The Welfare Implications of Fiscal Consolidations in Low-income Countries

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Motivation

Question

- Low income countries have low tax revenue to GDP ratio.
  - Average tax to GDP ratio is 15% in LICs and is 30% in advanced economies.
- Sustainable and inclusive growth require substantial revenue mobilization.
- Developing economies' structure is different from advanced economies.
  - Large agricultural and informal sector, and sharp rural-urban differences.
- Question: What is the welfare cost of revenue mobilization using consumption, labor and corporate income tax in low-income countries?

What We Do

- An Aiyagari economy with
  - Three Sectors: (i) Agriculture, (ii) Manufacturing, and (iii) Services.
  - Two Regions: (i) Rural and (ii) Urban.
- A utilitarian government with three Ramsey Taxes:
  1. Consumption tax (VAT)
  2. Labor income tax (PIT)
  3. Corporate income tax (CIT).
- Quantitative Experiments: raise tax revenue of 2% GDP.
  - Welfare decomposition.
  - Total and regional impacts.
  - Short-run and long-run impacts.
  - The role of idiosyncratic risks.

Overview of Results

- The welfare costs: VAT (4%) $>$ PIT (3%) $>$ CIT (2%).
  - VAT causes lower output loss, but widens the urban-rural gap.
  - PIT and CIT cause larger output loss, but distribute tax burdens more evenly.
- Transition dynamics are less important because capital stock is low.
- Idiosyncratic risks cause large distributional costs.
- *Policy Implications:* New theoretical guidance for low-income countries.
  - Mismatch between tax incidence and expenditure can generate welfare loss.
  - Transfer + VAT and Pro-growth + CIT/PIT.
  - Fast convergence.
  - Insuring idiosyncratic shocks reduces the costs of revenue mobilization.

Related Literature

- Incomplete markets, heterogeneous agents and taxation.
  - Aiyagari (1995), Domeij and Heathcote (2004), Conesa, Kitao and Krueger (2009), and Bakış, Kaymak and Poschke (2015).
  - Correia (2010), Anagnostopoulos and Li (2013), Conesa, Li and Li (2018).
  - We show that the between region redistribution has large welfare costs.
- Taxation in Developing Countries
  - Burgess and Stern (1993), Keen (2012), and Besley and Persson (2013).
  - Keen (2008), Keen and Lockwood (2010), and Gordon and Li (2009).
  - We show which tax is more desirable from a pure efficiency-equity trade-off.
- Development Economics
  - Gollin, Parente and Rogerson (2004, 2007), Restuccia, Yang and Zhu (2008), and Lagakos and Waugh (2013).
  - Adamopoulos and Restuccia (2014).
  - We show that developing countries characteristics have implication for revenue mobilization.

The Model

Overview

- Take Ethiopia as an example.
- A large agricultural sector.
  - Unproductive and employs about 70% of the labor force.
  - Subsistence farming.
  - Exports cash crops in exchange for oil.
- A sharp distinction between the rural and urban areas with little migration.
- Thin financial markets leaving idiosyncratic risks largely uninsured.
- A large informal sector of about 17% GDP.

The Model

The Environment

- A discrete time infinite horizon small open economy.
- Two regions, three sectors, and one risk free asset, with each region populated by a continuum of households.
  - Rural: Produces food and cash crops.
  - Urban: Produces manufacturing goods (numeraire) and services.
  - No migration in the model.
- The utilitarian government imports manufacturing goods to balance the trade account, and it also runs a balanced budget.
  - Let τ^a, τ^r and τ^w be VAT, CIT and PIT.
- All households share the same log-linear preference:

$$U = \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[\log c_t^a + \gamma \log c_t^m + \psi \log c_t^s \right].$$

The Model

Rural Area: Technology

- Food is produced by both subsistence farmers on their own plot

$$y_t^a = z^a \varepsilon_t^r (1 - h_t^r)^{1-\alpha^a},$$

and by large farms through hired labor

$$y_t^{a,f} = z^a (h_t^a)^{1-\alpha^a}.$$

- Cash crops are produced by large farms only:

$$y_t^* = z^* (k_t^f)^{\alpha_1^*} (h_t^*)^{\alpha_2^*},$$

where the production is modernized by using machinery k^f.

