Fiscal Policy in Multi-Sector Economies with Production Networks

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Motivation: Sectoral Heterogeneity and Stabilisation Policy

Question. How important is sectoral heterogeneity for the design of stabilisation policy, and what role should fiscal instruments play?

Networks matter

In input-output (IO) economies, intermediate-input linkages are a *fundamental* driver of cross-sectoral spillovers. Monetary policy targeting **CPI inflation** is suboptimal (Rubbo, 2023).

Fiscal policy restores divine coincidence

Without IO, **optimal sectoral fiscal policy** makes zero-inflation monetary targeting approximately optimal. Without fiscal, the standard result holds (Cox et al., 2024).

Research Question: Can restricted fiscal instruments available in open economies achieve the efficiency gains predicted by theoretical benchmarks, or does the interaction between production networks and wage rigidity require a fundamentally different approach to spending?

IO Economies: Divine Coincidence Fails, Fiscal Policy Helps

Rubbo (2023)

Multi-sector NK with IO linkages. The network Phillips curve:

$$\widehat{\mathrm{mc}}_{i,t} = \alpha_i \, \hat{w}_t + \sum_j \omega_{ij} \, \hat{p}_{j,t} - a_{i,t}$$

IO linkages break divine coincidence: monetary policy alone cannot close all sectoral gaps.

Cox et al. (2024, "Optimal FP")

Multi-sector NK *without* IO. With optimal sectoral fiscal policy, zero-inflation MP is near-optimal.

- With fiscal: welfare loss 3.1 vs. 2.8 (Table 3)
- Without fiscal: 6.3 vs. 4.7
- No IO linkages assumed

The open question

Rubbo shows IO breaks divine coincidence. Cox et al. ("Optimal FP") show fiscal policy restores it; however, they assume no IO linkages. Both models rely on multisectoral heterogeneity. What happens when we combine both features?

The Theoretical Benchmark: $2N$ Instruments Restore Efficiency

Two recent papers establish the **polar case**: with sufficiently many fiscal instruments, production efficiency is achievable even in IO economies.

La'O & Tahbaz-Salehi (2025)

$2N$ sector-specific taxes implement the **Ramsey optimum** (production efficiency) in multi-sector IO economies.

- Extends Correia, Nicolini & Teles (2008) to networks
- Optimal taxes independent of Calvo parameters

Antonova & Müller (2025)

$2N$ targeted taxes replicate the **flexible-price allocation** in a Rubbo-style IO framework.

- "Prices move as if fully flexible"
- Closed-economy, N-sector Calvo model

Critical shared assumption: both assume flexible wages (competitive labour market). The restoration result relies on price-side instruments being sufficient to close all distortionary wedges.

The Gap: From Benchmark to Reality

Benchmark (L&TS, A&M)

- $2N$ fiscal instruments
- Full set of sales and production taxes
- Flexible wages (competitive labour)
- Production efficiency achievable

Our setting (Aguilar et al.)

- Restricted instruments: τ_k^w, τ_{ki}^s
- Calvo wages ($\theta_k^w = 0.75$)
- Open economy (K=4 countries)
- Quantitative IO (I=44 sectors)

The friction interaction

L&TS's $2N$ instruments are all **price-side** taxes. With flexible wages, the wage adjusts freely to absorb labour misallocation. With **Calvo wage setting**, the wage is a state variable: the labour tax τ_k^w *interacts* with the wage friction, creating a key distortion that price-side instruments alone cannot address.

Fiscal Instruments in the Production Network

Aguilar et al. (2025): $K{=}4$ countries, $I{=}44$ sectors, nested CES with IO (OECD ICIO), Calvo pricing + **Calvo wages**.

