Optimal Taxation in a Monetary Search Model with Informal Markets

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"Inflationary finance is the form of taxation which the public finds hardest to evade and even the weakest government can enforce, when it can enforce nothing else "

— Keynes (Monetary Reform, 1924)

Our Objectives

Explore how the frictions that make money valuable with an explicit modeling of the financial system affect:

1. demand for currency stemming from the informal sector

2. design of optimal fiscal and monetary policy

3. composition of formal versus informal activity and its impact on the financial system

4. size distribution of firms across formal and informal markets

Some Motivating Facts

- The most common force that rationalizes the existence of informal markets is the high tax burdens imposed on economic agents

- Agents that engage in informal market activities are evading taxes

- Seigniorage accounts for a significant part of government revenues in countries where the size of the informal sector is large

- Informal agents do not reveal all their sources of income, preventing them from formal services like financial ones

- By its nature, transactions in informal markets are made in cash as to leave no traces for fiscal authorities

- However, not all cash transactions belong to informal activities

Financial Intermediation and Informal Economies

1. The size of the informal sector is negatively correlated with deposits in the financial system

   Deposit money bank assets to GDP and bank deposits to GDP

2. The size of the informal sector is negatively correlated with available private credit in the financial system

   Private credit by deposit money banks to GDP as well as private credit by deposit money banks and other financial institutions to GDP

3. The size of the informal sector is positively correlated with the inefficiency of the banking system

   Net interest margins, overhead costs and 3-concentration

Financial Intermediation and Informal Economies

The informal sector literature typically highlights the borrowing consequences of hiding economic activity from the taxing authority

A much less discussed point in the literature is the effect of a tax-evading sector on the intermediated savings of the economy

When agents deposit funds in the financial system, they are readily available for taxation purposes

Payment of taxes can be interpreted as a fee that allows agents to have access to financial services

Previous Literature

Real economies

Study how informal markets affect labor, product and credit markets

E.g. Amaral and Quintin (2006), Antunes and Cavalcanti (2007)

Drawbacks: Do not address the payment system used in the informal economy nor consider optimal funding of government expenditures
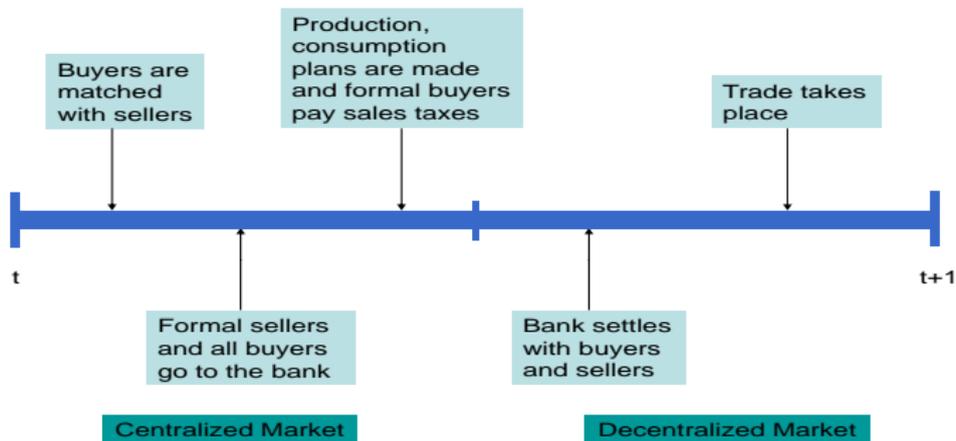
Monetary economies

Study public finance motive for inflation in economies with informal markets

E.g. Nicolini (1998), Cavalcanti and Villamil (2003) and Koreshkova (2006)

Drawbacks: Money is not microfounded, assumes all cash transactions are informal, do not study size distribution of firms across markets and no role for financial intermediation

Model– Extension of Rocheteau and Wright (2005)

