Economics Letters 172 (2018) 152–156

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

A note on optimal sectoral policies in production networks

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HIGHLIGHTS

- I study optimal sectoral policies in a model with input-output linkages and sectoral distortions.
- I characterize network pecuniary externalities and provide a framework to obtain multiple sets of optimal sectoral input subsidies.
- The results indicate that, in general networks, a set of intermediate input subsidies – or combinations of labor and intermediates subsidies – can decentralize the first best, while labor input subsidies alone cannot.
- Having multiple sets of corrective policies is desirable from a political economy perspective, especially when bailing out individual sectors is unpopular.

ARTICLE INFO

Article history:
Received 17 August 2018
Received in revised form 26 August 2018
Accepted 27 August 2018
Available online xxxx

JEL classification:
E32
E60

Keywords:
Pecuniary externality
Input–output linkages
Sectoral input subsidies

ABSTRACT

I study optimal sectoral policies in models with input–output linkages and distortions. Labor subsidies cannot implement the first best allocation. Intermediate input subsidies, or the right combination(s) between subsidies to labor and intermediates, can optimally correct for network externalities.

1. Introduction

The network origins of aggregate fluctuations are a new, but widely accepted, phenomenon in macroeconomics. It has been shown, theoretically and empirically, that disruptions in the production of a firm or industry – be sectoral productivity or financial shocks – can have significant aggregate effects by means of sectoral input–output connections (Horvath, 1998; Foerster et al., 2011; Acemoglu et al., 2012; Baqaee and Farhi, 2017a,b; Bigio and La'O, 2016; Carvalho et al., 2016; Atalay, 2017; Miranda-Pinto, 2018).

However, there are no policy lessons to be drawn from this literature. Bigio and La'O (2016), Luo (2015), and Miranda-Pinto and Young (2018) show that during the Great Recession, sectoral financing constraints distorted firms' optimal input choice. The effect of these sectoral *wedges* is amplified by sectoral linkages. Nevertheless, sectoral linkages might also offer a way out. In particular, can the authority – conditional on tighter credit conditions and existent input–output connections – mitigate a recession by relocating sectoral production via sectoral input subsidies? Finding an answer to this question is the goal of this paper.

I study the normative aspects of multisector economies with input–output linkages and sectoral distortions as in Bigio and La'O (2016) and Baqaee and Farhi (2017b). To study the scope for policy intervention I follow Bianchi (2011) and solve the constrained efficient planner problem. The social planner faces the same working capital constraints as private firms but internalizes the price effects of firms' production–borrowing decisions. When sectoral constraints bind, there exist network pecuniary externalities at work that open the scope for policy intervention. Firms in downstream (upstream) sectors do not internalize how their decisions affect the severity of the constraint of upstream (downstream) firms.

I show that the constrained planner solution is first best. Therefore, I proceed to study the set of optimal input subsidies that decentralize the first best allocation. I provide a framework that

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[1] This paper is a revised version of Chapter 4 of my dissertation submitted to the Graduate School of Arts and Science, University of Virginia, April 2017. I am extremely grateful to Eric Young, Sophie Osotimehin, Toshihiko Mukoyama, and Pierre-Daniel Sarte for their support and suggestions. I thank an anonymous referee for helpful suggestions that improved the paper. I also thank Andres Bellofatto, Renzo Castellares, Begoña Dominguez, Everett Grant, Ilhan Guner, Ben Hamilton, Guillermo Hausmann Guil, and Claudio Mezzeti for helpful comments. All errors are mine.

https://doi.org/10.1016/j.econlet.2018.08.036
0165-1765/

makes use of the model's system of linear equations on prices and subsidies to implement the first best allocation. Using a rank condition on the system of linear equations, I show that, when all firms use intermediates in production and when all firms are credit constrained, a set of intermediate input subsidies on each sector can decentralize the first best. On the other hand, when all sectors use intermediates, labor subsidies alone do not have enough degrees of freedom to relocate inputs and undo the constraints. There are, however, multiple combinations of labor and intermediate subsidies that can implement the first best allocation.

This paper makes two contributions to the literature. The first one is to provide a mathematical characterization of the feasible set of policy instruments in the form of a rank condition in the system of linear equations that characterize the economy. The rank condition depends on the set of instruments considered – be subsidies to labor and/or intermediate input to a given sector – and the structure of input–output connections. In this regard, this paper emphasizes the importance of the microeconomic structure of economy in the design of optimal policy.

The second contribution is to emphasize multiple policy tools that effectively relocate sectoral activity and undo sectoral distortions. This is crucial from a political economy perspective, when bailing out some industries or banks is unpopular or when injecting liquidity to the financial sector is an inefficient way of increasing credit supply.

