

Fiscal Policy in Multi-Sector Economies with Production Networks

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Macro Workshop, February 2026

Starting point. In one-sector New Keynesian models, monetary policy achieves the first-best.

The monetary policy problem

- ▶ IO linkages amplify misallocation (Acemoglu et al., 2012; Baqaee & Farhi, 2020)
- ▶ **Divine coincidence fails:** no single interest rate closes all sectoral gaps (Rubbo, 2023; La'O & Tahbaz-Salehi, 2024)

Can fiscal policy help?

- ▶ Sectoral fiscal instruments can target individual sectors and lead to constrained optimality (Cox et al., 2024)
- ▶ But: How many instruments? And which?

IO Economies: Divine Coincidence Fails

Rubbo (2023): The Problem

Network Phillips curve:

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

IO linkages propagate cost distortions across sectors.
Monetary policy cannot close all sectoral gaps simultaneously.

The Polar Case

La'O & Tahbaz-Salehi (2025); Antonova & Müller (2025):

- ▶ $2N$ sector-specific taxes (sales + production) implement production efficiency
- ▶ Requires: full instrument set + flexible wages

The gap: in practice, wages are sticky and instruments are restricted. What can limited fiscal tools achieve?

The Gap: From Benchmark to a More Realistic Economy

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)

With **Calvo wages**, the wage is a state variable: price-side instruments cannot absorb wage misallocation. The labour tax τ_k^w is essential, unnecessary in the benchmark but critical here.

Fiscal Instruments in the Production Network

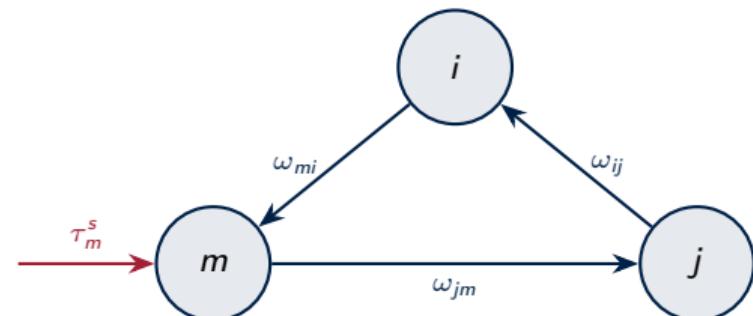
Aguilar et al. (2025): $K=4$ countries, $I=44$ sectors, nested CES with IO (OECD ICIO), Calvo pricing + Calvo wages.

Wage PC: labour tax τ_k^w :

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

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

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



IO network with fiscal entry

i, j, m : sectors in country k ; ω_{ij} : IO expenditure share (i sources from j); τ_m^s : production subsidy on m

Model

- ▶ Multi-sector NK, no IO linkages
- ▶ Calvo pricing, flexible wages
- ▶ Fiscal instrument: **sectoral procurement** $G_{k,t}$

Key Result (Table 3, welfare loss)

	Opt. G	No G
Opt. MP	2.8	4.7
Zero- π MP	3.1	6.3

Sectoral G approximately restores divine coincidence under zero-inflation MP.

Critical assumption: no IO linkages. Upstream cost distortions absent by construction.

Research Agenda: Fiscal Policy as Demand Composition

Goal: Characterise optimal sectoral government spending in a networked economy.

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 aggregate labour taxes τ^w .
- 2 Network amplification:** Upstream vs. downstream spending; interaction with heterogeneous price stickiness.
- 3 Two policy regimes:** endogenous level and composition of government procurements vs. fixed aggregate budget (composition only). The end goal is to quantify the welfare gap.

Paper Comparison

	Sector-specific fiscal				
	IO	Sales	Prod.	Procure.	Wages
Rubbo (2023)	✓				Rigid
Antonova & Müller (2025)	✓	✓	✓		Flexible
Aguilar et al. + ext.	✓	✓	✓		Rigid
Cox et al. (2024)				✓	Flexible
Eugenelo	✓			✓	Rigid

Thank you

- 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_k^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.
Obtain the optimal fiscal policy and compare it with a constrained "Big G" version of the model.

Why government spending?