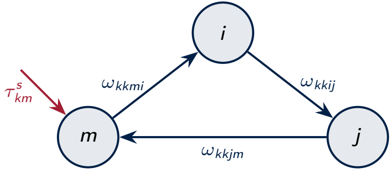
Wage PC: labour tax τ_k^w:

$$\pi_{wk,t} = \kappa_{wk}\left(\sigma\hat{c}_{k,t}+\varphi\hat{n}_{k,t}-\hat{w}_{k,t}+\hat{\tau}^w_{k,t}\right) + \beta\mathbb{E}_t\pi_{wk,t+1}$$

Price PC: production subsidy τ_{ki}^s:

$$\pi_{ki,t} = \kappa_{ki}\left(\widehat{\mathrm{mc}}_{ki,t}-\hat{p}_{ki,t} - \hat{\tau}^s_{ki,t}\right) + \beta\mathbb{E}_t\pi_{ki,t+1}$$

(shock terms u^w, u^p omitted; see appendix)



IO network with fiscal entry

From Subsidies to Government Spending

Departure from Rubbo (2023)

- Rubbo: Network Phillips curve allows MP to target a divine coincidence index.
- Here: Wage rigidity creates endogenous wedges. Fiscal policy must address separate price and wage distortions.

Government Procurement (G)

Cox et al. (2024, "Big G") show procurement is key:

- Accounts for the bulk of variation in G.
- **Highly concentrated:** specific sectors (defense, healthcare) receive $>35\%$ of contracts.
- **Compositionally distinct** from private consumption.

Implication: We cannot treat G as a uniform aggregate demand shifter. In a production network, the *sectoral composition* of procurement determines how demand propagates.

Research Agenda: Fiscal Policy as Demand Composition

Goal: Characterise optimal sectoral government spending in a networked economy with dual price–wage rigidities.

Market clearing with G:

$$Y_{ki,t} = \sum_{l} C_{lki,t} + \sum_{l} \sum_{j} X_{lkji,t} + G_{ki,t}$$

1. **Revenue-neutral fiscal policy:** sectoral spending G_{ki} funded by labour taxes τ_k^w. The government reallocates demand across the network while wage-setters face the tax wedge.
2. **Two policy regimes:** endogenous level + composition vs. fixed aggregate budget (composition only). Quantify the welfare gap relative to the Phase 1 wedge benchmark and the L&TS $2N$ ceiling.
3. **Network amplification:** how does IO structure shape the optimal sectoral allocation of G? Upstream vs. downstream spending; interaction with heterogeneous price stickiness.

Conjecture: sectoral *composition* of spending matters more than its aggregate level. The network propagates sectoral G shocks asymmetrically.

Summary

1. **The benchmark:** L&TS and A&M show $2N$ fiscal instruments restore efficiency in IO economies. Critical assumption: government controls both sales and production taxes, and wages are flexible.
2. **The Initial Project:** Extending Aguilar et al. with (τ_k^w, τ_{ki}^s). Staggered wages create a second friction: even flexible price-side instruments cannot fully address wage misallocation.
3. **The Research Agenda:** Moving from subsidies to government spending G funded by labour taxes. Cox et al. ("Big G") show procurement is concentrated and compositionally distinct.
4. **Conjecture:** Sectoral *composition* of spending matters more than its aggregate level. The network propagates sectoral G shocks asymmetrically.

Thank you

Appendix: Related Literature

Production Networks & NK

- Acemoglu et al. (2012)
- Baqaee & Farhi (2020, 2024)
- Pasten, Schoenle & Weber (2020)
- **Rubbo (2023)**
- La'O & Tahbaz-Salehi (2024)

Tariffs & Open-Economy NK

- Galí & Monacelli (2005)
- Comin & Johnson (2023)
- **Aguilar et al. (2025)**

Fiscal Policy in Disaggregated Economies

- Aoki (2001)
- **La'O & Tahbaz-Salehi (2025, WP)**
- **Antonova & Müller (2025)**
- **Cox et al. (2024)**

Fiscal–Price Effects (Empirical)

- Nekarda & Ramey (2020)
- Ben Zeev & Pappa (2017)

Appendix: Rubbo (2023) — Model Detail

Network Phillips curve. Under Cobb–Douglas production ($\psi = 1$) and Calvo pricing:

$$\boldsymbol{\pi}_t = \boldsymbol{\kappa}\,\boldsymbol{\Psi}\,\hat{\mathbf{w}}_t + \beta\,\mathbb{E}_t\boldsymbol{\pi}_{t+1}$$

where $\boldsymbol{\Psi} = (\mathbf{I} - \boldsymbol{\Omega})^{-1}$ is the Leontief inverse and $\boldsymbol{\kappa} = \mathrm{diag}(\kappa_1, \dots, \kappa_N)$. (The general CES case involves additional relative-price terms.)

