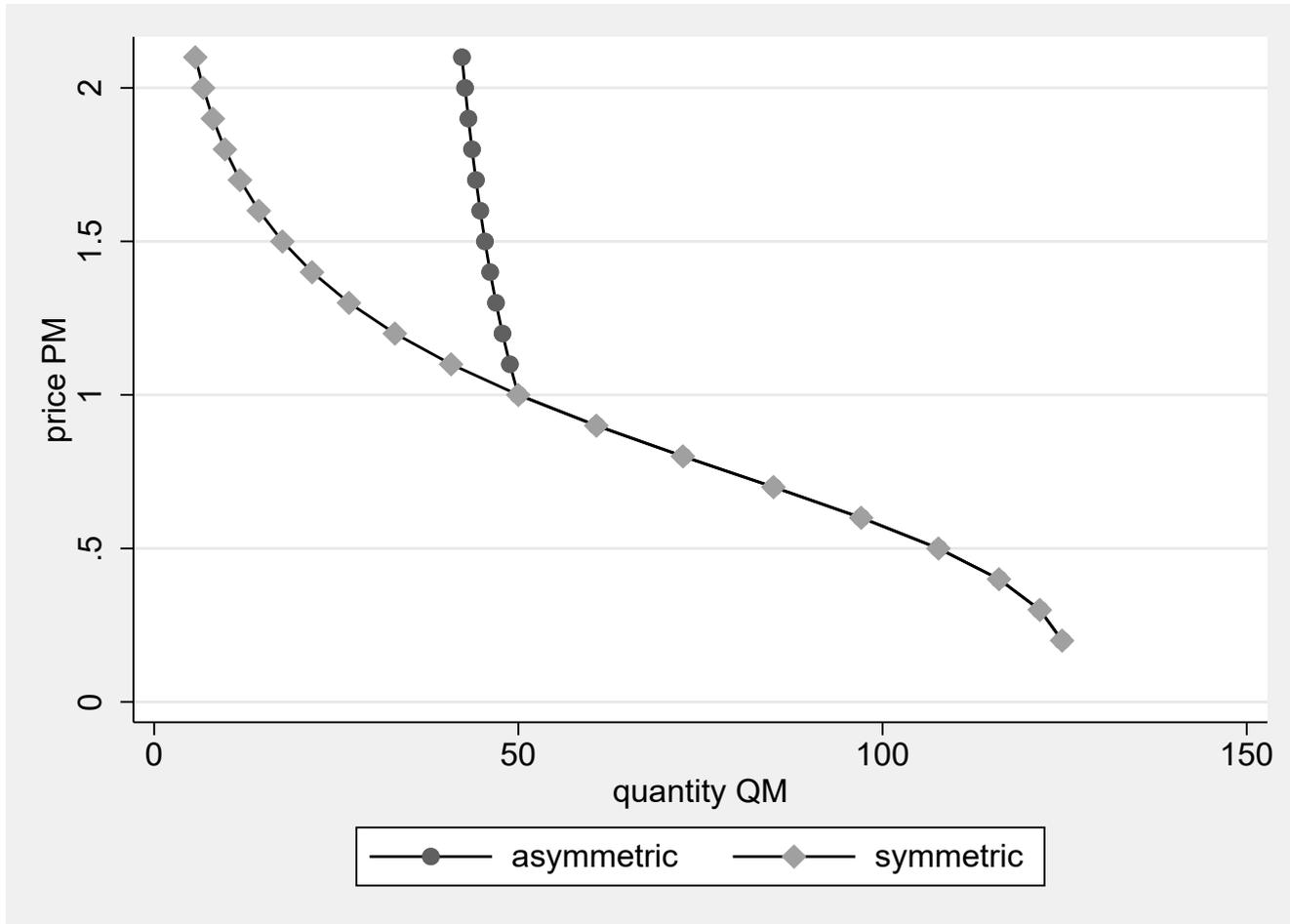
$$QD = QD^0 \cdot \frac{QQ}{QQ_0} \cdot \left(\frac{PD^0}{PD} \cdot \frac{PQ}{PD^0} \right)^{SIGMA^Q}$$

$$PQ = PQ^0 \cdot \left(\theta^m \cdot \left(\frac{PM}{PM^0} \right)^{1-SIGMA^Q} + \theta^{dd} \cdot \left(\frac{PD}{PD^0} \right)^{1-SIGMA^Q} \right)^{\frac{-1}{1-SIGMA^Q}}$$

Partial equilibrium example

- To test the new method, we first construct a partial equilibrium model and use it to derive the import demand curves for the symmetric and asymmetric cases.
- To derive the import demand functions, the world price of imports is changed exogenously for both cases, with the changes ranging from -80% to +110%.
- For the asymmetric case, $\sigma^{ql} = 0.5$ and $\sigma^{qh} = 4$. For the symmetric case, $\sigma^q = 4$.

Partial equilibrium example – cont.