The Model

Rural Area: Households

- Define household's total consumption expenditure be

$$\mathbf{c}^j = (1+\tau^a)(p^a c^{a,j} + c^{m,j}) + p^s c^{s,j}, \quad j \in \{u, r, f\}.$$

- The recursive problem for rural households:

$$V^r(b^r, \varepsilon^r) = \max_{\{\mathbf{c}^r, b^{r'}, h^r\}} \left\{ u(\mathbf{c}^r) + \beta \mathbb{E}\left[V^r(b^{r'}, \varepsilon^{r'}) | \varepsilon^r \right] \right\}$$

$s.t.$

$$\mathbf{c}^r + b^{r'} = \underbrace{(1-\tau^w) w^f h^r}_{\text{As Hired Labor}} + \underbrace{p^a z^a \varepsilon^r (1-h^r)^{1-\alpha^a}}_{\text{Subsistence Farming}} + (1+r) b^r.$$

The Model

Rural Area: Large Farms

- The deterministic sequential problem for large farms:

$$\max_{\{\mathbf{c}_t^f, k_{t+1}^f, h_t^a, h_t^*\}} \sum_{t=0}^{\infty} \beta^t u(\mathbf{c}_t^f)$$

$s.t.$

$$\mathbf{c}_t^f + k_{t+1}^f = (1-\tau^r)(\pi_t^f + \pi_t^*) + (1-\delta)k_t^f + \tau^r \delta k_t^f,$$

$$\pi_t^f = p^a z^a (h_t^a)^{1-\alpha^a} - w^f h_t^a \qquad \text{(Food)},$$

$$\pi_t^* = p^* (k_t^f)^{\alpha_1^*} (h_t^*)^{\alpha_2^*} - w^f h_t^* \qquad \text{(Cash Crops)}.$$

The Model

Urban Area: Technology

- Services are produced by urban households informally

$$y_t^s = z^s \left(1 - h_t^u\right)^{1-\alpha^s}.$$

- Manufacturing goods are produced by urban neoclassical firms:

$$y_t^m = z^m \left(k_t^m\right)^{\alpha^m} \left(h_t^m\right)^{1-\alpha^m}.$$

- The manufacturing firm's problem is

$$\max_{\left\{k_t^m, h_t^m\right\}} \left\{ \left(1 - \tau^r\right) z^m \left(k_t^m\right)^{\alpha^m} \left(h_t^m\right)^{1-\alpha^m} - w^m h_t^m - \left(r + \delta\right) k_t^m \right\}.$$

The Model

Urban Area: Households

- The recursive problem for urban households:

$$V^u(b^u, \varepsilon^u) = \max_{\{\mathbf{c}^u, b^{u'}, h^u\}} \left\{ u(\mathbf{c}^u) + \beta \mathbb{E}\left[V^u(b^{u'}, \varepsilon^{u'}) | \varepsilon^u \right] \right\}$$

$s.t.$

$$\mathbf{c}^u + b^{u'} = \underbrace{(1-\tau^w)\varepsilon^u w^m h^u}_{\text{As Hired Worker}} + \underbrace{p^s z^s (1-h^u)^{1-\alpha^s}}_{\text{Self-employment}} + (1+r) b^u.$$

- Let the joint CDFs of households be $\Gamma^r(b^r, \varepsilon^r)$ and $\Gamma^u(b^u, \varepsilon^u)$.

The Model

The Government

- Define aggregate consumption for each good $x \in \{a, m, s\}$ as:

$$C_t^x = \mu^u \int c_t^{x,u} d\Gamma^u(b_t^u, \varepsilon_t^u) + \mu^r \int c_t^{x,r} d\Gamma^r(b_t^r, \varepsilon_t^r) + \mu^f c_t^{x,f}.$$

- Define the total efficient units labor supply in urban and rural areas as

$$H_t^u = \int \varepsilon_t^u h_t^u d\Gamma^u(b_t^u, \varepsilon_t^u), \quad H_t^r = \int h_t^r d\Gamma^r(b_t^r, \varepsilon_t^r).$$

- The government's balance sheet is

$$G + \mu^f \tau^r \delta k_t^f = \underbrace{\tau^a(p^a C_t^a + C_t^m)}_{\text{Consumption Tax}} + \underbrace{\mu^f \tau^r (\pi_t^f + \pi_t^*) + \tau^r y_t^m}_{\text{Corporate Income Tax}} + \underbrace{\tau^w (\mu^u w^m H_t^u + \mu^r w^f H_t^r)}_{\text{Labor Income Tax}}.$$

The Model

Stationary Equilibrium(1/2)

- The stationary equilibrium is defined as prices $\{p^a, p^s, w^f, w^m, r\}$ and allocations where households and firms optimize and all markets clear.
- The Factor Markets:
  - Urban Labor Market:

$$\mu^u \int \varepsilon^u h^u d\Gamma^u(b^u, \varepsilon^u) = h^m.$$

  - Rural Labor Market:

$$\mu^r \int h^r d\Gamma^r(b^r, \varepsilon^r) = \mu^f(h^a + h^*).$$

  - Capital Market:

$$\mu^u \int b^{u'} d\Gamma^u(b^u, \varepsilon^u) + \mu^r \int b^{r'} d\Gamma^r(b^r, \varepsilon^r) = k^m.$$

The Model

Stationary Equilibrium(2/2)