Key insight: the Leontief inverse maps wage costs into sectoral inflation. A sector with flexible prices but upstream sticky suppliers still experiences inflation distortions through $\boldsymbol{\Psi}$.

Optimal monetary policy (divine coincidence index):

$$\sum_i \tilde{\mu}_i\,\hat{y}_{i,t} = 0 \qquad \text{where weights } \tilde{\mu}_i \text{ depend on sales shares } \lambda_i \text{ and price adjustment frequencies}$$

Equivalently, the planner targets a specific weighted inflation index (the "divine coincidence index"), not CPI. The weights over-weight sectors that are: (i) large (high Domar weight λ_i), (ii) sticky (low price adjustment frequency), and (iii) upstream (high influence through the Leontief inverse).

Failure of zero inflation: targeting $\pi_{i,t} = 0\ \forall\, i$ requires all marginal cost gaps to be zero. With IO linkages, this is generically impossible because upstream price distortions propagate to downstream costs.

Appendix: Cox et al. (2024): Key Quantitative Results

Model. N sectors, no IO. Production: $Y_{k,t} = A_{k,t} N_{k,t}$. Calvo pricing ($\theta^p_k$), government share χ_k.

Four policy regimes (Table 3, baseline U.S. calibration, welfare loss):

	Optimal fiscal	Passive fiscal ($\tilde{f}_{kt} = 0$)
Optimal MP	2.8	4.7
Zero-inflation MP	3.1	6.3

Interpretation: with optimal sectoral fiscal, zero-inflation MP is approximately optimal (3.1 vs. 2.8). Without fiscal, the standard result holds: optimal MP must target the divine coincidence index (4.7 vs. 6.3).

Critical assumption: without IO, sectoral marginal costs depend only on own wages and productivity. There is *no channel* for upstream price distortions to affect downstream sectors, precisely the mechanism Rubbo identifies as first-order.

Appendix: Welfare with $\sigma \neq 1$ and $\kappa \neq 0$

When CRRA preferences and government-demand pass-through are active:

$$-\frac{1}{2}\sum_k \mu_k \Bigg((1+\varphi)\, y_{k,t}^2 + \frac{\theta(1-\chi_k)}{\lambda_k}\, \pi_{k,t}^2 + \chi_k^*\,(g_{k,t}-y_{k,t})^2$$
$$+ (\sigma-1)\left[(1-\chi_k)\,\omega_{c,k}\left(\frac{y_{k,t}}{1-\chi_k} - \chi_k^*\, g_{k,t}\right)^2 + \omega_{g,k}\,\chi_k\, g_{k,t}^2\right]\Bigg)$$

- The $\sigma-1$ term introduces an **insurance motive**: the planner uses sectoral fiscal policy to hedge against aggregate risk.
- $\kappa > 0$ steepens Phillips curves ($\lambda_k' > \lambda_k$), making fiscal policy a supply-side instrument.

Appendix: Relative Allocation Rule — Structural Coefficients

Under exogenous $\bar{G}_t$ (with $\sigma = 1$, $\kappa = 0$):