ILLUSTRATIVE SIMULATIONS

Model and data

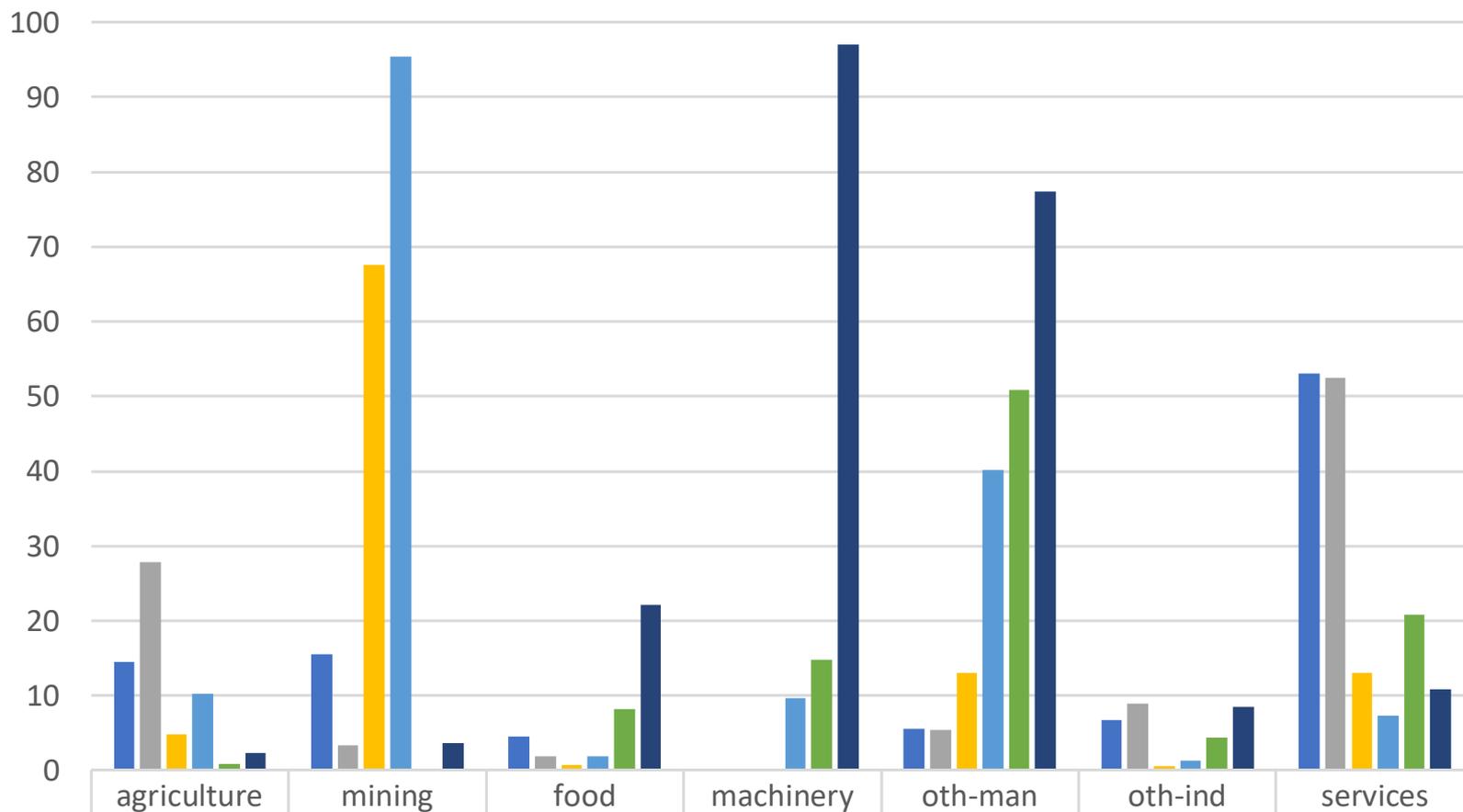
- Simple static CGE model applied to Mongolia.
- Labor is perfectly mobile; capital is sector-specific.
- Macro closure:
 - the real exchange rate clears the current account balance
 - savings clear the savings-investment balance
 - Direct taxes clear the government budget
- SAM for 2015 – an aggregated version of the SAM used in Cicowiez and Lofgren (2018):
 - 7 activities/commodities
 - 4 factors (labor, capital, land, extractive resource)
 - 1 representative household
 - other institutions: enterprises, government, rest of world

Elasticities

	Value added	Armington		CET	LES*
		low	high		
Agriculture	0.25	0.90	3.00	3.00	1.00
Mining	0.20	0.90	3.00	3.00	1.00
Food and beverages	0.95	0.90	3.00	3.00	1.00
Machinery and equipment	0.95	0.90	3.00	3.00	1.00
Other manufacturing	0.95	0.90	3.00	3.00	1.00
Other industry	0.95	0.90	3.00	3.00	1.00
Services	0.95	0.90	3.00	3.00	1.00

*Utility function is Cobb-Douglas.

Figure 4. Sectoral structure, Mongolia, 2015 (%)



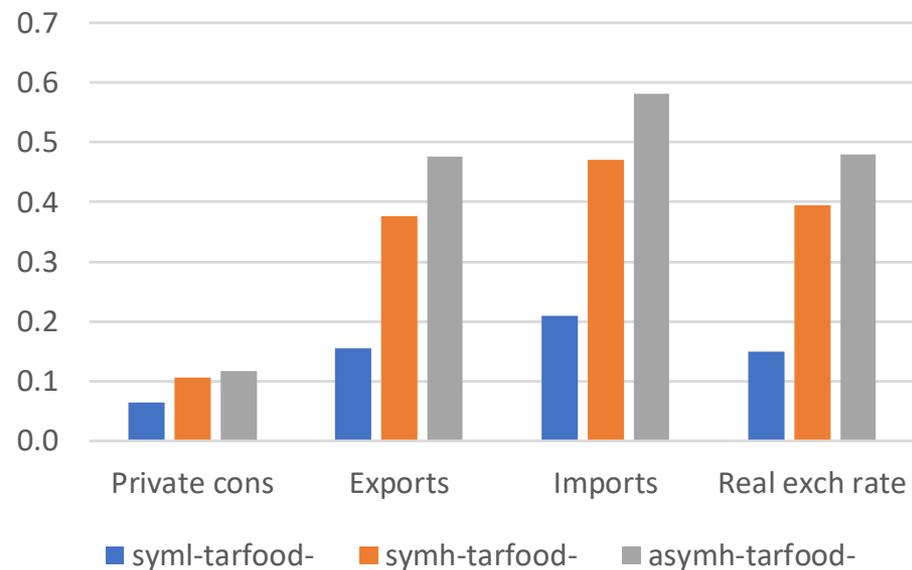
	agriculture	mining	food	machinery	oth-man	oth-ind	services
■ VAshr	14.5	15.6	4.5	0.1	5.5	6.7	53.0
■ EMPshr	27.8	3.4	1.9	0.0	5.5	8.9	52.4
■ EXPshr	4.8	67.6	0.7	0.1	13.1	0.6	13.1
■ EXP-OUTshr	10.3	95.4	2.0	9.7	40.2	1.3	7.3
■ IMPshr	0.8	0.1	8.2	14.8	50.8	4.4	20.8
■ IMP-DEMshr	2.3	3.7	22.2	97.0	77.4	8.5	10.9

