The Economic Implications of Carbon Financial Frictions

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Motivation

Adam Smith (1776)[1]

Every individual necessarily labours to render the annual revenue of the society as great as he can... He is in this, as in many other ways, led by an invisible hand to promote an end which was no part of his intention... By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it.

- But what about the public goods and externalities?
- It is well known that the market fails to allocate resources efficiently in the presence of externalities.
- One of the most important externalities is the environmental externalities, such as the CO2 emission.

[1] "Wealth of nations" (1776), Book IV, Chap II

Motivation

- So, governments decided to intervene in the market to correct the market failure.
- This means that they are reallocating resources in the economy.
- But, what are the costs of this reallocation?

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Literature

Not comprehensive list

- Misallocation literature:
  - Whited and Zhao (2021): They estimate real losses arising from the cross-sectional misallocation of financial liabilities.
- Carbon pricing literature:
  - Shapiro and Walker (2018): They show that the emissions reductions in the US are primarily driven by within-product changes in emissions intensity rather than changes in output or in the composition of products produced.

Contribution

- Most of the prior literature has focused on the success of environmental policies in reducing the emissions.
- However, the costs of these policies have been less studied.
- This paper aims to fill this gap by investigating the costs of reallocating resources.

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Methodology

My methodology builds on a recent paper by Whited and Zhao (2021):

- The real benefit of finance for firms s in sector s is:

$$F_{si} = A_{si}^{F} \left(\alpha_s D_{si}^{\frac{\gamma_s - 1}{\gamma_s}} + (1 - \alpha_s) E_{si}^{\frac{\gamma_s - 1}{\gamma_s}} \right)^{\frac{\gamma_s}{\gamma_s - 1}}$$

- The nominal benefit of finance for firms:

$$\pi_{si} = P_{si} F_{si} - [(1 + \tau_{D_{si}}) r_{si} D_{si} + (1 + \tau_{E_{si}}) \lambda_{si} E_{si}] - \tau_z Z_{si}$$

- The firm's emission is:

$$Z_{si} = A_{si}^{z} \times F_{si}$$

- To maximize the profit, first firm chooses the debt and equity to minimize the cost of production and then chooses the price level.

Methodology

Optimal Allocation

- First step:

$$\min_{D_{si},E_{si}} \quad (1+\tau_{D_{si}})r_{si}D_{si} + (1+\tau_{E_{si}})\lambda_{si}E_{si} + \tau_z Z_{si}$$

$$\text{s.t.} \quad A_{si}^F \left(\alpha_s D_{si}^{\frac{\gamma_s - 1}{\gamma_s}} + (1-\alpha_s) E_{si}^{\frac{\gamma_s - 1}{\gamma_s}} \right)^{\frac{\gamma_s}{\gamma_s - 1}} = \bar{F}_{si}$$

Let's rewrite the problem:

$$\max \quad -Cost \quad \text{s.t.} \quad A_{si}^F K^{\frac{\gamma_s}{\gamma_s - 1}} = \bar{F}_{si}$$

$$L_{si} \equiv \frac{D_{si}}{E_{si}} = \left[\frac{\alpha_s}{1-\alpha_s} \frac{\frac{\partial}{\partial E} Cost_{si}}{\frac{\partial}{\partial D} Cost_{si}} \right]^{\gamma_s}$$

Methodology

Optimal Allocation

- Now we know the optimal ratio $L_{si} \equiv (\frac{D_{si}}{E_{si}})^*$

$$
\begin{aligned}
D^*_{si} &= \frac{1}{A^F_{si}}[\alpha_s + (1-\alpha_s)L_{si}^{-\frac{\gamma_s-1}{\gamma_s}}]^{-\frac{\gamma_s}{\gamma_s-1}}\bar{F}_{si} \\
E^*_{si} &= \frac{1}{A^F_{si}}[(1-\alpha_s) + \alpha_s L_{si}^{\frac{1}{\gamma_s}}]^{-\frac{\gamma_s}{\gamma_s-1}}\bar{F}_{si} \\
\Rightarrow C(\bar{F}_{si}) &= (1+\tau_{D_{si}})r_{si}D^*_{si} + (1+\tau_{E_{si}})\lambda_{si}E^*_{si} + \tau_z Z_{si} \\
&= C_{si}\bar{F}_{si}
\end{aligned}
$$

$$
\begin{aligned}
\text{where} \quad C_{si} &= (1+\tau_{D_{si}})r_{si}\frac{1}{A^F_{si}}[\alpha_s + (1-\alpha_s)L_{si}^{-\frac{\gamma_s-1}{\gamma_s}}]^{-\frac{\gamma_s}{\gamma_s-1}} \\
&\quad + (1+\tau_{E_{si}})\lambda_{si}\frac{1}{A^F_{si}}[(1-\alpha_s) + \alpha_s L_{si}^{\frac{1}{\gamma_s}}]^{-\frac{\gamma_s}{\gamma_s-1}} \\
&\quad + \tau_z A^z_{si}
\end{aligned}
$$

Methodology

Optimal Allocation

- Now Firm need to choose the price level to maximize the profit:

$$\max_{P_{si}} \quad \pi_{si} = P_{si} F_{si} - C_{si} F_{si}$$

$$\Rightarrow P_{si} = \frac{\sigma}{\sigma - 1} C_{si}$$

Methodology

Reallocation

- Now, we need to find the optimal allocation of resources in the economy.
  - Social planner point of view (With and without cost for environmental externalities)
  - Economy without emission cost (Baseline)
- Let's show the optimal variables by hat (e.g. $\hat{D}_{si}$,$\hat{E}_{si}$, and $\hat{F}_{si}$)

Methodology

Estimation

- Estimate model:
  - Estimate γ_s using an extension of the method in Kmenta (1967)
  - Use nonlinear regression of value-added on debt and equity's residuals to estimate A_{is}
  - Calibrate σ to match $\hat{D}_{si} + \hat{E}_{si}$ with the $D_{si} + E_{si}$ in the data
- With the parameters in hand, we can use the framework to compute the hypothetically efficient levels of debt and equity for each firm
- Compare value-added computed with these efficient levels to value-added computed with actual levels, thus obtaining the reallocation gains

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Data

Martinsson et al. (2024)

- Total liabilities as measure of D_{si}
- Shareholder's equity as measure of E_{si}
- Nominal value added which is the sum of profits, indirect taxes, wages, and depreciation as measure of $P_{si}F_{si}$

Thank you!

References I

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