Related Literature: Contemporaneous to this study, Liu (2017) studies sectoral interventions that have the highest social value. The author proposes development policies targeting the most upstream industries of the economy. The framework provided in this paper instead provides a variety of optimal input subsidies that implement the first best allocation. Indeed, the existence of input–output linkages, heterogeneous frictions, and different policy tools, provide a variety of corrective policies that not only target large upstream industries. In addition, unlike (Liu, 2017) who focuses on long-term development policies, I study business cycle stabilization policies.

2. The model economy

There are N sectors in the economy. Firms in sector j produce output Q_j using labor L_j and intermediate inputs M_{ij} from other sectors. The production technologies is:

$$Q_j = Z_j\left[a_j^{1/\epsilon_Q} L_j^{\frac{\epsilon_Q-1}{\epsilon_Q}} + (1-a_j)^{1/\epsilon_Q} M_j^{\frac{\epsilon_Q-1}{\epsilon_Q}}\right]^{\frac{\xi\epsilon_Q}{\epsilon_Q-1}}, \tag{1}$$

where Z_j is sectoral total factor productivity, a_j is the importance of labor in production, and ϵ_Q is the elasticity of substitution between labor and intermediates. When $\epsilon_Q = 1$, a_j is exactly the expenditure share of labor in gross output. ξ measures the returns to scale. When $\xi < 1$, there are decreasing returns to scale and when $\xi = 1$ the technology displays constant returns to scale (CRS). The benchmark case assumes CRS in the limit. The intermediate input bundle is:

$$M_j = \left(\sum_{i=1}^{N} \omega_{ij}^{1/\epsilon_M} M_{ij}^{\frac{\epsilon_M-1}{\epsilon_M}}\right)^{\frac{\epsilon_M}{\epsilon_M-1}}, \tag{2}$$

where ω_{ij} is the expenditure share of intermediate inputs from sector i in the total intermediate input expenditure of sector j. The elasticity of substitution between intermediates is ϵ_M.

Firms in each sector face the following working capital constraint:

$$wL_j + \sum_{i=1}^{N} P_i M_{ij} \leq \eta_j P_j Q_j. \tag{3}$$

As in Bigio and La'O (2016) firms need to pay input before production. The external funds that a firm can obtain are limited by a fraction η_j of total sales. This assumption is the result of an enforcement problem. Firms could run away with revenues without paying back the intra-period loan to the financial intermediary. In this environment, firms are exogenously and permanently (un) constrained if the value of the collateral constraint parameter η_j is smaller (larger) than the degrees of scale (ξ).

The representative household utility is:

$$U(C, L) = \log C - L, \tag{4}$$

where

$$C = \prod_{j=1}^{N} C_j^{\phi_j}. \tag{5}$$

The consumption share of sector j in total consumption expenditure is ϕ_j. Labor is elastically supplied and freely mobile across sectors. The household budget constraint is $wL = \sum_{j=1}^{N} P_j C_j$, where w is the wage rate.[2]

I assume that markets are perfectly competitive. All agents in this economy make static decisions which is why I suppress the time subscripts from the model. I assume that the wage rate is the numeraire of the economy, implying $w = 1$.

Definition 1. The unconstrained competitive equilibrium vector of prices P^* and allocations (C^*, Q^*, L^*, M^*) are the solution to the model when $\psi_j = 1$ for all j (see solution in Appendix B).

3. A network pecuniary externality

The scope for policy intervention arises from the fact that individual firms do not internalize how their decisions affect other firms in the production network. To formally characterize these network externalities I follow Bianchi (2011) and Benigno et al. (2013) and define the constrained efficient planner problem.

Definition 2. The constrained efficient planner chooses allocations $(\{C_j, Q_j, L_j, M_j\}_j)$, by maximizing the households utility (4) subject to sectoral technology (1)–(2), the working capital constraints (3), and subject to the competitive equilibrium optimality conditions that determine the vector of prices $\{P_j\}_j$.

The planner chooses allocations facing the same working capital constraints while letting goods and input markets to clear competitively. Therefore, the planner internalizes how production decisions affect sectoral prices and then the value of sectors' collateral, which is determined endogenously.

Suppose there are only two sectors in the economy. Sector one produces using only labor and sector 2 produces using labor and intermediates from sector 1. For simplicity, assume that $\epsilon_Q = \epsilon_M = 1$. The planner's optimality conditions for the use of intermediates and the price of intermediates are:[3]

$$M_2 : -\lambda_1 + \lambda_2(1-a_2)\frac{C}{M_2} - \mu_2 P_1 + \underbrace{\mu_1\eta_1 P_1}_{downstream\ externality} - \gamma_1 P_1 + \gamma_3 \frac{P_1}{\psi_2(1-a_2)} = 0$$

[2] I abstract from firms' profits, which is the same as interpreting the results in the limit CRS case, as in Bigio and La'O (2016). To simplify the analysis, I also assume that the excess revenues generated by sectoral distortions are thrown into the ocean.

[3] The variables λ_j and γ_j represent the Lagrange multiplier for technologies and firms' first order conditions, respectively.