Scenarios

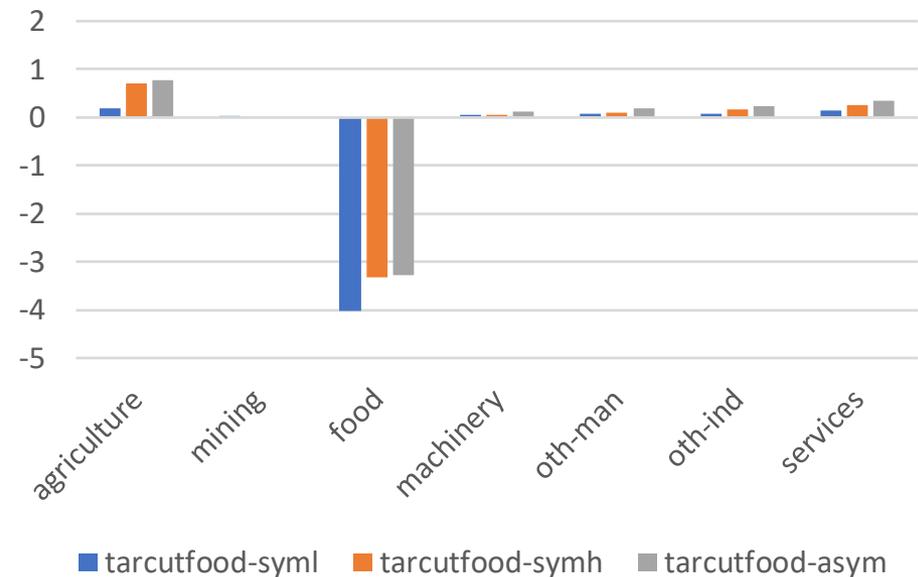
- **tarfood-:**
 - **syml-tarfood-:** Symmetric Armington treatment with low elasticities; elimination of tariff on food products.
 - **symh-tarfood-:** Same except for high elasticities.
 - **asymh-tarfood-:** Same except for asymmetric Armington treatment.
- **pwm+:**
 - **sym-pwm+:** Symmetric Armington treatment; 35% increase in the world (foreign-currency) price of imported machinery and equipment
 - **asym-pwm+:** Same except for asymmetric Armington treatment.
- **savf-:**
 - **sym-savf-:** Symmetric Armington treatment; elimination of current account deficit (5.7% of GDP)
 - **asym-savf-:** Same except for asymmetric Armington treatment.

Results for tarfood- scenarios: Macro and PM/PDD

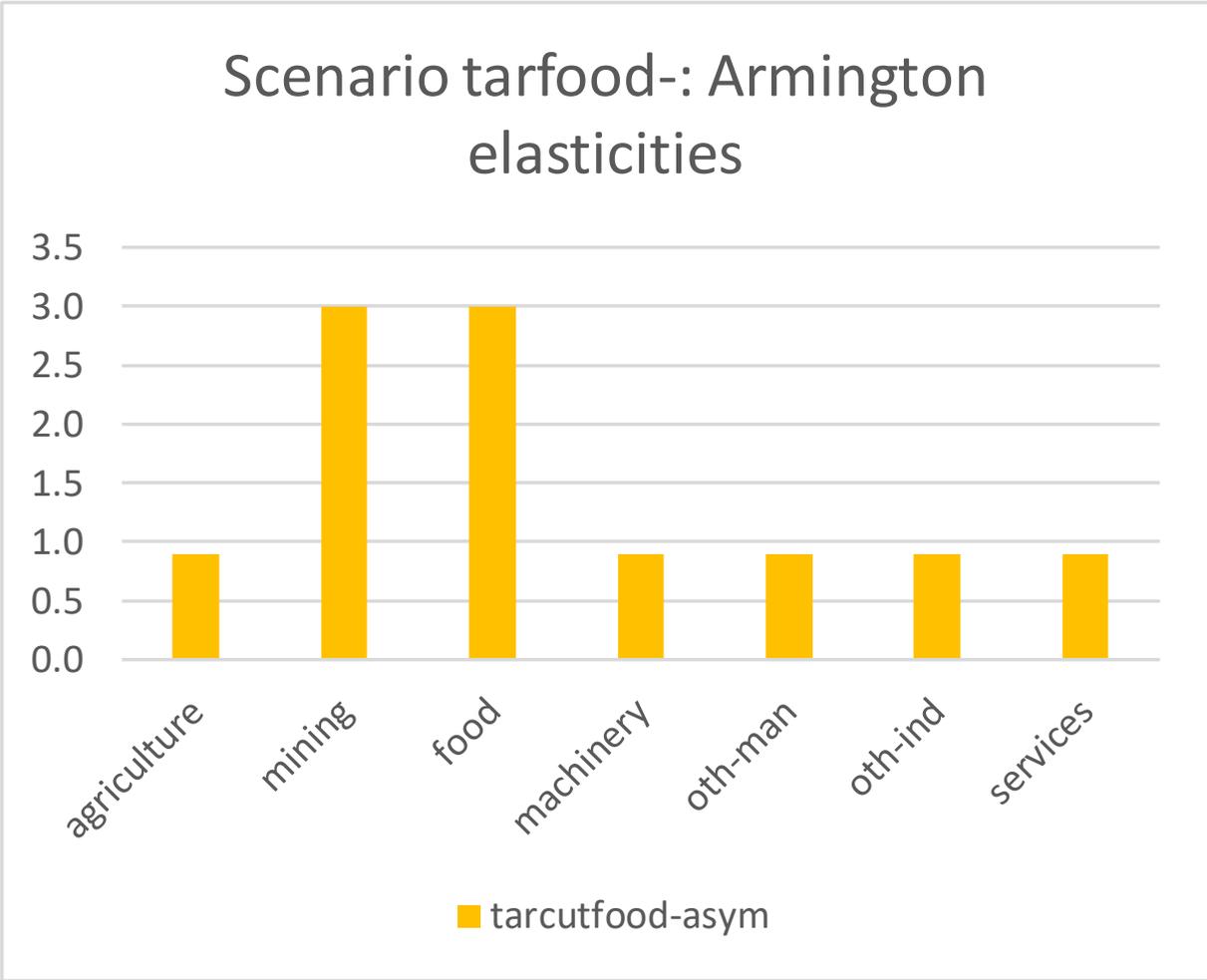
Scenario tarfood-: Macro indicators
(% change)



Scenario tarfood-: PM/PDD (% change)