Buyers are matched with sellers

Production, consumption plans are made and formal buyers pay sales taxes

Trade takes place

t

t+1

Formal sellers and all buyers go to the bank

Bank settles with buyers and sellers

Centralized Market

Decentralized Market

Economic Model

Time is discrete and each period is divided into two subperiods, called day and night, where economic activity differs

During the day market there are explicit frictions and at night, there is a frictionless centralized market

Following Rocheteau and Wright (2005) there is a continuum of agents with a measure of B (buyers) and S (sellers) in the DM

DM Sellers produce a good that they do not consume

DM Buyers cannot produce goods but can use their cash balances to buy and consume

DM good's trades are anonymous

Economic Model

Sellers are distinguished by their productivity γ_j with a compact support $[\underline{\gamma}, \overline{\gamma}]$ with a distribution of types given by $F(\gamma^j)$

Sellers decide whether to produce formally or informally

There is a technology that allows record keeping of financial histories but not trading histories in the goods market

During the night subperiod agents trade a general good that everyone can produce and wants to consume

During CM, all agents have the same productivity

All markets are competitive and the only asset in both subperiods is divisible fiat money

Formal *vs* Informal Trading

1. Goods traded in formal markets are subject to a sales tax

2. Goods traded in informal markets are not taxed

3. The disutility cost of producing in the informal sector increases at a faster rate than in the formal market as production increases

4. Only formal producers can deposit the proceeds of their sales to the bank, obtaining interest income

5. All buyers can borrow from the bank

Seller's Problem

Sellers trade with a buyer in DM market with probability one. A **formal (informal)** seller that has m_j units of money has the following CM value function:

$$V_S^F(m_j) = \max_{q_{S,j}^F, h, D_j} \left\{ -c^F(h) + W_S^F \left(m_j - D_j + P_j^F q_{S,j}^F, D_j \right) \right\}$$

$$s.t. \quad q_{S,j}^F = \gamma_j h^\alpha$$

$$c^F(h) = h \quad (c^I(h) = ah^2)$$

$$0 \le D_j \le P_j^F q_{S,j}^F \quad (D_j = 0)$$

The CM value function of a **formal** seller is given by:

$$W_S^F(m_j, D_j) = \max_{X, H, m_j'} \left\{ U(X) - H + \beta V_S^F(m_j') \right\}$$

$$s.t. \quad X = (1 - \tau_N) H + \phi \left[(1 + r_d) D_j + m_j - m_j' \right]$$

Seller's Entry Decision to the Formal DM

If the net present value of utility flows of a seller of type γ^j is larger in the formal market than in the informal one, $V_S^F(m_j) > V_S^I(m_j)$, she will produce formally. Otherwise she produces informally

This can be summarized as follows:

$$-\left[\frac{\phi P_j^F \alpha \gamma_j}{1-\tau_N}\right]^{\frac{1}{1-\alpha}} + \frac{(1+r_d)\,\phi P_j^F}{1-\tau_N}\gamma_j\left[\frac{\phi P_j^F \alpha \gamma_j}{1-\tau_N}\right]^{\frac{\alpha}{1-\alpha}} >$$

$$-a\left[\frac{\phi P_j^I \alpha \gamma_j}{2a(1-\tau_N)}\right]^{\frac{2}{2-\alpha}} + \frac{\phi P_j^I}{1-\tau_N}\gamma_j\left[\frac{\phi P_j^I \alpha \gamma_j}{2a(1-\tau_N)}\right]^{\frac{2\alpha}{2-\alpha}}$$

