

Redistributing Emission Tax Revenues: The Impact on Occupational Choice Decisions

Philipp M. Richter*

University of Würzburg
CESifo, DIW Berlin, and KCG

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Abstract

This paper focuses on the redistribution of emissions tax revenues on the occupational choice decisions of individuals. Two different redistribution schemes are considered: a uniform transfer to all individuals and, alternatively, a progressive redistribution scheme with transfers only to low-income individuals in the economy. Accounting for general equilibrium effects, we find that for a given emissions tax a progressive redistribution scheme leads to a shift in the factor allocation towards more employees and fewer, but more productive firms. This distortion leads to reduced aggregate emissions but increased income inequality between managers and employees relative to a uniform per capita transfer scheme.

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*University of Würzburg, Faculty of Business Management and Economics, Sanderring 2, 97070 Würzburg, Germany; Email: philipp.richter@uni-wuerzburg.de.

1 Introduction

The distributional impact of environmental policy played a crucial role both in the *gilets jaunes* movement in France and in the debate on newly enacted climate policy in Germany. Ambitious climate policy will lead to a significant transformation with unclear effects on equity. Various ideas on making climate policy socially balanced are discussed. Ultimately, the distributional effects of environmental policy are a crucial factor in the success of policy implementation. While the distributional consequences of environmental policy play an increasing role in today's debate, they are not new to the academic discourse.¹ Important contributions highlight and causally identify the role of environmental policies on labour market outcomes, such as wages, employment or reallocation (cf. [Walker, 2011, 2013](#); [Curtis, 2017](#)).

Our paper focuses on individual occupational choice decisions and how these are affected by emissions taxation and different redistribution schemes.² For this purpose, we develop a general equilibrium model based on individuals that are differently able to manage a firm. Building on [Lucas \(1978\)](#) we model the occupational choice of individuals to become either a manager, earning the firm profits, or an employee, earning the economy-wide wage rate. As in [Egger and Kreickemeier \(2012\)](#) and [Kohl \(2020\)](#) the difference in managerial ability translates into the existence of heterogeneous firms in equilibrium. To account for environmental aspects and emissions pricing, we add an emissions-generating process based on [Copeland and Taylor \(1994\)](#). Each manager decides on how many workers to employ and on how to allocate them across the production process and emissions abatement. Hence, firms differ both in their productivity and in emissions intensities. We introduce an emissions tax, while two systems of tax revenues redistribution are considered: a uniform per capita transfer to all individuals and a progressive redistribution scheme with transfers only to low-income individuals in the economy.

Our main results highlight a crucial importance of the chosen scheme to redistribute tax revenues. We show that in equilibrium for any given emissions tax rate a progressive redistribution scheme leads to a factor allocation with more employees and fewer but more productive firms compared to a uniform per capita transfer. As a consequence, both the economy-wide wage rate and aggregate emissions are smaller. Moreover taking general equilibrium effects into account, we find that the progressive redistribution scheme leads to a relatively larger inter-group income inequality. This seems counter-intuitive but is due to the distorted occupational choice decisions

¹ See [Fullerton and Muehlegger \(2019\)](#) for a recent overview, while [Fullerton \(2011\)](#) classifies six possible channels of distributional effects of environmental policy to be taken into account.

² In analyzing the (distributional) effect of an increase in the gasoline tax, [Bento et al. \(2009\)](#) show the important role of the redistribution scheme.

of individuals.

This paper particularly adds to the literature on the impact of environmental regulation in the context of heterogeneous firms. This literature focuses on different policy instruments (cf. Anouliès, 2017; Konishi and Tarui, 2015; Tombe and Winter, 2015; Li and Sun, 2015) and on different firm responses to emissions pricing in their decision to abate emissions (cf. Cao et al., 2016; Andersen, 2016; Najjar and Cherniwchan, 2018). Andersen (2018), in turn, highlights the effects on firm variety on the costs of environmental regulation. We add to this literature by focussing on the impact of emissions taxes and redistribution schemes on the occupational choice decisions of individuals. This highlights an important channel of the (distributional) effects of environmental policy.

In a current revision of this paper, we allow the reforming country to be integrated in the world market (cf. Egger et al., 2021). By including international trade, both emissions pricing itself and the chosen redistribution scheme affects a trading partner in a distinguished manner. Through firm decisions to self-select into export and earn profits from supply a foreign market (cf. Melitz, 2003), income inequality has a different underlying source that is affected by the chosen redistribution scheme.