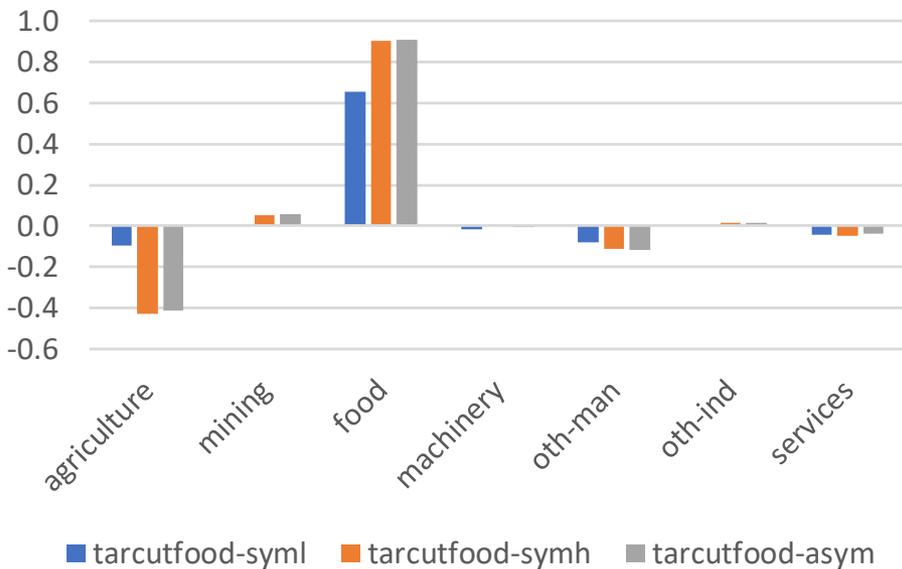


Results for tarfood- scenarios: Endogenously selected elasticities

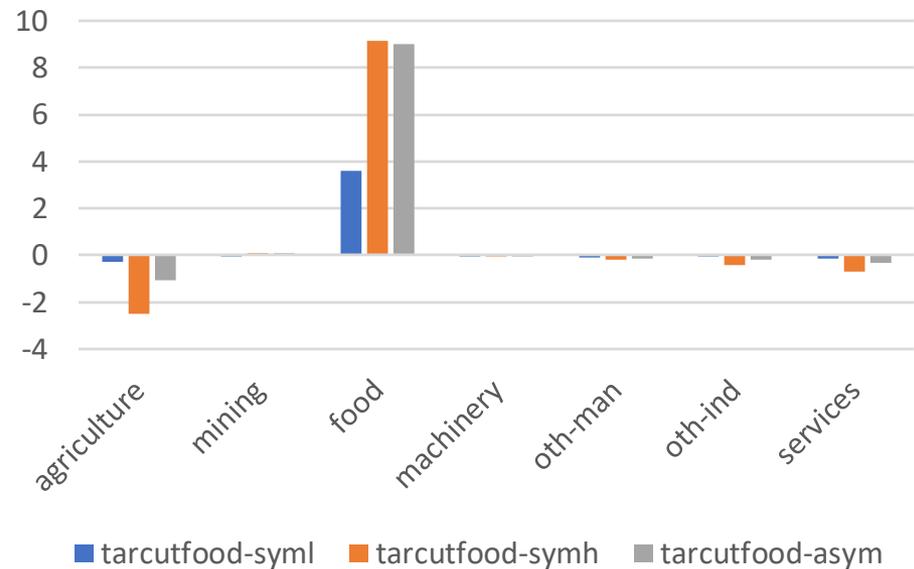


Results for tarfood- scenarios: Composite demand and imports

Scenario tarfood-: Composite demand by commodity (% change)

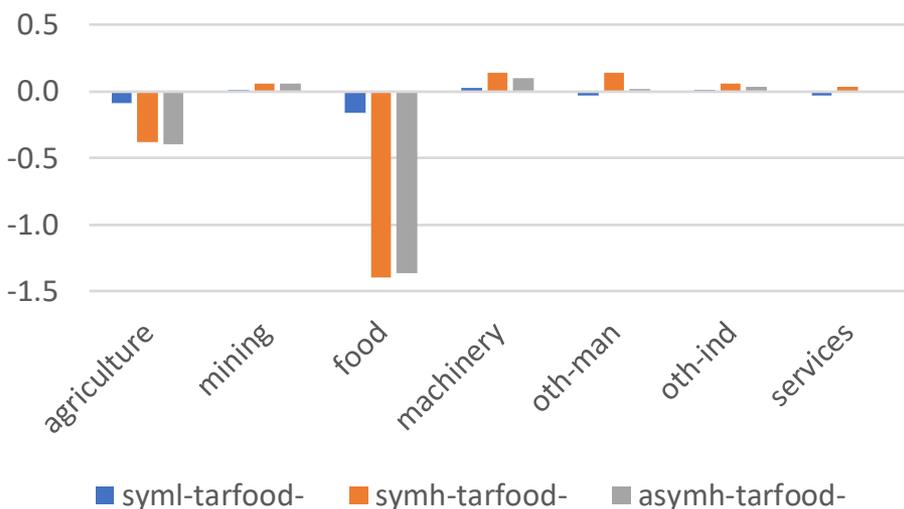


Scenario tarfood-: Imports by commodity (% change)

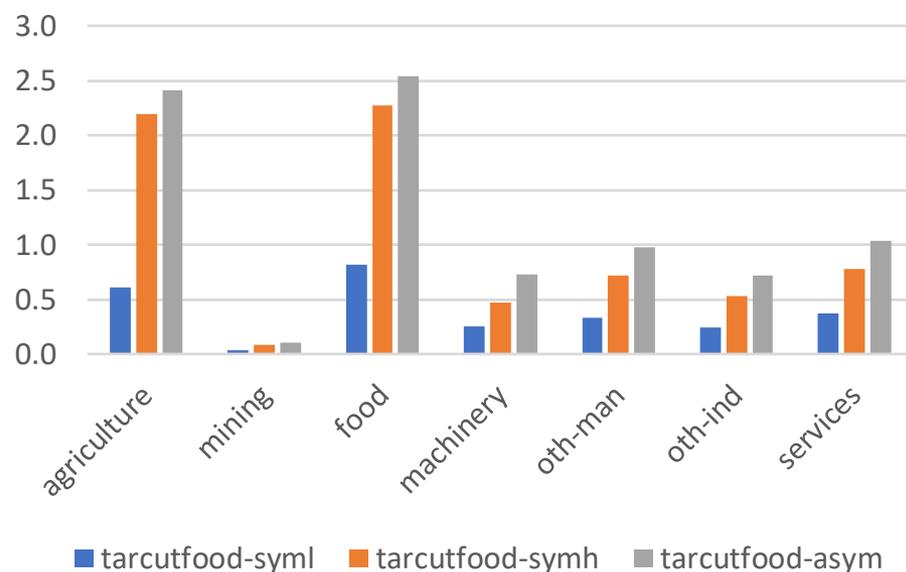


Results for tarfood- scenarios: Domestic output sales and purchases; exports

Scenario tarfood-: Domestic output sales and purchases by commodity (% change)



Scenario tarfood-: Exports by commodity (% change)



Concluding remarks

- The real-world significance of the asymmetric treatment (or lack thereof) can only be determined by econometric research that test the hypothesis of elasticity asymmetry and, if the hypothesis is not rejected, estimate the asymmetric elasticities that are needed for empirical applications of this approach.
- If the world is asymmetric, then it is more difficult for countries to adapt themselves to negative external shocks.