$$
\begin{aligned}
g_{k,t} \;=\; & \frac{1-\chi_k}{1-\chi_i}\left(\frac{1+\lambda_i+\varphi\lambda_i}{1+\lambda_i+\varphi\lambda_i(1-\chi_i)}\right)\left(\frac{\omega_{g,k}}{\omega_{g,i}}\right)^{\rho}\left(\frac{1+\lambda_k+\varphi\lambda_k}{1+\lambda_k+\varphi\lambda_k(1-\chi_k)}\right)^{-1} g_{i,t} \\
& - \frac{\varphi\, y_{k,t}}{1+\lambda_k+\varphi\lambda_k} - \frac{\theta\,\varphi\,(1-\chi_k)\,\pi_{k,t}}{1+\lambda_k+\varphi\lambda_k} \\
& + \frac{1-\chi_k}{1-\chi_i}\left(\frac{\omega_{g,k}}{\omega_{g,i}}\right)^{\rho}\left(\frac{1+\lambda_k+\varphi\lambda_k}{1+\lambda_k+\varphi\lambda_k(1-\chi_k)}\right)^{-1} \\
& \quad \times\left(\frac{\varphi\, y_{i,t}}{1+\lambda_i+\varphi\lambda_i(1-\chi_i)} + \frac{\theta\,\varphi\,(1-\chi_i)\,\pi_{i,t}}{1+\lambda_i+\varphi\lambda_i(1-\chi_i)}\right)
\end{aligned}
$$

$\omega_{g,k}$: weight of sector k in the government Cobb–Douglas aggregator. ρ: CES elasticity of public-good bundle.

Per-period utility: $U_t = \left(C_{k,t}^{1-\sigma}/(1-\sigma) - \int_0^1 \mathcal{N}_{gk,t}^{1+\varphi}/(1+\varphi)\,dg\right) Z_{k,t}$

Consumption nested CES (energy/non-energy, domestic/foreign):

$$C_{k,t} = \left[\widetilde{\beta}_k^{1/\gamma}\, C_{kE,t}^{(\gamma-1)/\gamma} + (1-\widetilde{\beta}_k)^{1/\gamma}\, C_{kM,t}^{(\gamma-1)/\gamma}\right]^{\gamma/(\gamma-1)}$$

Euler equations:

$$C_{k,t}^{-\sigma} = \beta\,\mathbb{E}_t\, C_{k,t+1}^{-\sigma}\, \frac{1+i_{k,t}}{1+\pi_{kC,t+1}}\, \frac{Z_{k,t+1}}{Z_{k,t}}$$

$$i_{k,t} - i_{K,t} = \mathbb{E}_t \Delta e_{kK,t+1} - \gamma_*\,\mathrm{nfa}_{k,t} + \varepsilon^{e}_{kK,t} \qquad \text{(UIP)}$$

Calvo wage setting yields:

$$\pi_{wk,t} = \kappa_{wk}\left(\sigma\hat{c}_{k,t} + \varphi\hat{n}_{k,t} - \hat{w}_{k,t}\right) + \beta\,\mathbb{E}_t\pi_{wk,t+1} + u^{w}_{k,t}$$

Appendix: Aguilar et al. —Firm Problem

CES production: $Y_{ki,f,t} = A_{ki,t}\left[\widetilde{\alpha}_{ki}^{1/\psi}\, N_{fki,t}^{(\psi-1)/\psi} + \widetilde{\vartheta}_{ki}^{1/\psi}\, X_{fki,t}^{(\psi-1)/\psi}\right]^{\psi/(\psi-1)}$

Intermediate bundle mirrors the household CES nesting (energy/non-energy, domestic/foreign).

Log-linearised marginal cost:

$$\widehat{\mathrm{mc}}_{ki,t} = -a_{ki,t} + \mathcal{M}_{ki}\alpha_{ki}\,\widehat{w}_{k,t} + \sum_{l=1}^{K}\sum_{j=1}^{I}\mathcal{M}_{ki}\omega_{klij}\,\widehat{p}_{klij,t}$$

where α_{ki}: labour share, ω_{klij}: IO expenditure share, $\mathcal{M}_{ki}$: steady-state markup.

Calvo pricing yields:

$$\pi_{ki,t} = \kappa_{ki}\left(\widehat{\mathrm{mc}}_{ki,t} - \widehat{p}_{ki,t}\right) + \beta\,\mathbb{E}_t\pi_{ki,t+1} + u_{ki,t}^{p} \qquad \kappa_{ki} = \frac{(1-\theta_{ki}^{p})(1-\beta\theta_{ki}^{p})}{\theta_{ki}^{p}}$$

Appendix: Aguilar et al. —Tariff Propagation

Tariffs enter as price wedges on final and intermediate goods:

$$P_{k,l,i,t} = (1 + \tau_{k,l,i,t})\,\widetilde{P}_{l,k,i,t}$$

Propagation:

1. Tariff on country l raises input prices $\widehat{p}_{klij,t}$ for domestic sectors sourcing from sector j in l.
2. Higher input costs raise $\widehat{\mathrm{mc}}_{ki,t}$, feeding into $\pi_{ki,t}$.
3. Cost increases cascade downstream through the IO network.
4. Tariff revenue accrues to the government; currently rebated lump-sum.