The remainder of this paper is organized as follows. Section 2 introduces the model and presents the equilibrium conditions. Section 3 analyses the effects of environmental policy subject to different forms of revenue recycling with a focus on distributional aspects. Section 4 extends the model to the open economy case with asymmetric countries. Section 5 concludes and discusses possible extensions.

2 The model setup

We consider an economy that is populated by the mass of individuals N . Each individual can choose to become an employee or a manager, while individuals differ in their ability to run a firm. We assume managerial ability φ to be distributed Pareto with a cumulative density function of $G(\varphi) = 1 - \varphi^k$. Two types of goods are produced in the closed economy, a homogeneous final good and a differentiated intermediate good. We assume that emissions E are only generated in the production process of the intermediate good and are taxed. Tax revenues are transferred lump-sum either to all individuals or, alternatively, only to employees, who are the low-income group of the economy (see below). We, hence, compare a uniform per capita redistribution scheme with a targeted, progressive one.

2.1 Preferences and technology

The final good is produced using all available varieties of the intermediate good (cf. [Egger and Kreckemeier, 2009](#); [Ethier, 1982](#)). We follow the literature and assume perfect competition and a production function of the standard CES form with the elasticity of substitution between varieties of $\sigma > 1$. Hence,

$$Y = \left[\int_{v \in V} q(v)^{\frac{\sigma-1}{\sigma}} dv \right]^{\frac{\sigma}{\sigma-1}}, \quad (1)$$

with V denoting all available varieties and $q(v)$ the demand for specific variety v . The corresponding ideal CES price index is given by

$$P = \left[\int_{v \in V} p(v)^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}}, \quad (2)$$

with $p(v)$ being the price of variety v . Eventually, we will set the Price index equal to unity by choosing the homogeneous final good as the numéraire.

Standard profit maximisation gives the iso-elastic demand function for each variety of the intermediate good

$$q(v) = Y P^\sigma [p(v)]^{-\sigma}, \quad (3)$$

where we assume that final good consumers spend their entire income on the domestic final good, i.e. YP . An individual's income originates from either firm profits or wages (depending on her occupational choice decision) and possibly from redistributed tax income (depending on the redistribution scheme).

In the intermediate good's sector, we assume a continuum of firms competing under monopolistic competition. Each firm consists of one manager and a variable amount of employees. The ability of the manager determines the productivity φ of the firm. During production, emissions are generated which can be abated using labour inputs. We follow the specific functional form proposed by [Copeland and Taylor \(1994\)](#) and widely used in the literature. Accordingly, each firm produces a unique variety of the intermediate good with production function

$$q(\varphi) = [e(\varphi)]^\alpha [l(\varphi)]^{1-\alpha} \varphi, \quad (4)$$

with labour input $l(\varphi)$ and emissions treated as input of $e(\varphi)$. Parameter α determines the cost share of emissions in the production process.

Corresponding to this Cobb-Douglas production function we can derive unit production costs

as

$$c(\varphi) = \frac{\beta t^\alpha w^{1-\alpha}}{\varphi} \quad \text{with} \quad \beta \equiv \alpha^{-\alpha} (1-\alpha)^{\alpha-1}, \quad (5)$$

where the wage rate w and the emissions tax $t > 0$ are treated parametrically by the firm. While the emissions tax is exogenously determined, the wage rate is determined in general equilibrium.

Given the iso-elastic demand function, Eq. (3), each firm charges a constant markup over its marginal costs. Accordingly, we get the following pricing rule:

$$p(\varphi) = \frac{c(\varphi)}{\rho} \quad \text{with} \quad \rho = \frac{\sigma-1}{\sigma} \in (0; 1). \quad (6)$$

We can, hence, write profits of firm with productivity φ as

$$\pi(\varphi) = [p(\varphi) - c(\varphi)] q(\varphi) = \frac{r(\varphi)}{\sigma} \quad (7)$$

i.e. as a constant fraction of firm revenues that are given by Eqs. (3) and (6) as

$$r(\varphi) = Y P^\sigma \left[\frac{c(\varphi)}{\rho} \right]^{1-\sigma}. \quad (8)$$

2.2 Equilibrium conditions

In equilibrium, a set of conditions must hold.