Buyer's Problem

Buyers meet sellers randomly in DM and with a certain probability they are going to buy in formal or informal markets. The DM value function of buyer is given by:

$$V_B(m_B) = \mu^F \int_{\gamma^*}^{\overline{\gamma}} \max_{q_{B,j}^F, I_j^F} \left[u(q_{B,j}^F) + W_B \left(m_B + I_j^F - (1+\tau_b) P_j^F q_{B,j}^F, I_j^F \right) \right] dF(\gamma^j) +$$

$$+ \mu^I \int_{\underline{\gamma}}^{\gamma^*} \max_{q_{B,j}^I, I_j^I} \left[u(q_{B,j}^I) + W_B \left(m_B + I_j^I - P_j^I q_{B,j}^I, I_j^I \right) \right] dF(\gamma^j)$$

$$s.t. \quad (1+\tau_b) P_j^F q_{B,j}^F \leq m_B + I_j^F$$

$$P_j^I q_{B,j}^I \leq m_B + I_j^I \quad I_j^F, \ I_j^I \leq \bar{L}$$

The CM value function of buyer is given by:

$$W_B \left(m_B; I_j^F, I_j^I \right) = \max_{X, H, m_B'} \{ U(X) - H + \beta V_B(m_B') \}$$

$$s.t. \quad X = (1 - \tau_N) H + \phi \left[m_B - \epsilon^F (1+r_I) I_j^F - \epsilon^I (1+r_I) I_j^I - m_B' \right]$$

Banks

We model credit as financial firms who accept nominal deposits and make nominal loans, as in Berentsen, Camera and Waller (2007)

All financial contracts are one-period contracts

All banks are perfectly competitive so that:

$$r_l - r_d = \kappa; \quad \kappa \geq 0$$

κ can be thought as regulation costs that banks face when operating in the economy

Frictions of the Model

The economic environment that we are studying has the following frictions:

(i) in monetary exchanges some agents pay a cost today (production) to receive a future benefit (money that can be used to purchase goods in future trades),

(ii) utility costs faced by sellers are different depending if they produce formally or informally,

(iii) the financial sector is segmented, only buyers and formal sellers can access it

Government

A benevolent government must fund a positive stream of expenditures. Namely,

$$\tau_N H_t + (M_t - M_{t-1})\phi_t + \int_{\gamma^*}^{\overline{\gamma}} \tau_b \phi_t P_j^F q_{B,j}^F dF(\gamma^j) \geq G;$$

Fiscal and monetary policies are chosen as to maximize social welfare which is given by:

$$
\begin{aligned}
\mathcal{W} &= B\int_{\underline{\gamma}}^{\gamma^*} u(\gamma^j h_j^\alpha) dF(\gamma^j) + B\int_{\gamma^*}^{\overline{\gamma}} u(\gamma^j h_j^\alpha) dF(\gamma^j) - \\
&\quad S\int_{\underline{\gamma}}^{\gamma^*} a h_j^2 dF(\gamma^j) + S\int_{\gamma^*}^{\overline{\gamma}} h_j dF(\gamma^j) + (B+S)(U(X)-X),
\end{aligned}
$$

subject to budget constraint and consistent with equilibrium behaviors of buyers and sellers

Equilibrium

> **Definition**
>
> An equilibrium for this economy consists of three tax rates (τ_N, τ_b, π) and sequences of money holdings distributions, formal and informal supplies, prices, and interest rates $\{m_j, m_B, \mu_{F,t}, \mu_{I,t}, \phi_t, P_j^I, P_j^F, r_d, r_l\}$, as well as sequences of consumption and production plans, loans, and deposits $\{ q_{B,j}^F, q_{B,j}^I, q_{S,j}^F, q_{S,j}^I, X, H, I_j^F, I_j^I, D_j \}$ such that
>
> [i] $\left\{ q_{B,j}^F, q_{B,j}^I, q_{S,j}^F, q_{S,j}^I, X, H, I_j^F, I_j^I, D_j, m_B, m_j \right\}$ solve the representative buyers and sellers' problem taking prices, taxes, government expenditures, and all distribution functions as given
>
> [ii] The government budget constraint holds $\forall t > 0$
>
> [iii] All aggregate resource constraints hold and markets clear $\forall t > 0$
>
> [iv] There is consistency of beliefs and the actual distributions of money, and formal and informal sellers