- The Goods Markets:
  - Food:

$$C^a = \mu^r \int z^a \varepsilon^r (1 - h^r)^{1-\alpha^a} d\Gamma^r(b^r, \varepsilon^r) + \mu^f z^a (h^a)^{1-\alpha^a}.$$

  - Services:

$$C^s = \mu^u \int z^s (1 - h^u)^{\alpha^s} d\Gamma^u(b^u, \varepsilon^u).$$

  - Manufacturing Goods:

$$C^m + \delta(k^m + \mu^f k^f) + G = z^m (k^m)^{\alpha^m} (h^m)^{1-\alpha^m} + \mu^f R^*,$$

where

$$R^* = p^* z^* (k^f)^{\alpha_1^*} (h^*)^{\alpha_2^*},$$

is the revenue from exporting cash crops.

A Simplified Economy

Economic Inuitions

- Consider a static economy with a number of simplifications (no risk, no large farm, etc.).
- Result 1: The urban-rural income gap is increasing in τ_a.
  - Intuition: VAT implicitly transfers resources from rural to urban area.
- Result 2: If the government uses the tax revenue collected through value added tax to purchase the same good, then value added tax has zero efficiency cost.

Calibration

Idiosyncratic Shocks

- The idiosyncratic shocks follow AR(1) processes:

$$\varepsilon^j_{t+1} = \rho^j \varepsilon^j_t + \eta^j_{t+1}, \quad j = u, r.$$

- Assume $\rho^j = 0.90$ and approximate the shocks using Tauchen's method.
- Formal hours are supplied more by:
  - High productivity households in the urban area (Shleifer and La Porta, 2014).
  - Low productivity households in the rural area (Anderson, Rausser and Swinnen, 2013).

Calibration

Endogenously Calibrated Parameters

- The model is calibrated to Ethiopia at year 2011.

Data Targets	Parameters	Data	Model
Manufacturing Share in Consumption	γ	0.33	0.35
Services Share in Consumption	ψ	0.21	0.22
Rural Consumption Gini	σ_r^2	0.26	0.26
Urban Consumption Gini	σ_u^2	0.40	0.40
Tax to GDP Ratio	τ^a	0.08	0.08
CIT in Total Tax Revenues	τ^r	0.30	0.30
PIT in Total Tax Revenues	τ^w	0.17	0.19
Food Share in Output	z^a	0.42	0.34
Manufacturing Share in Output	z^m	0.33	0.38
Export Share in Output	z^*	0.08	0.10