The first equilibrium condition builds on the assumption that individuals choose between becoming an employee or a manager based on the following indifference condition:

$$\pi(\varphi^*) + (1 - \mathbb{I}) b = w + b, \quad (9)$$

where the left hand side shows the income of the least able manager with φ^* being the cutoff ability level, while the right hand side gives the income of an employee. More able managers can earn more, as from Eq. (7) profits increase in firm productivity. Employees in turn do not benefit of working for a more productive firm but earn the economy-wide wage rate plus transfer b . Conditional on the redistribution scheme, managers may also benefit from the per capita transfer. This is formulated by the dummy variable $\mathbb{I} \in (0, 1)$, which indicates whether the transfer is paid to both employees and managers ($\mathbb{I} = 0$), or to employees only ($\mathbb{I} = 1$). We can rewrite the occupational choice condition as:

$$\frac{r(\varphi^*)}{\sigma} = w + \mathbb{I} b. \quad (10)$$

Note that the (endogenously determined) cutoff ability directly corresponds to the number, more precisely to the mass, of managers M and, hence, firms. With Pareto this follows as

$$M = [1 - G(\varphi^*)] N = (\varphi^*)^{-k} N. \quad (11)$$

The second equilibrium condition is the resource constraint

$$N = M + L, \quad (12)$$

where we assume that each individual becomes either a manager or an employee with L being the mass of workers.

Finally, a third equilibrium condition is given by a balanced budget. The entire emissions tax revenue is redistributed. Accordingly,

$$tE = bL + (1 - \mathbb{I}) bM. \quad (13)$$

Jointly these equilibrium conditions and the assumption on preferences and technology constitute the model setup.

3 Environmental policy and redistribution

We now turn to the role of the emissions tax and of the choice of the redistribution scheme in general equilibrium.

3.1 Factor allocation

Let us first analyse the aggregate factor allocation that builds on the individual occupational choice decisions.

In equilibrium, due to the assumed CES production function, aggregate income is distributed with constant shares to aggregate profit income, aggregate labour income, and tax revenues according to:

$$M\bar{\pi} = \frac{1}{\sigma} YP, \quad wL = \rho(1 - \alpha)YP, \quad \text{and} \quad tE = \rho\alpha YP, \quad (14)$$

respectively.

Using this information, we can rewrite aggregate labour income as

$$wL = \rho(1 - \alpha)\sigma M\bar{\pi}. \quad (15)$$

Importantly, it is straightforward to show that with Pareto distributed productivity levels average profits are a constant multiple of the profits of the marginal firm. Accordingly,

$$M\bar{\pi} = \int_{\varphi^*}^{\infty} M\pi(\varphi) \frac{dG(\varphi)}{1 - G(\varphi^*)} = \theta M\pi(\varphi^*), \quad (16)$$

with $\theta \equiv k/[k - (\sigma - 1)]$. Hence, we can rewrite aggregate labour income further to get

$$wL = \rho(1 - \alpha)\sigma\theta M\pi(\varphi^*) = (\sigma - 1)(1 - \alpha)\theta M(w + \mathbb{I}b), \quad (17)$$

where the last equality follows from the definition of ρ and the occupational choice condition given in Eq. (9). Finally, by means of the balanced budget condition, Eq. (13), we can replace the transfer b by

$$b = \frac{tE}{L + (1 - \mathbb{I})M} = \frac{\alpha}{1 - \alpha} w \frac{L}{L + (1 - \mathbb{I})M} \quad (18)$$

and get

$$wL = (\sigma - 1)(1 - \alpha)\theta Mw \left[1 + \mathbb{I} \frac{\alpha}{1 - \alpha} \frac{L}{L + (1 - \mathbb{I})M} \right]. \quad (19)$$

Closely inspecting the term in brackets and recalling the binary nature of \mathbb{I} , we find that this is equivalent to the simpler term $[1 + \mathbb{I}\alpha/(1 - \alpha)]$, which will be used in the following. Accordingly, the term in brackets is either equal to unity or equal to $(1 - \alpha)^{-1}$ depending on the redistribution scheme.