- ▶ Subsidies (τ_k^w , τ_{ki}^s) enter as cost-push wedges in Phillips curves
- ▶ Government *spending* G_{ki} enters goods market clearing: a **demand-side** instrument
- ▶ Revenue-neutral policy: G funded by τ^w links both channels

Cox et al. (2024, “Big G”): facts

- ▶ **Concentrated:** top 3 sectors >60% of procurement; top 10 firms = 35%
- ▶ **Biased:** manufacturing 31% of G vs. 6% of VA; real estate 13% of VA vs. <1% of G
- ▶ **Sticky:** G targets sectors with 9% monthly price adjustment (vs. 20% economy-wide)
- ▶ **Granular:** idiosyncratic shocks explain >50% of G growth

Implication: G is not a uniform demand shifter. Its sectoral composition interacts with the IO network and heterogeneous price stickiness, precisely the frictions that break divine coincidence.

Appendix: Related Literature

Production Networks & NK

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

Fiscal Policy in Disaggregated Economies

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

Tariffs & Open-Economy NK

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

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:

$$\pi_t = \kappa \Psi \hat{w}_t + \beta \mathbb{E}_t \pi_{t+1}$$

where $\Psi = (\mathbf{I} - \Omega)^{-1}$ is the Leontief inverse and $\kappa = \text{diag}(\kappa_1, \dots, \kappa_N)$. (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 Ψ .

Optimal monetary policy (divine coincidence index):

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

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 (θ_k^P), 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 Rubio identifies as first-order.

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

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

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

- ▶ 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 $\sigma = 1$, $\kappa = 0$):

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

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

Appendix: Aguilar et al. —Household Problem

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):

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

Euler equations:

$$\begin{aligned} C_{k,t}^{-\sigma} &= \beta \mathbb{E}_t C_{k,t+1}^{-\sigma} \frac{1 + i_{k,t}}{1 + \pi_{kC,t+1}} \frac{Z_{k,t+1}}{Z_{k,t}} \\ i_{k,t} - i_{K,t} &= \mathbb{E}_t \Delta e_{kK,t+1} - \gamma_* nfa_{k,t} + \varepsilon_{kK,t}^e \quad (\text{UIP}) \end{aligned}$$

Calvo wage setting yields:

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

Appendix: Aguilar et al. —Firm Problem

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

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

Log-linearised marginal cost:

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

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

Calvo pricing yields:

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

Appendix: Aguilar et al. — Tariff Propagation

Tariffs enter as price wedges on final and intermediate goods:

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

Propagation:

- 1 Tariff on country l raises input prices $\hat{p}_{klji,t}$ for domestic sectors sourcing from sector j in l .
- 2 Higher input costs raise $\widehat{\text{mc}}_{ki,t}$, 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:

$$\begin{aligned} \frac{B_{k,t}}{1 + i_{k,t}} + T_{k,t} + \sum_{l \neq k} \sum_i \tau_{klj,t} P_{klj,t}^l \left(C_{klj,t} + \sum_j X_{klji,t} \right) \\ = B_{k,t-1} + \sum_i \tau_{ki,t}^s \text{MC}_{ki,t} Y_{ki,t} \end{aligned}$$

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 $\tau_{k,t}^w$:

$$\sum_{l=0}^{\infty} (\beta \theta_k^w)^l \mathbb{E}_t \left[N_{k,t+l|t} C_{k,t+l|t}^{-\sigma} \left(\frac{(1-\tau_{k,t+l}^w) W_{k,t}^*}{P_{kC,t+l}} - \mathcal{M}_{wk,t} \text{MRS}_{k,t+l|t} \right) \right] = 0$$

Log-linearised reset wage:

$$w_{k,t}^* = (1-\beta \theta_k^w) \sum_{l=0}^{\infty} (\beta \theta_k^w)^l \mathbb{E}_t [\text{mrs}_{t+l|t} + \mu_{wk,t+l}^n + p_{kC,t+l} + \hat{\tau}_{k,t+l}^w]$$

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

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

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 $\tau_{ki,t}^s$:

$$\sum_{l=0}^{\infty} (\beta \theta_{ki}^p)^l \mathbb{E}_t [\Lambda_{t,t+l} Y_{ki,t+l|t} (P_{ki,t}^* - \mathcal{M}_{pk,t+l} (1 - \tau_{ki,t+l}^s) MC_{ki,t+l|t}^n)] = 0$$

Log-linearised reset price:

$$p_{ki,t}^* = (1 - \beta \theta_{ki}^p) \sum_{l=0}^{\infty} (\beta \theta_{ki}^p)^l \mathbb{E}_t [mc_{ki,t+l|t}^n + \mu_{pk,t+l}^n - \hat{\tau}_{ki,t+l}^s]$$

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

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

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.

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

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

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

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.