Additional Slides

Results for pwm+ scenarios: Macro and PM/PDD

Figure 6.1. Scenario pwm+: Macro indicators (% change)

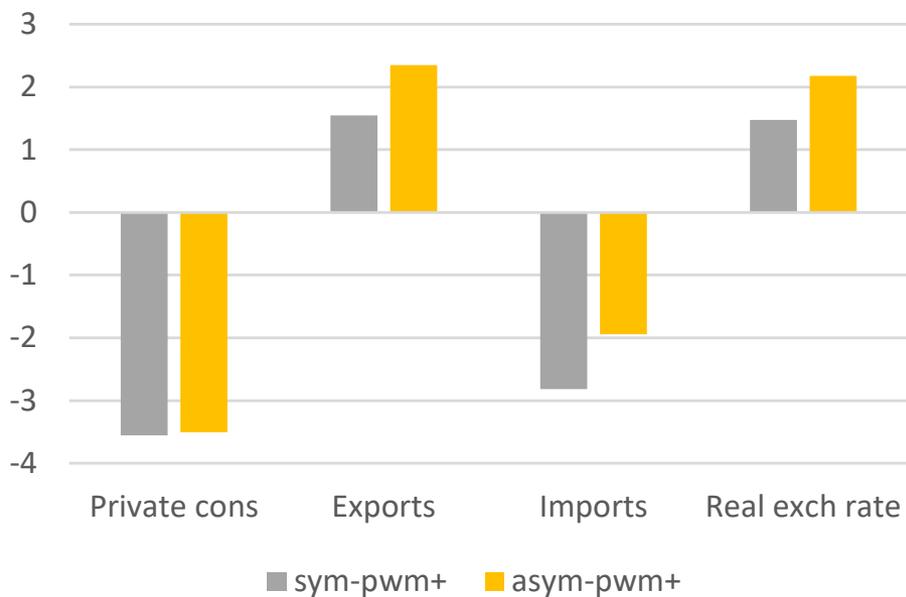
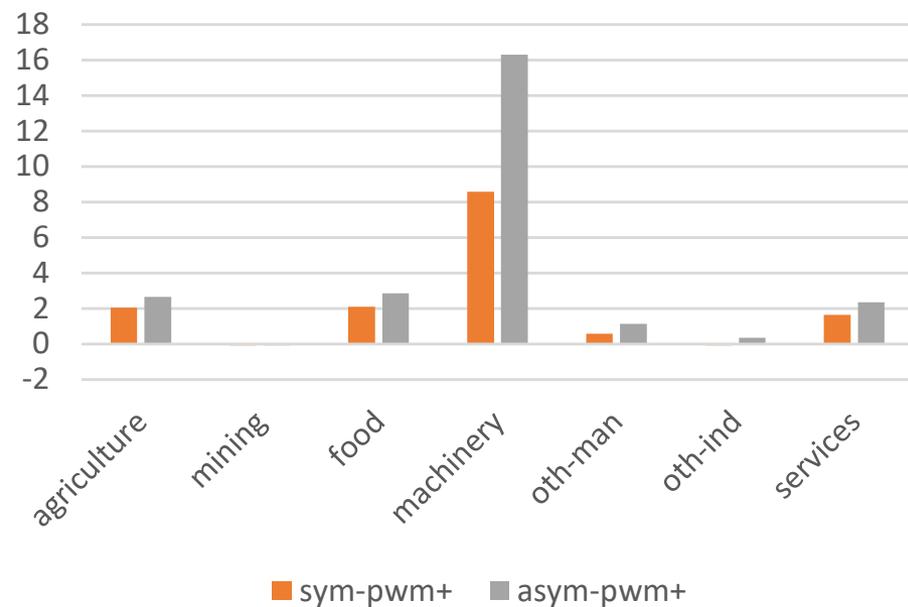
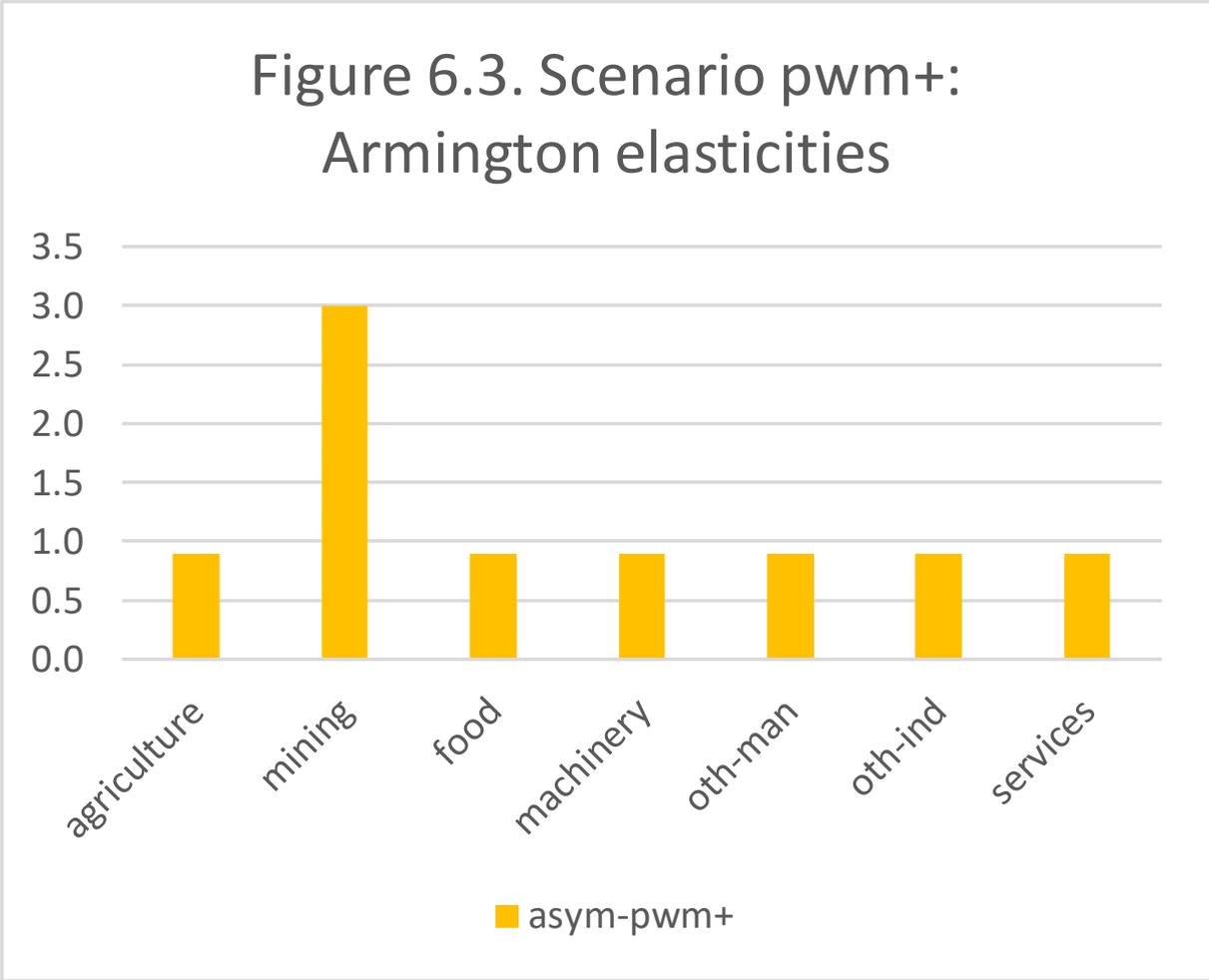