Some Properties of Equilibrium

1. Given a uniform distribution of productivities, a compact support $[\underline{\gamma}, \overline{\gamma}]$ can be chosen so that there exists γ^*, with $\underline{\gamma} < \gamma^* < \overline{\gamma}$, so that all sellers with $\gamma_j \geq \gamma^*$ choose to produce in the formal sector, similarly, for all $\gamma_j < \gamma^*$ sellers produce in the informal sector

2. Sellers of every type carry zero real balances to the DM

3. Buyers bring the same positive amount of money to the DM

Holding other factors fixed:

1. As sales tax rates increase the demand for formal goods decreases

2. The size of the informal sector increases with inflation

Quantitative Analysis

Preferences are given by $u(q) = \frac{(q+b)^{1-\eta} - b^{1-\eta}}{1-\eta}$ with $b \to 0$ and $U(X) = Z \, log(X)$

First consider a base country, the U.S., and find a set of parameters and match some macroeconomic observables β=0.96, κ=0.043, $\underline{\gamma}$=0.1

The rest of parameters (a, $\overline{\gamma}$, G, Z and α) are chosen to minimize the distance between the size of the informal sector relative to GDP, the relative firm size of informal versus formal, government expenditures to GDP and inflation rate to U.S. observables

Quantitative Results

Table: Welfare Maximizing Policies when $G{=}0$

π	τ_b	τ_N	$\frac{P^l q^l}{GDP}$	$\frac{D}{GDP}$	$\frac{L^l}{L^F}$	r_d
0%	-	-	0.052	0.57	0.033	3.9%
-3%	5.4%	-%	0.133	0.444	0.085	1%
-3%	5.4%	0%	0.133	0.444	0.085	1%

A single policy instrument, π, cannot completely counteract all frictions

Having active fiscal policies helps reduce the intertemporal friction

τ_b only distorts the decision of formal buyers, whereas τ_N affects both buyers' and sellers' decisions

Finally, we find that the optimal size of the informal sector is not zero even when there are no government expenditures

Quantitative Results

Table: Welfare Maximizing Policies when $G>0$

π	τ_b	τ_N	$\frac{P^l q^l}{GDP}$	$\frac{D}{GDP}$	$\frac{L^l}{L^F}$	r_d
83.2%	54.6%	-	0.026	0.189	0.028	90.8%
1.6%	9%	28.3%	0.092	0.295	0.077	10%

$\tau_N>0$ implies that the government exploits the different marginal utilities of consumption between the day and night markets

An active production tax reduces deposits and increases the size of the informal sector

Quantitative Results

Table: Increase of 1% from Welfare Maximizing Policies when $G>0$

π	τ_b	τ_N	$\frac{P^l q^l}{GDP}$	$\frac{D}{GDP}$	$\frac{L^l}{L^F}$	r_d
1.6%	**9%**	**28.3%**	**0.092**	**0.295**	**0.077**	**10%**
2.6%	9%	28.3%	0.084	0.305	0.077	6.8%
1.6%	10%	28.3%	0.104	0.274	0.089	5.8%
1.6%	9%	29.3%	0.092	0.295	0.077	5.8%

Size of the informal sector grows as the sales taxes increase, and declines with inflation

Deposits, the sales proceeds of the formal decentralized market, increase with inflation and are reduced with increases in sales taxes

Other Experiments

When the costs of hiding from the fiscal authority decreases

- the size of the informal sector increases

- inflation increases

When the financial sector becomes more inefficient

- the size of the informal sector increases

- inflation increases

As BCW (2007) there are substantial benefits of having a large formal sector since it channels idle cash holding of formal sellers while increasing the amount of credit available to the economy

Conclusions

1. When the government collects seigniorage, sales taxes can be lowered, reducing the incentives to produce in the informal market

2. The size of the informal sector grows as fiscal taxes increase, and declines with inflation and total amount of available loans in the economy increases with inflation

3. When cash is used for transactions in the informal and formal economy, there is a trade-off between fiscal policies and the inflation tax

4. Inflation has two effects: (i) distorts the rate of return on money, and (ii) redistributes resources from one type of agents to the other one

5. The health of the financial systems is critical in determining the size of the informal sector