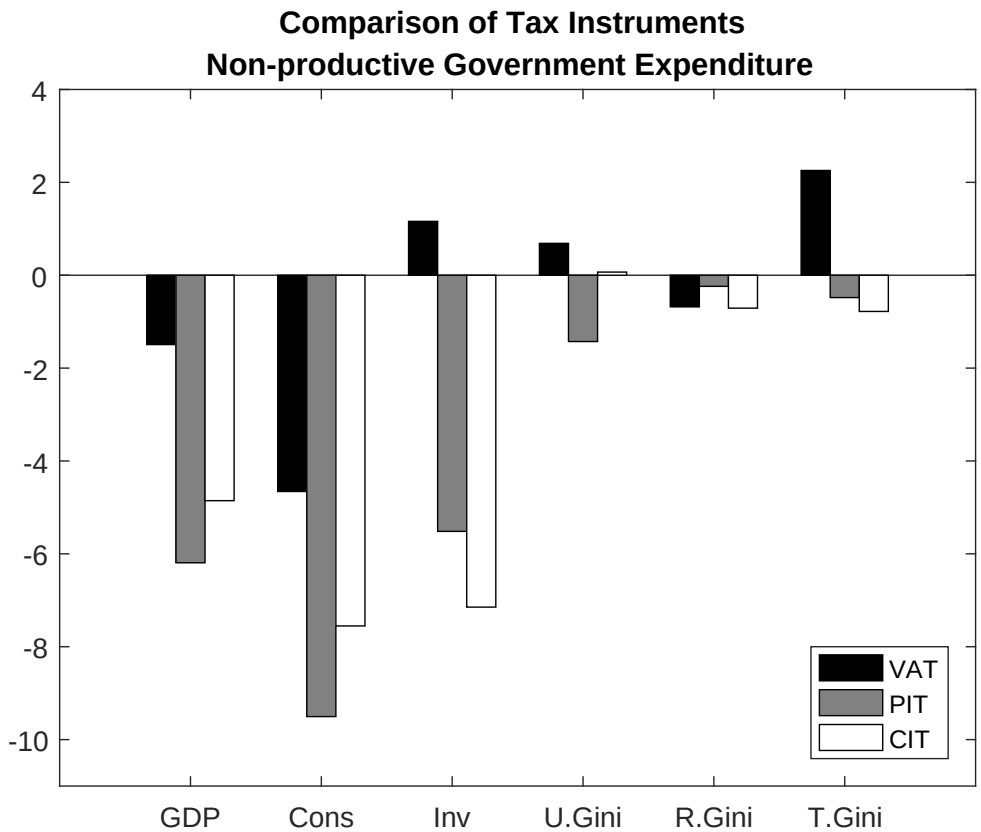
Quantitative Results

The Experiments

- Raising tax revenue of 2% GDP through VAT, CIT and PIT.
  - Tax revenue is spent on manufacturing goods.
  - Not directly valued by households.
- Welfare costs.
  - Aggregate and distributional components.
  - Total and regional impacts.
  - Steady State versus Transition.
- The role of idiosyncratic risks.
  - Use the wealth distribution of the benchmark equilibrium.
- Lump-sum transfers.

Steady State Comparison

Macro Aggregates



Steady State Comparison

Welfare Costs on the Whole Economy

- The consumption equivalence reduction:

Taxes	Total	Aggregate	Distributional
VAT	−3.89%	−2.61%	−1.32%
CIT	−2.24%	−2.52%	0.28%
PIT	−3.31%	−3.95%	0.66%

- PIT and CIT distort the economy mainly by reducing aggregate consumption, while for VAT the distributional cost is also important.
- VAT is best accompanied by transfer policy, while CIT/PIT by pro-growth policy.