Figure 6.2. Scenario pwm+: PM/PDD (% change)



Results for pwm+ scenarios: Endogenously selected elasticities



Results for pwm+ scenarios: Composite demand and imports

Figure 6.4. Scenario pwm+:
Composite demand by commodity
(% change)

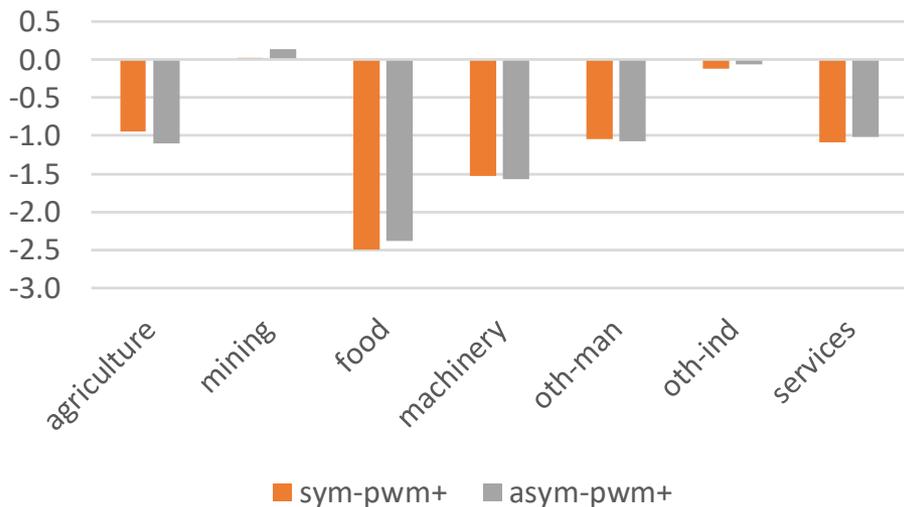
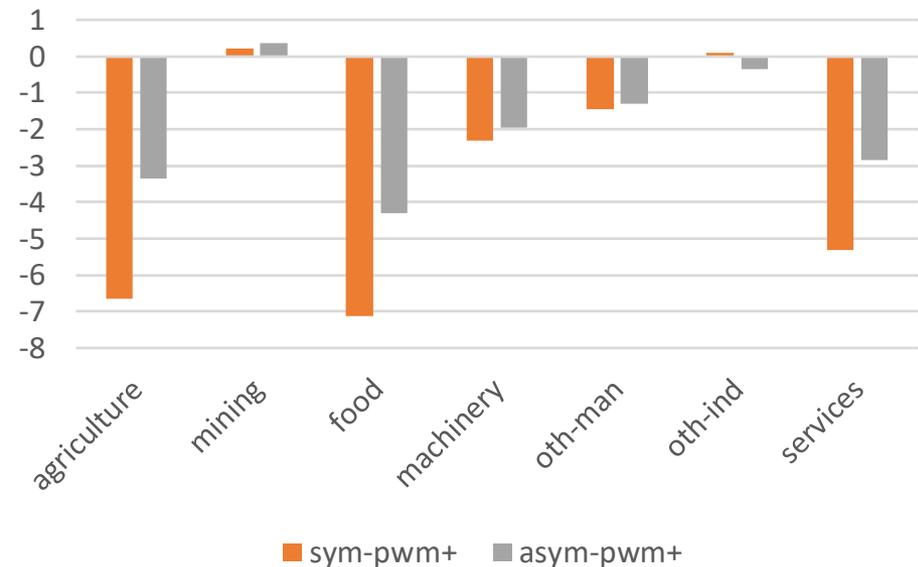


Figure 6.5. Scenario pwm+: Imports
by commodity (% change)



Results for pwm+ scenarios: Domestic output sales and purchases; exports

Figure 6.6. Scenario pwm+: Domestic output sales and purchases by commodity (% change)

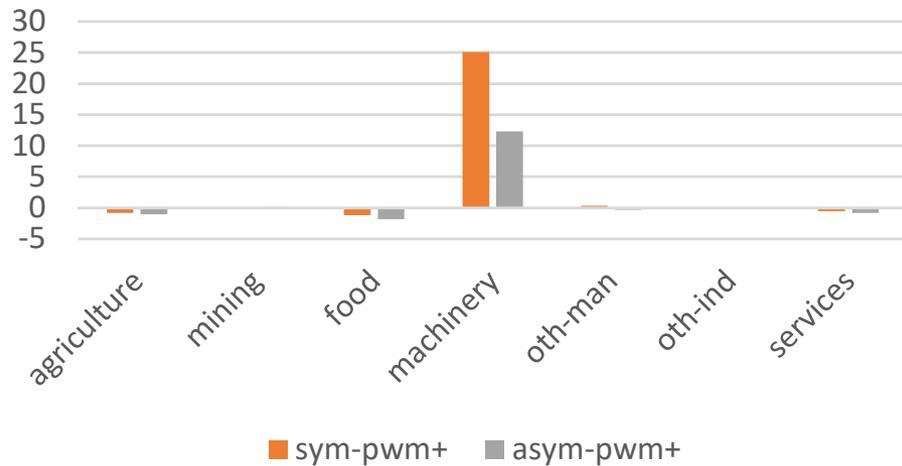
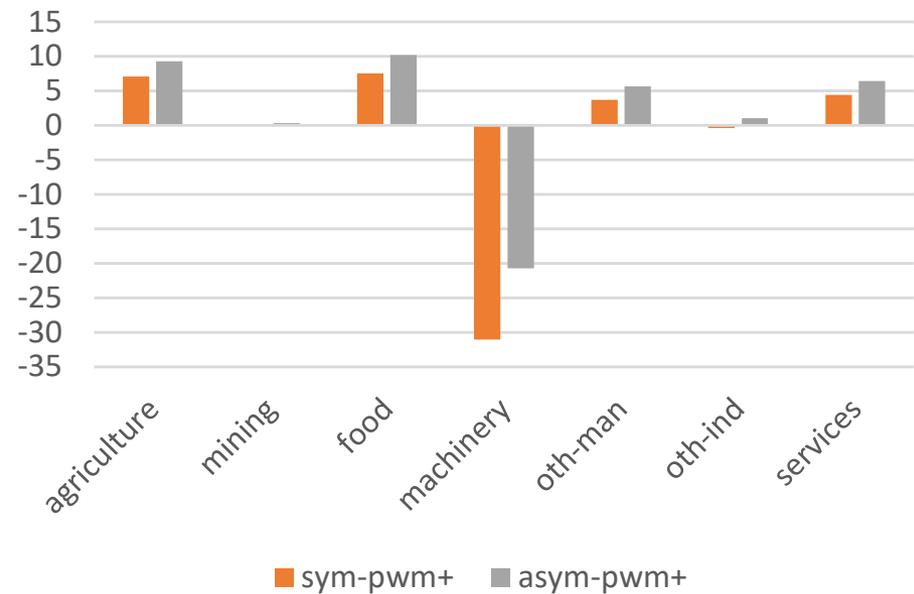


