# The Transmission of Foreign Shocks in a Networked Economy

## Critical Assessment and Policy Implications

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# Paper Overview

**Research Question:**

- How do energy price shocks propagate through production networks?
- What role do input-output linkages play in inflation dynamics?
- How does this affect monetary policy trade-offs?

**Methodology:**

- Multi-country DSGE model (6 regions, 44 sectors)
- National & international production networks
- Heterogeneous price rigidities (PRISMA micro data)
- Calibrated to Euro Area + ROW

# Main Contributions of the Paper

1. **IO Network Amplification**
   - Production networks amplify headline inflation by **60%**
   - Feedback loop: selling prices $\leftrightarrow$ production costs
   - Headline-to-core pass-through: $\sim$20% (matches empirical evidence)

2. **Cross-Country Heterogeneity**
   - Countries with different production structures experience different inflation dynamics
   - Germany: longer production chains $\rightarrow$ more persistent inflation
   - Spain: higher energy CPI share $\rightarrow$ larger impact but shorter-lived

3. **Monetary Policy Implications**
   - IO networks worsen stabilization trade-offs
   - Passive policy $\rightarrow$ higher inflation volatility
   - Networks tend to dampen the effects of monetary shocks

# Key Quantitative Results

| Result | Magnitude | Interpretation |
|---|---|---|
| Headline inflation amplification | +0.53pp (cumulative) | With full IO network |
| Without IO networks | +0.32pp (cumulative) | 40% smaller response |
| Pass-through to core inflation | ∼20% (on impact) | Consistent with Adolfsen et al. (2024) |
| Germany vs Spain inflation | More persistent vs higher impact | Driven by production structure differences |
| Monetary policy trade-off | Larger output contraction needed | IO networks worsen stabilization costs |

**Bottom line:** Production networks are **quantitatively important** for understanding inflation dynamics in the Euro Area.

# Critical Issue #1: Energy Substitution Elasticity

## The Problem

Model uses $\gamma = \phi = 0.4$ (energy-non-energy substitution) from **long-run** studies (Böhringer & Rivers 2021)

$\Rightarrow$ Applied to **business cycle** analysis

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**What Literature Says:**

- Hamilton (2009): $\epsilon \approx 0.05$ for gasoline (quarterly)
- Kilian (2008): Low short-run elasticity
- Boehm et al. (2023): $0.5 - 2.0$ at business cycle frequency

**Why It Matters:**

- 60% amplification result highly sensitive
- Higher elasticity $\rightarrow$ easier substitution $\rightarrow$ lower persistence
- Quantitative conclusions depend critically on this

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## Recommendation

Action: Conduct sensitivity analysis varying $\gamma, \phi \in [0.1, 0.6]$

Report: How do key results (amplification, persistence, cross-country heterogeneity) change?

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**Empirical Evidence:**

- **Saito (2004, IMF):** 1.23 (textiles) to 5.66 (chemicals)
- **Hertel et al. (2007):** Natural gas highest, minerals lowest
- **Theory:** Homogeneous goods (energy, metals) $\rightarrow$ HIGH elasticity
- Heterogeneous goods (autos, services) $\rightarrow$ LOW elasticity

**Implications:**

- Energy should have elasticity **3-5× higher** than services
- Affects cross-country transmission
- DE vs ES differences sensitive to elasticities
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## Recommendation

Minimum: Differentiate energy, agriculture, manufacturing, services
Preferred: Calibrate sector-specific elasticities from GTAP/Hertel et al. (2007)

# Critical Issue #3: Do We Need 44 Sectors?

## The Question

Model uses **44 sectors** from OECD tables. Is this necessary?

**Evidence from Literature:**

| Study | Sectors Used | Finding |
|---|---|---|
| Pasten et al. (2020, JME) | 341 vs 58 vs 7 | 58 captures 94% (341 adds 6% more) |
| Nakamura & Steinsson (2010) | 14 | Sufficient for amplification |

**Benefits of 6-10 Sectors:**

- More countries (10-15 EA members instead of 6)
- Clearer interpretation
- Policy-relevant categories
- Computational efficiency

**What Captures Mechanisms:**

1. **Energy:** Upstream, flexible prices
2. **Food/Agri:** Flexible prices
3. **Manufacturing:** Intermediate
4. **Services:** Downstream, sticky

## Recommendation

Re-calibrate with 6-10 sectors and compare results. If robust → expand country coverage.