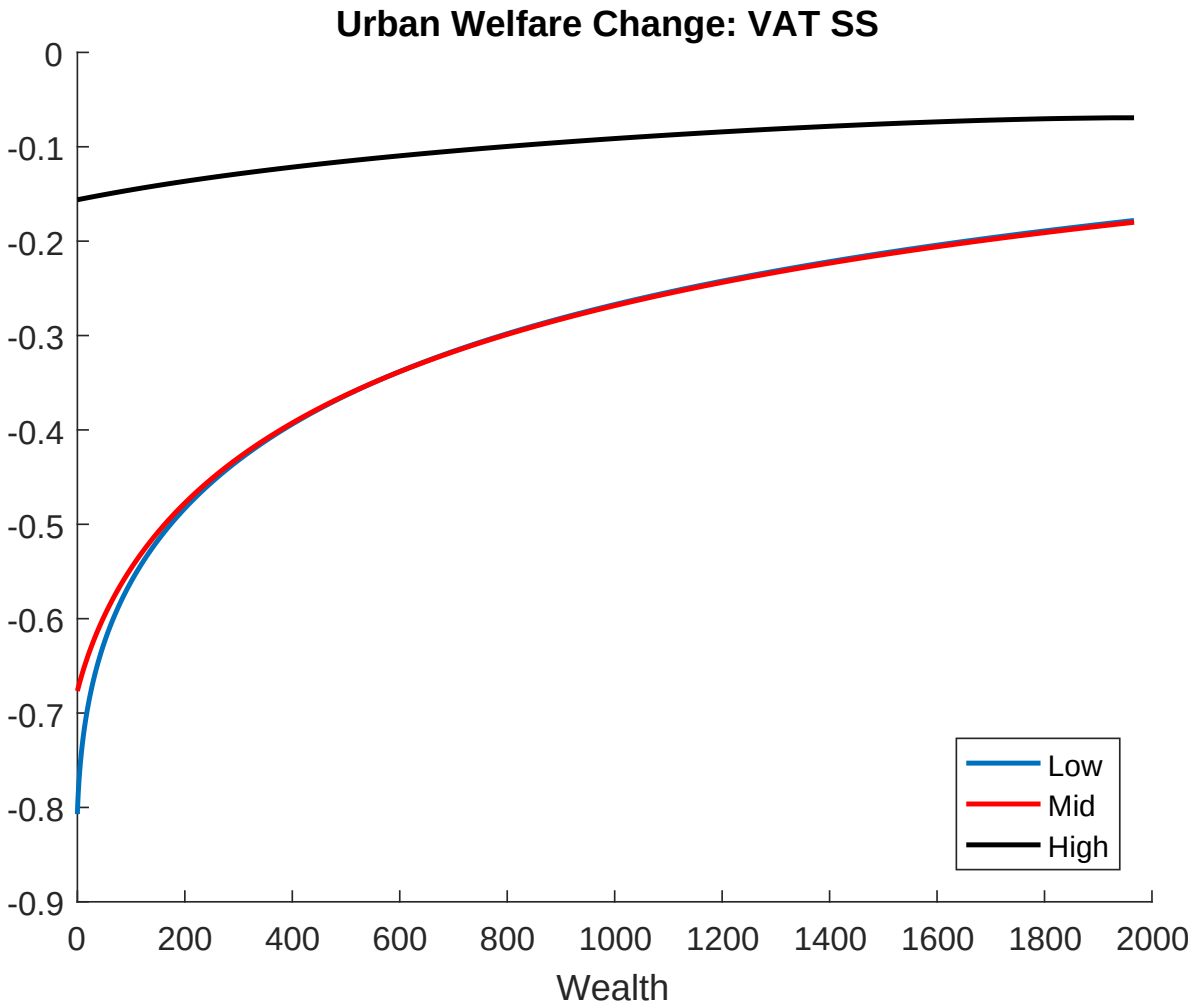
Steady State Comparison

Regional Welfare Costs

Taxes	Urban	Rural	Whole
VAT			
Total	−0.68%	−5.17%	−3.89%
Aggregate	−0.29%	−5.26%	−2.61%
Distributional	−0.46%	−0.10%	−1.32%
CIT			
Total	−2.80%	−2.02%	−2.24%
Aggregate	−2.76%	−2.25%	−2.52%
Distributional	−0.04%	0.24%	0.28%
PIT			
Total	−3.77%	−3.13%	−3.31%
Aggregate	−4.65%	−3.14%	−3.95%
Distributional	0.92%	0.02%	0.66%