Government budget constraint:

$$\frac{B_{k,t}}{1+i_{k,t}} + T_{k,t} + \sum_{l \neq k} \sum_{i} \tau_{kli,t}\, P^{l}_{kli,t} \Big(C_{kli,t} + \textstyle\sum_j X_{klji,t} \Big)$$

$$= B_{k,t-1} + \sum_i \tau^{s}_{ki,t}\, \mathrm{MC}_{ki,t}\, Y_{ki,t}$$

Back

Appendix: Aguilar et al. —Calibration

Households

- $\beta = 0.99$, $\sigma = 1$, $\varphi = 1$
- Energy/non-energy elast. $\gamma = 0.4$
- Trade elasticity $\delta = 1$
- Calvo wage $\theta_k^w = 0.75$
- Consumption shares from OECD ICIO (2019)

Monetary policy

- $\rho_r = 0.7$, $\phi_\pi = 1.5$, $\phi_y = 0.125$
- Target: headline inflation

Firms

- Labour/input elast. $\psi = 0.5$
- Energy/non-energy elast. $\phi = 0.4$
- Trade elasticity $\mu = 1$
- IO shares from OECD ICIO (2019)
- Markups from Eurostat Figaro
- Calvo prices from ECB PRISMA

Tariff shocks

- $\rho^\tau = 0.96$, $\sigma^\tau = 1$

Appendix: Derivation —Wage Phillips Curve with Tax

Household FOC with labour income tax $\tau^{w}_{k,t}$:

$$\sum_{l=0}^{\infty}(\beta\theta^{w}_{k})^{l}\,\mathbb{E}_t\left[N_{k,t+l|t}\,C^{-\sigma}_{k,t+l|t}\left(\frac{(1-\tau^{w}_{k,t+l})\,W^{*}_{k,t}}{P_{kC,t+l}}-\mathcal{M}_{wk,t}\,\mathrm{MRS}_{k,t+l|t}\right)\right]=0$$

Log-linearised reset wage:

$$w^{*}_{k,t}=(1-\beta\theta^{w}_{k})\sum_{l=0}^{\infty}(\beta\theta^{w}_{k})^{l}\,\mathbb{E}_t\left[\mathrm{mrs}_{t+l|t}+\mu^{n}_{wk,t+l}+p_{kC,t+l}+\hat{\tau}^{w}_{k,t+l}\right]$$

Calvo aggregation ($\pi_{wk,t}=w_{k,t}-w_{k,t-1}$):

$$\pi_{wk,t}=\kappa_{wk}\left(\sigma\hat{c}_{k,t}+\varphi\hat{n}_{k,t}-\hat{w}_{k,t}+\hat{\tau}^{w}_{k,t}\right)+\beta\,\mathbb{E}_t\pi_{wk,t+1}+u^{w}_{k,t}$$

Tax deviation enters additively: wage-setters pass the wedge through to the pre-tax wage.

Appendix: Derivation —Price Phillips Curve with Subsidy

Firm FOC with time-varying production subsidy $\tau^{s}_{ki,t}$:

$$\sum_{l=0}^{\infty}(\beta\theta^{p}_{ki})^{l}\,\mathbb{E}_t\Big[\Lambda_{t,t+l}\,Y_{ki,t+l|t}\Big(P^{*}_{ki,t}-\mathcal{M}_{pk,t+l}\,(1-\tau^{s}_{ki,t+l})\,\mathrm{MC}^{n}_{ki,t+l|t}\Big)\Big]=0$$