# Critical Issue #4: Missing Empirical Validation

## The Problem

Model calibrated to **2019** data but NOT validated against **2021-2023 energy crisis**

**What We Know from 2021-2023:**

- Energy prices increased dramatically (similar to model shock)
- Detailed data on EA inflation dynamics available
- Cross-country heterogeneity observed
- Pass-through from headline to core documented

**Questions to Answer:**

1. Does model's 20% pass-through match data?
2. Is predicted DE vs ES heterogeneity correct?
3. What fraction of observed inflation explained?
4. Is persistence in line with evidence?

**Why Validation Matters:**

- We have a natural experiment
- Tests model's predictive power
- Builds confidence in quantitative results
- **Policy relevance** depends on it

## Recommendation

Compare model IRFs with VAR/event-study from 2021-2023. Use this to validate (or recalibrate) the model.

# Additional Methodological Recommendations

**Beyond calibration fixes, two key modeling extensions would strengthen the framework:**

1. **Two-Tier Armington Structure (CRITICAL)**
   - Current: Single elasticity $\delta$ for domestic vs all imports
   - **Standard CGE practice:** Upper tier (domestic-import, $\sigma_D \approx 2$) $<$ Lower tier (import-import, $\sigma_M \approx 4 - 6$)
   - **Rationale:** Home bias well-documented (Obstfeld & Rogoff 2000); easier to substitute between imported sources than domestic vs imported
   - **Impact:** Affects trade diversion patterns and cross-country transmission after energy shock
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2. **Capital Accumulation & Energy-Efficient Investment**
   - Model has *no capital stock* or investment decisions
   - **2021-2023 reality:** Massive investment in renewable energy, electric vehicles, heat pumps, energy-efficient machinery
   - **Evidence:** IEA World Energy Investment 2023 - Clean energy investment up 40% (2020-2023)
   - **Implication:** Without capital adjustment, model overstates long-run persistence of energy price shocks

# Why These Issues Matter for Policy

1. **For Inflation Forecasting:**
   - If energy substitution is actually lower → **stronger** amplification than model predicts
   - If trade elasticities are heterogeneous → different cross-country spillovers
   - Affects ECB's inflation projections
2. **For Monetary Policy Design:**
   - Trade-off between inflation and output depends on network structure
   - Heterogeneous elasticities → different optimal responses to energy shocks
   - Should ECB target headline or core? Depends on pass-through mechanism
3. **For Structural Reforms:**
   - If 6-10 sectors capture mechanisms → focus on key industries (energy, food)
   - Production network structure determines resilience
   - Policy interventions should target critical nodes

**Bottom Line**

Getting calibration right is **essential** for policy-relevant quantitative analysis.

# Summary of Recommendations

**This is an important paper with valuable contributions.**

## Critical Actions Required:

1. **Energy elasticity:** Sensitivity analysis $\gamma, \phi \in [0.1, 0.6]$
2. **Trade elasticities:** Calibrate sector-specific Armington elasticities
   - Use GTAP values or Hertel et al. (2007), Saito (2004)
   - Minimum: Energy $\neq$ Manufacturing $\neq$ Services
3. **Sectoral aggregation:** Test with 6-10 sectors, compare results
4. **Empirical validation:** Compare with 2021-2023 energy crisis data

**Bottom line:** Addressing these issues will make this paper a **major contribution** to our understanding of inflation dynamics in networked economies.