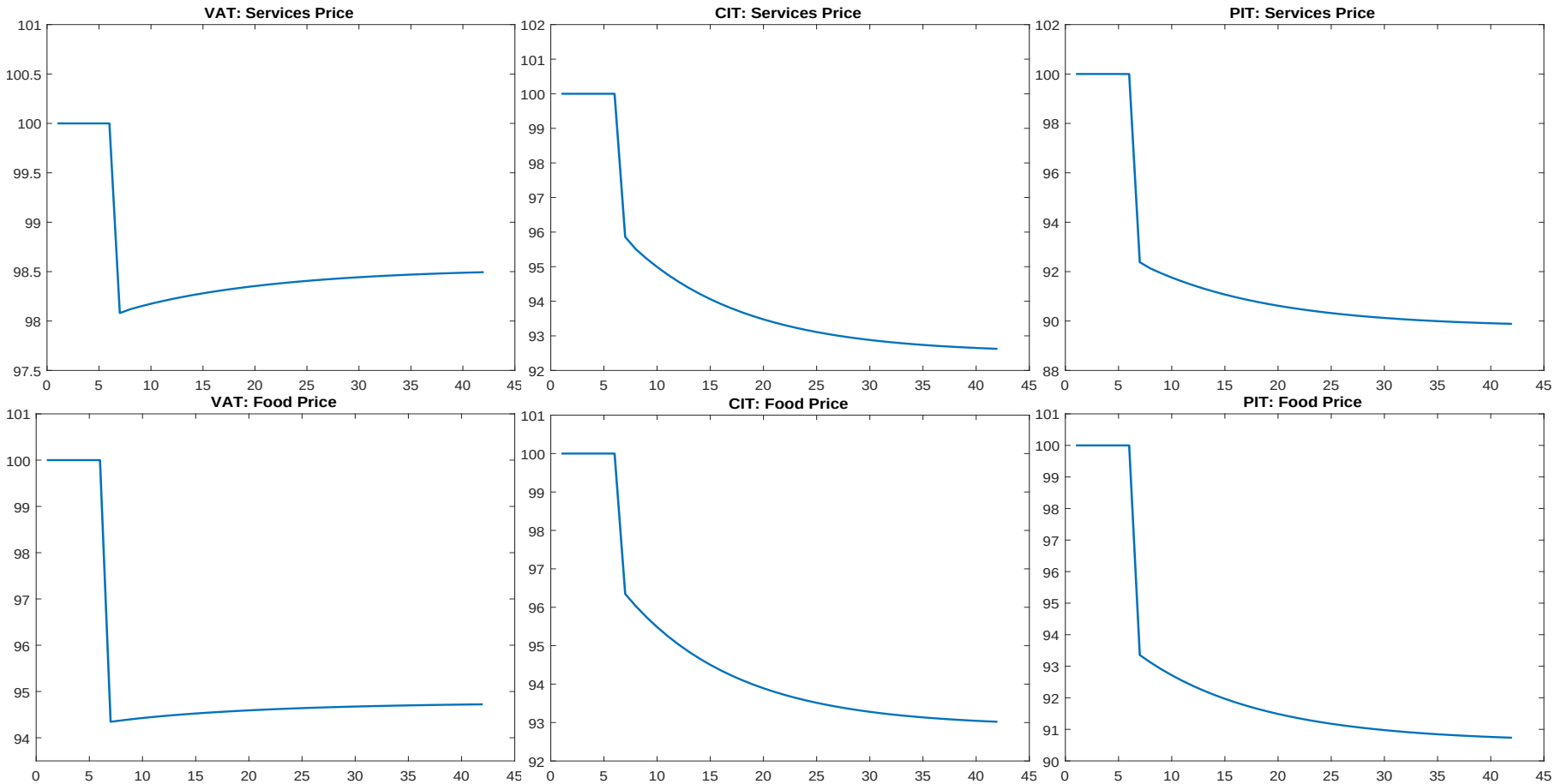
Steady State Comparison

Unintended Impact of VAT on Urban Households



Transitional Dynamics

Convergence of Prices



Transitional Dynamics

Consumption Equivalence Changes

	Urban			Rural		
	Total	Aggregate	Distribut.	Total	Aggregate	Distribut.
VAT						
Steady State	−0.68%	−0.29%	−0.39%	−5.17%	−5.26%	0.10%
Transition	−0.95%	−0.50%	−0.46%	−5.22%	−4.96%	−0.27%
CIT						
Steady State	−2.80%	−2.76%	−0.04%	−2.02%	−2.25%	0.24%
Transition	−2.17%	−2.09%	−0.08%	−1.85%	−1.72%	−0.13%
PIT						
Steady State	−3.77%	−4.65%	0.92%	−3.13%	−3.14%	0.02%
Transition	−3.33%	−3.86%	0.55%	−3.16%	−2.82%	−0.36%

- The welfare costs do not differ with those in steady state by much because of fast convergence.

Lump-sum Transfers

VAT with Rural Transfers

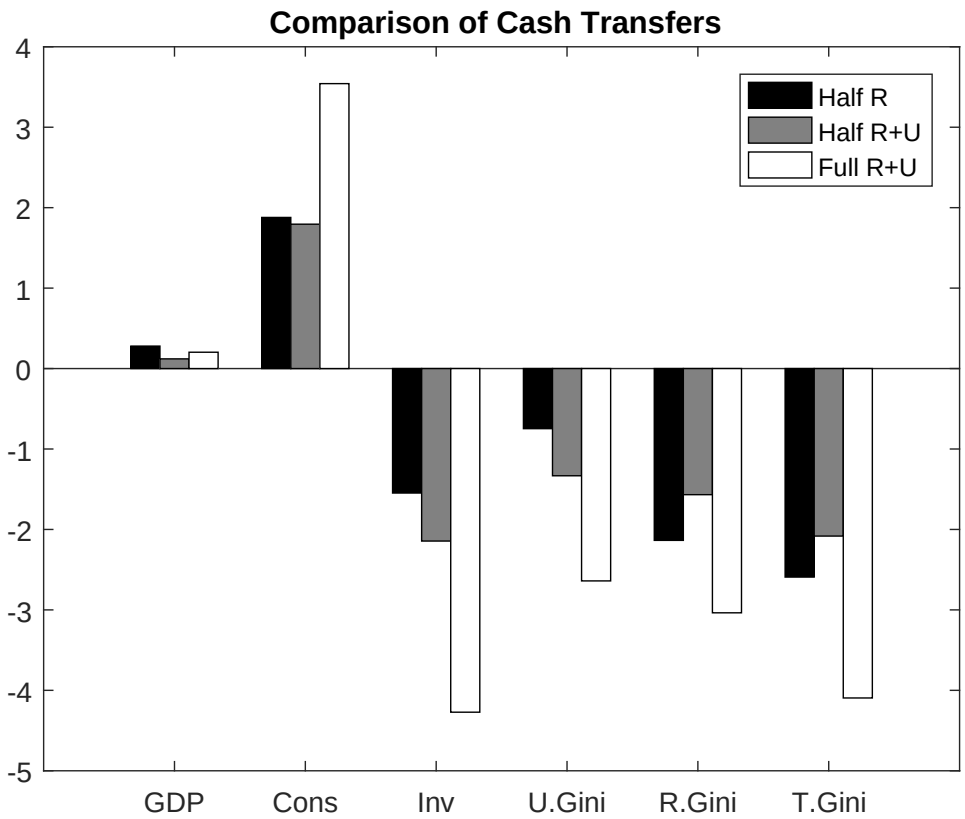
	Urban	Rural	Whole
Transition			
Total	−1.43%	−1.29%	−1.33%
Aggregate	−1.37%	−1.68%	−1.51%
Distributional	−0.07%	0.40%	0.19%
Steady State			
Total	−1.29%	−1.30%	−1.29%
Aggregate	−1.32%	−1.95%	−1.72%
Distributional	0.03%	0.66%	0.32%

- Overall, about 67% of the welfare costs from revenue mobilization with VAT are mitigated.
  - Caveat: Here less resources are “wasted,” hence the comparison is not a “fair” one.

Lump-sum Transfers

Macro Aggregates: More Cases

- All results are from steady state comparison.



Government Utility Function

Welfare Costs

- We double the weights the government assigns to each rural household.

	VAT		CIT		PIT	
	Equal	Rural	Equal	Rural	Equal	Rural
Total	−4.01%	−4.51%	−1.94%	−1.90%	−3.21%	−3.19%
Aggregate	−2.58%	−3.34%	−1.91%	−1.85%	−3.37%	−3.20%
Distributional	−1.46%	−1.21%	−0.02%	−0.05%	0.17%	0.01%

- The effects are small because Ethiopia already features a large rural population (69%).