Log-linearised reset price:

$$p^{*}_{ki,t}=(1-\beta\theta^{p}_{ki})\sum_{l=0}^{\infty}(\beta\theta^{p}_{ki})^{l}\,\mathbb{E}_t\Big[\mathrm{mc}^{n}_{ki,t+l|t}+\mu^{n}_{pki,t+l}-\hat{\tau}^{s}_{ki,t+l}\Big]$$

Calvo aggregation ($\pi_{ki,t}=p_{ki,t}-p_{ki,t-1}$):

$$\pi_{ki,t}=\kappa_{ki}\Big(\widehat{\mathrm{mc}}_{ki,t}-\hat{p}_{ki,t}-\hat{\tau}^{s}_{ki,t}\Big)+\beta\,\mathbb{E}_t\pi_{ki,t+1}+u^{p}_{ki,t}$$

Subsidy increase lowers effective marginal cost $\rightarrow$ disinflationary cost-push.

Q&A: Why Not Derive the Ramsey Problem Directly?

The question

Why modify Phillips curves with fiscal instruments rather than solving a full Ramsey taxation problem?

- The Phillips-curve approach is a **reduced-form shortcut**: it isolates the cost-push channel of taxation while preserving the existing IO structure of Aguilar et al. (2025).
- A full Ramsey problem in a 4×44 networked model is computationally demanding: it requires solving for $K \times I$ optimal tax instruments simultaneously.
- The **research agenda goal** is precisely to move toward the full Ramsey characterisation. The current extensions are a tractable first step.
- La'O & Tahbaz-Salehi (2025) show that even in simpler networks, the Ramsey problem has a rich structure — $2N$ instruments implement production efficiency. Our approach builds intuition before scaling up.

Q&A: How Does This Relate to Antonova & Müller (2025)?

The question

Antonova & Müller already study fiscal policy in Rubbo's IO framework. What is your contribution?

Antonova & Müller (2025):

- $2N$ targeted taxes replicate flexible-price allocation
- Flexible wages (competitive labour market)
- Closed-economy framework
- The **polar case**: sufficient instruments + simple frictions

Our contribution:

- Restricted instruments ($\tau_k^w + \tau_{ki}^s$)
- Calvo wages ($\theta_k^w = 0.75$)
- Quantitative open economy ($K \times I$)
- What can restricted instruments achieve?

Key distinction: A&M establish the polar case (flexible-price restoration with $2N$ instruments and flexible wages). We test what restricted instruments can achieve when staggered wages make that restoration impossible.

Q&A: Relation to La'O & Tahbaz-Salehi

The question

La'O & Tahbaz-Salehi have two relevant papers. How do they relate to your work?

Econometrica (2024): optimal *monetary* policy in production networks; network structure shapes the optimal inflation target.

"Missing Tax Instruments" (2025 WP):

- $2N$ taxes implement Ramsey optimum (production efficiency)
- Optimal taxes independent of Calvo parameters
- Extends Correia, Nicolini & Teles (2008) to IO

Our contribution:

- Restricted instruments ($\tau_k^w + \tau_{ki}^s$, not $2N$)
- Calvo wages break their flexible-wage assumption
- Quantitative open economy ($K \times I$)
- Their Ramsey optimum is our benchmark

Key distinction: L&TS provide the theoretical ceiling. We ask how far restricted instruments can go when wage rigidity makes that ceiling unattainable.

Q&A: Why Not Just Use $2N$ Instruments?

The question

La'O & Tahbaz-Salehi show $2N$ taxes implement production efficiency. Why not use them?

1. **Instrument restriction:** $2N$ sector-specific taxes require the government to target each sector individually. In practice, labour income taxes are set at *country level* (τ_k^w). Our instrument set ($K + K \times I$) is a strict subset of $2N$.
2. **Staggered wages:** L&TS and A&M assume **flexible wages**. With Calvo wage setting ($\theta_k^w = 0.75$), wage-rigidity misallocation creates distortions that *no price-side taxes* can address.
3. **Open economy:** L&TS study a closed economy. Cross-border IO linkages and exchange rate dynamics introduce additional channels absent from the benchmark.

Bottom line: the $2N$-instrument result is the polar case. We study the realistic setting where that ceiling is unattainable.