# Thank you!

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# Backup: Literature on Energy Substitution

| **Study** | **Context** | **Elasticity** |
|---|---|---|
| Hamilton (2009) | US gasoline, quarterly | 0.05 |
| Kilian (2008) | Oil prices, short-run | 0.05-0.10 |
| Boehm et al. (2023) | Business cycle frequency | 0.5-2.0 |
| Böhringer & Rivers (2021) | *Long-run carbon tax (used in paper)* | 0.4 |

**Key point:** Business cycle elasticities are much lower than long-run elasticities.

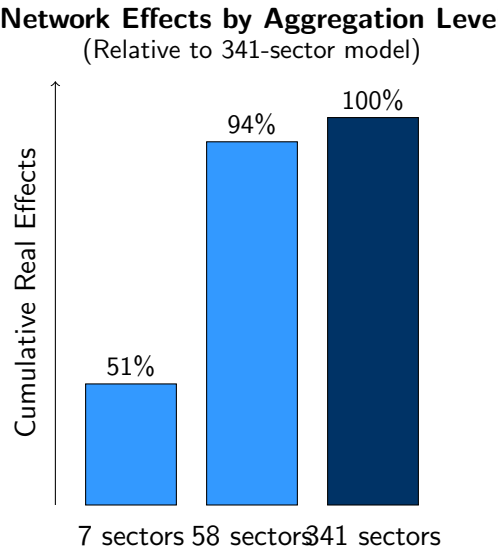
# Backup: CGE Literature on Trade Elasticities

| **Study** | **Sector** | **Armington $\sigma$** |
|---|---|---|
| Saito (2004, IMF) | Textiles | 1.23 |
| | Agriculture | 3.53 |
| | Chemicals | 5.66 |
| Hertel et al. (2007, GTAP) | Natural gas | Highest |
| | Mineral products | Lowest |
| Broda & Weinstein (2006) | Average manufacturing | 4.0-6.6 |

**Standard practice:** Two-tier Armington with $\sigma_{\text{domestic-import}} < \sigma_{\text{import-import}}$

# Backup: Pasten et al. (2020) on Sectoral Aggregation

**Implication:** Moderate disaggregation (50-60 sectors) captures most network effects.



# References I


**Energy Substitution Elasticities:**

- Boehm, C. E., Flaaen, A., & Pandalai-Nayar, N. (2023). "Input Linkages and the Transmission of Shocks: Firm-Level Evidence from the 2011 Tōhoku Earthquake." *Quarterly Journal of Economics*, 138(1), 565-624.
- Böhringer, C., & Rivers, N. (2021). "The Energy Efficiency Rebound Effect in General Equilibrium." *Journal of Environmental Economics and Management*, 109, 102508.
- Hamilton, J. D. (2009). "Understanding Crude Oil Prices." *Journal of Money, Credit and Banking*, 41(2-3), 179-216.
- Kilian, L. (2008). "The Economic Effects of Energy Price Shocks." *Review of Economic Studies*, 70(4), 871-909.

**Trade Elasticities:**

- Broda, C., & Weinstein, D. E. (2006). "Globalization and the Gains from Variety." *Quarterly Journal of Economics*, 121(2), 541-585.
- Hertel, T., Hummels, D., Ivanic, M., & Keeney, R. (2007). "How Confident Can We Be of CGE-Based Assessments of Free Trade Agreements?" *Economic Modelling*, 24(4), 611-635.

# References II


- Saito, M. (2004). "Armington Elasticities in Intermediate Inputs Trade: A Problem in Using Multilateral Trade Data." IMF Working Paper WP/04/22.

# References III


**Sectoral Aggregation:**

- Afrouzi, H., & Bhattarai, S. (2023). "Inflation and Relative Price Dispersion." NBER Working Paper 31218.
- Nakamura, E., & Steinsson, J. (2010). "Monetary Non-Neutrality in a Multisector Menu Cost Model." *Quarterly Journal of Economics*, 125(3), 961-1013.
- Pasten, E., Schoenle, R., & Weber, M. (2020). "The Propagation of Monetary Policy Shocks in a Heterogeneous Production Economy." *Journal of Monetary Economics*, 116, 1-22.

**Energy Crisis and Investment:**

- Adolfsen, J. F., Lappe, S., & Norkutė, M. (2024). "The Impact of the Energy Crisis on Euro Area Inflation: Pass-Through to Core Inflation and Second-Round Effects." *Economic Bulletin Articles*, European Central Bank, Volume 1.
- International Energy Agency (2023). *World Energy Investment 2023*. Paris: IEA Publications.

**Home Bias and Armington:**

# References IV


- Obstfeld, M., & Rogoff, K. (2000). "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" *NBER Macroeconomics Annual*, 15, 339-390.