Figure 6.7. Scenario pwm+: Exports by commodity (% change)



Results for savf- scenarios: Macro and PM/PDD

Figure 7.1. Scenario fsav-: Macro indicators (% change)

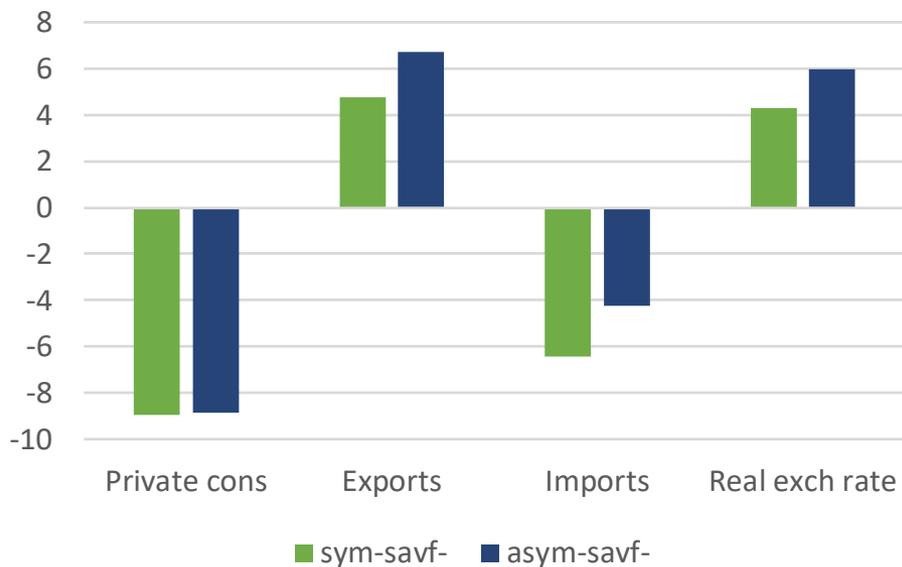
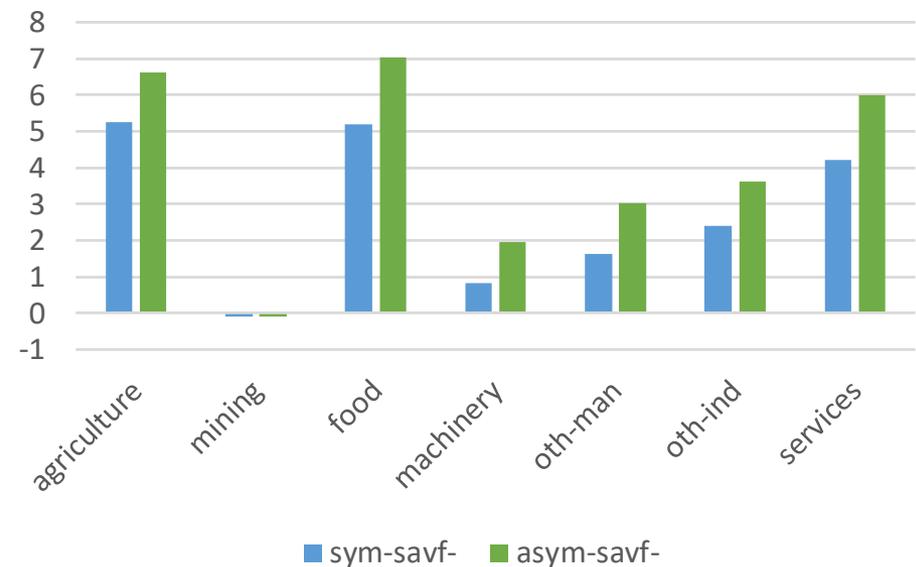
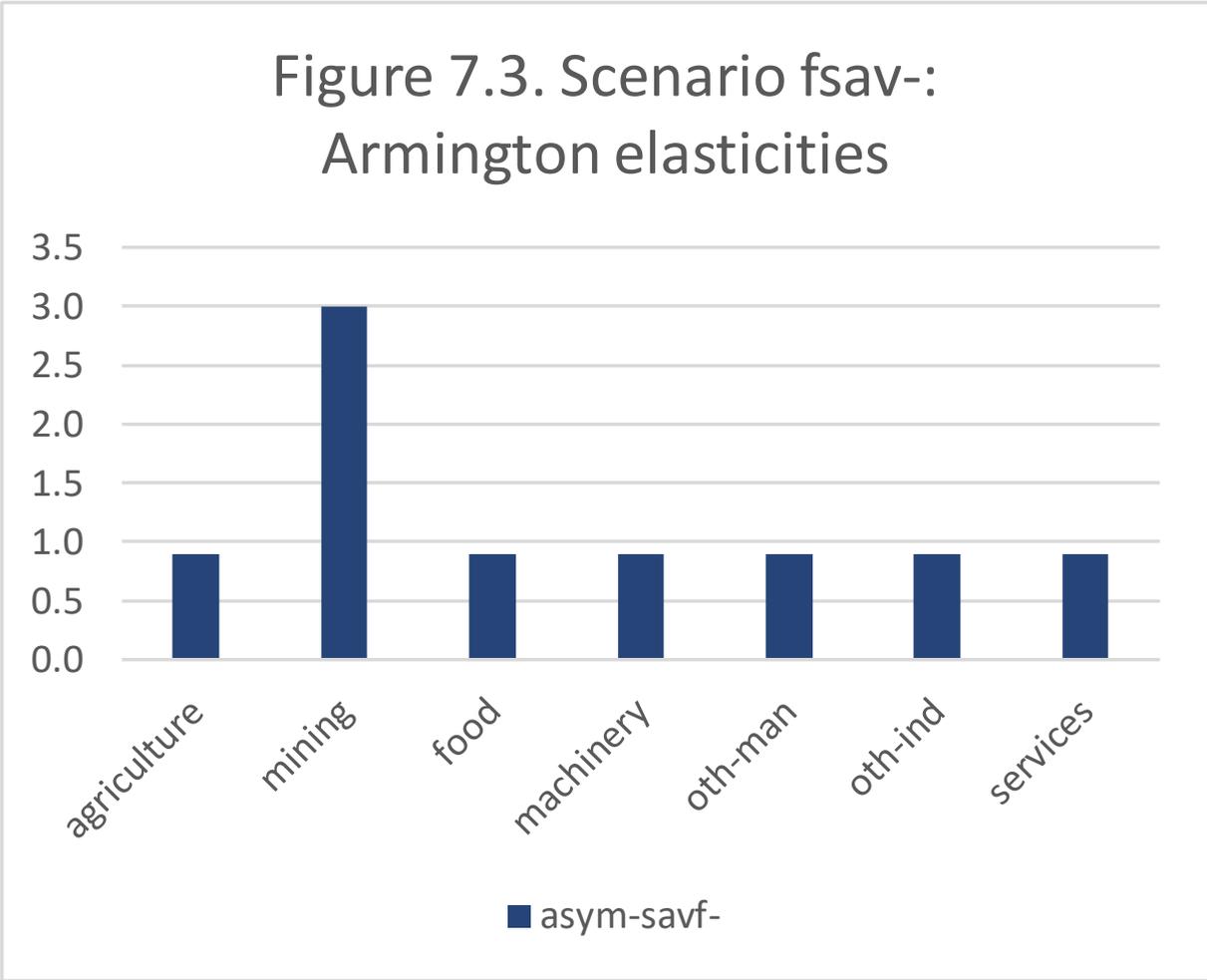