Idiosyncratic Risks

Risk vs No Risk

- In all cases, transitional dynamics are considered.

	VAT		CIT		PIT	
	Risk	No Risk	Risk	No Risk	Risk	No Risk
Total	−4.01%	−0.59%	−1.94%	−0.33%	−3.21%	1.91%
Aggregate	−2.58%	−2.55%	−1.91%	−2.21%	−3.37%	−2.74%
Distributional	−1.46%	2.01%	−0.02%	1.92%	0.17%	4.77%

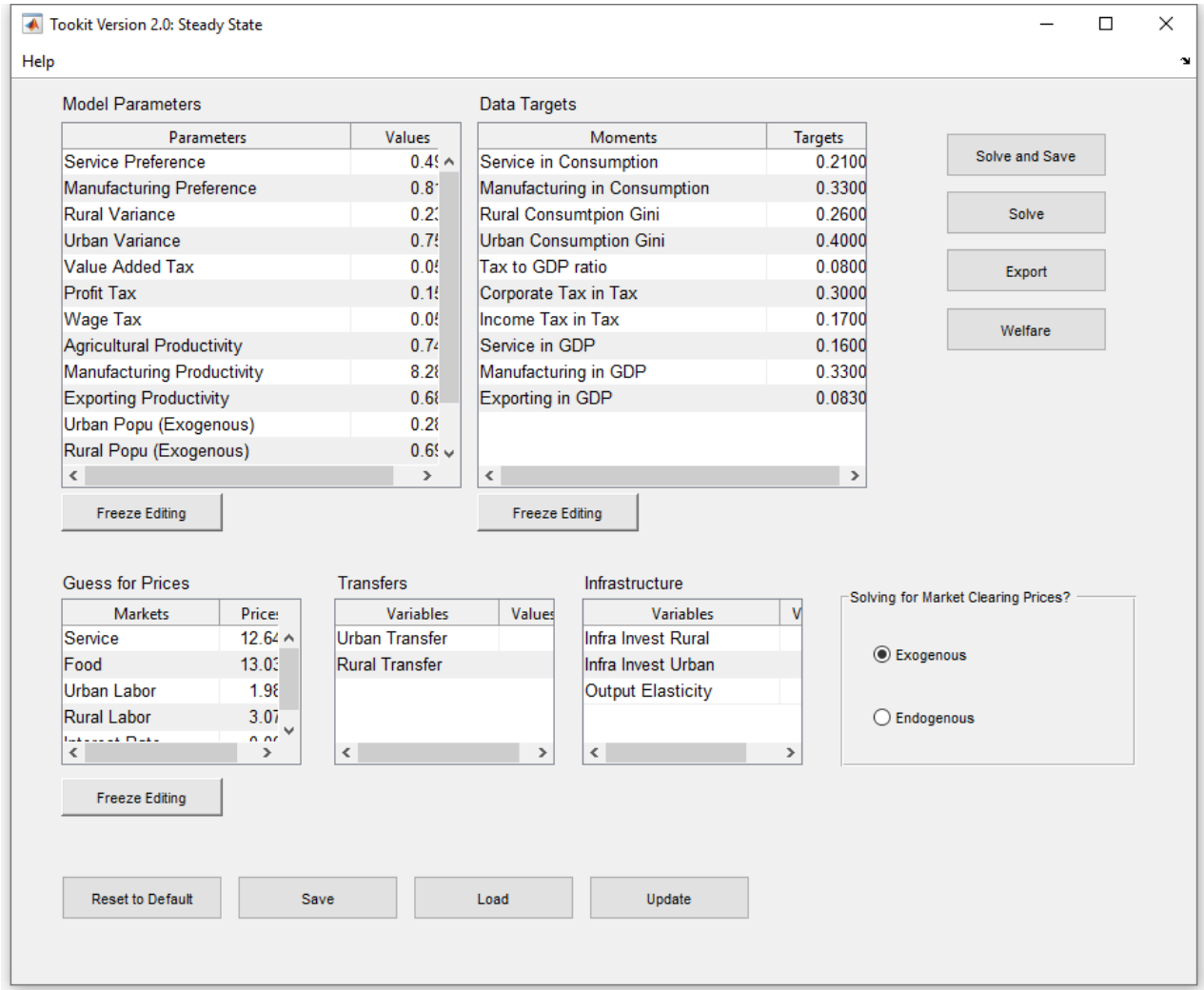
- Idiosyncratic risks influence the welfare costs mainly through the distributional components.