Figure 7.2. Scenario fsav-: PM/PDD (% change)



Results for savf- scenarios: Endogenously selected elasticities



Results for savf- scenarios: Composite demand and imports

Figure 7.4. Scenario fsav-:
Composite demand by commodity
(% change)

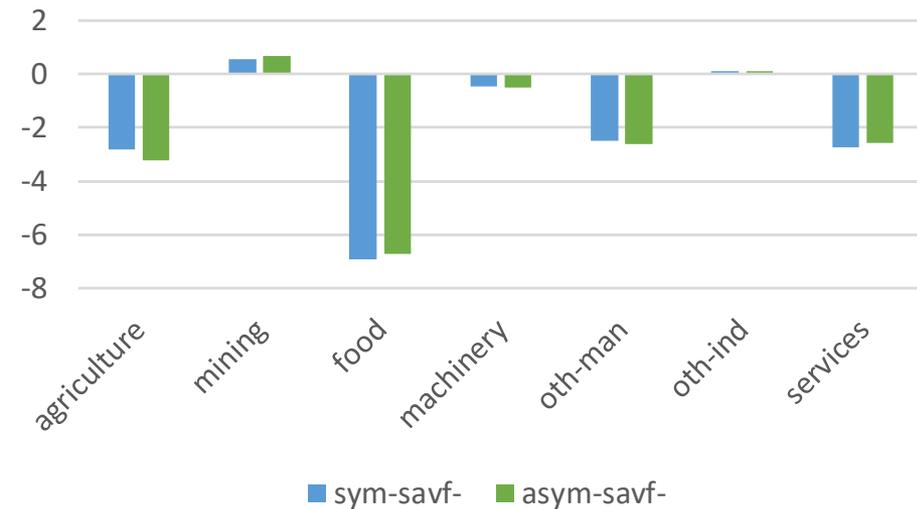
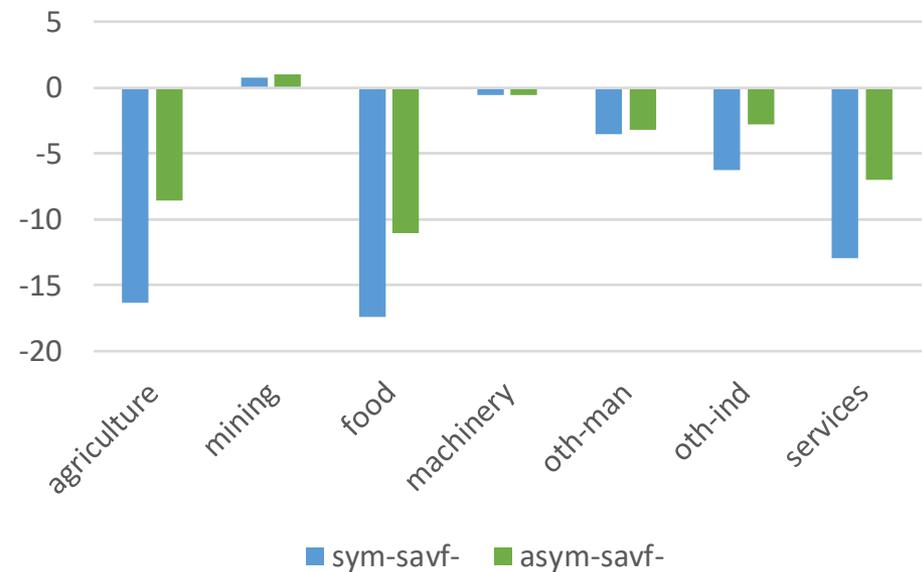


Figure 7.5. Scenario fsav-: Imports
by commodity (% change)



Results for savf- scenarios: Domestic output sales and purchases; exports

Figure 7.6. Scenario fsav-: Domestic output sales and purchases by commodity (% change)

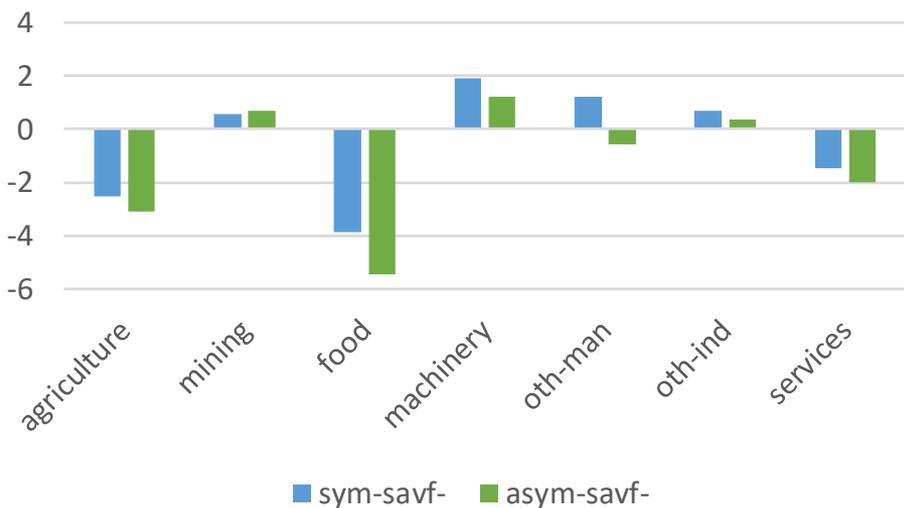


Figure 7.7. Scenario fsav-: Exports by commodity (% change)