Conclusions

- We build an Aiyagari model with multiple sectors and regions to capture salient features of low-income countries.
- We use the model to quantify the welfare costs of fiscal consolidations using VAT, CIT and PIT.
- The economic structure of low-income countries yields new insight to the design of fiscal reforms.
  - VAT + Transfer and PIT/CIT + Pro-growth.
  - Low overall capital stock results in fast transition between steady states.
  - Idiosyncratic risks have large distributional costs.
- Tools have been developed for easy application of the model to policy advices.

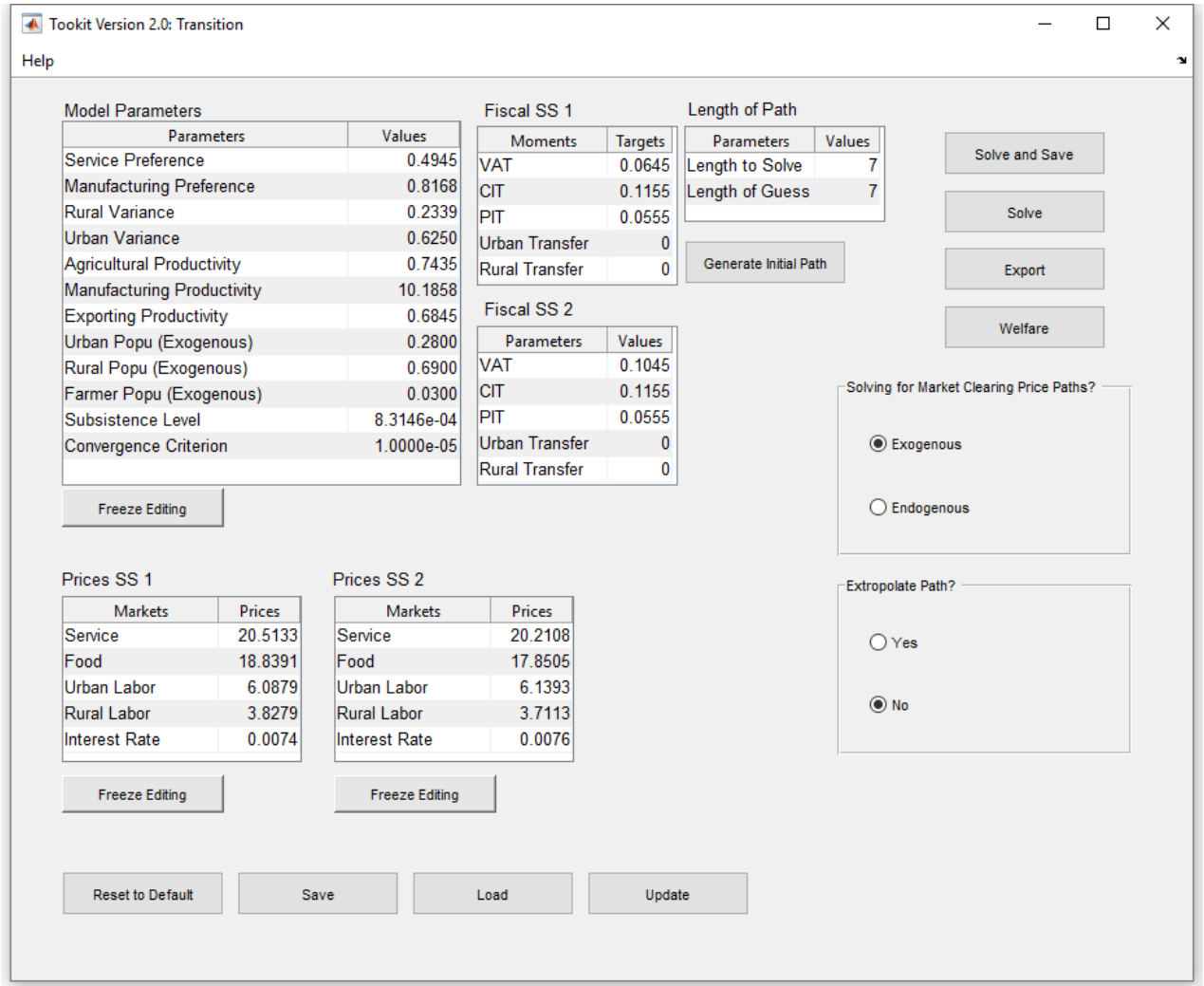
A Toolkit for Policy Analysis

Interface: Steady State



A Toolkit for Policy Analysis

Interface: Transitional Dynamics



A Toolkit for Policy Analysis

Major Features

- Solves the model and exports the results to Excel by point-and-click.
- Integrated support of parallel execution.
- Open source support of using with GNU Octave.
- Widely used in the Fund's surveillance and capacity development work.
  - Article IV Consultations: Cambodia, Benin, Ethiopia, Dominican Republic, Senegal, Serbia, etc.
  - Capacity Development: Dominican Republic and Senegal.
  - https://github.com/IMFInequality/inequality