Solving Eq. (19) for L gives us a relation of the mass of employees and the mass of managers. Accordingly,

$$L = (\sigma - 1)(1 - \alpha)\theta M \left[1 + \mathbb{I} \frac{\alpha}{1 - \alpha} \right] \quad (20)$$

By means of the resource constraint, Eq. (12), we can isolate each L and M as a function of parameters only.

$$L = \frac{(\sigma - 1)(1 - \alpha)\theta \left[1 + \mathbb{I} \frac{\alpha}{1 - \alpha} \right]}{1 + (\sigma - 1)(1 - \alpha)\theta \left[1 + \mathbb{I} \frac{\alpha}{1 - \alpha} \right]} N; \quad M = \frac{1}{1 + (\sigma - 1)(1 - \alpha)\theta \left[1 + \mathbb{I} \frac{\alpha}{1 - \alpha} \right]} N. \quad (21)$$

This gives the following first result:

Proposition 1. *The factor allocation is independent of the level of the emissions tax. By contrast, the choice of the redistribution scheme impacts the occupational choice decision of individuals. The progressive redistribution scheme leads to more employees and fewer managers in equilibrium for any given emissions tax rate.*

In order to see this, note that the term $[1 + \mathbb{I}\alpha/(1 - \alpha)]$ is larger in case of the progressive redistribution scheme ($\mathbb{I} = 1$) than in case of a uniform transfer. Technically, this term increases the denominator for both groups in Eq. (21), while it additionally increases the nominator in the equation for L only. Intuitively, the progressive redistribution scheme distorts the occupational choice, see Eq. (9), and it becomes relatively more attractive to become employee.

Correspondingly, we see that the equilibrium cutoff ability,

$$\varphi^* = \left(1 + (\sigma - 1)(1 - \alpha)\theta \left[1 + \mathbb{I} \frac{\alpha}{1 - \alpha} \right] \right)^{1/k} \quad (22)$$

is larger in case of the progressive scheme. In this case, the equilibrium is characterised by fewer firms with a higher lowest productivity level and higher average productivity.

3.2 Aggregate emissions

Next, we want to analyse the impact of emissions tax and redistribution scheme on aggregate emissions. To this end, we use the link between aggregate income and aggregate emissions from Eq. (14) and get

$$E = \frac{\rho\alpha Y P}{t} = \frac{\alpha}{(1 - \alpha)} \frac{w}{t} L \quad (23)$$

Accordingly, aggregate emissions crucially depend on the wage-tax ratio and on the endogenously determined mass of employees as derived as in Eq. (21).

Importantly, we can derive a function for the wage rate from the price index as determined as

$$P^{1-\sigma} = \int_{\varphi^*}^{\infty} M [p(\varphi)]^{1-\sigma} \frac{dG(\varphi)}{1 - G(\varphi^*)} = \theta M p(\varphi^*) = \theta M \left(\frac{\beta t^\alpha w^{1-\alpha}}{\rho} \right)^{1-\sigma} (\varphi^*)^{\sigma-1}, \quad (24)$$

where the last equality follows from the optimal pricing rules of firms given in Eq. (6). Solving this equation for the wage rate and using Eq. (11) to replace M gives

$$w = \theta^{\frac{1}{(\sigma-1)(1-\alpha)}} \left(\frac{\rho}{\beta} \right)^{\frac{1}{1-\alpha}} t^{\frac{-\alpha}{1-\alpha}} (\varphi^*)^{\frac{(\sigma-1-k)}{(\sigma-1)(1-\alpha)}} P^{\frac{1}{1-\alpha}}. \quad (25)$$

Taking the homogeneous final good as the numéraire, which makes P a constant, we can see that the (real) wage rate declines in the emissions tax. Moreover, for any given emission tax rate, it is smaller with the progressive redistribution scheme ($\mathbb{I} = 1$) than with a uniform transfer ($\mathbb{I} = 0$). This follows both from the equilibrium results for φ^* in Eq. (22) and from its negative exponent in Eq. (25).

Finally, using Eqs. (11), (20), and (25), aggregate emissions are determined by

$$E = (\sigma - 1)\alpha (\theta)^{\frac{1+(\sigma-1)(1-\alpha)}{(\sigma-1)(1-\alpha)}} \left(\frac{\rho}{\beta}\right)^{\frac{1}{1-\alpha}} t^{\frac{-1}{1-\alpha}} (\varphi^*)^{\frac{(\sigma-1)-k[1+(\sigma-1)(1-\alpha)]}{(\sigma-1)(1-\alpha)}} P^{\frac{1}{1-\alpha}} \left[1 + \mathbb{I} \frac{\alpha}{1-\alpha}\right]. \quad (26)$$

As expected, aggregate emissions decline in the emissions tax. For a given emissions tax, the choice of the redistribution scheme indirectly (and negatively) affects aggregate emissions via the cutoff ability and directly (and positively) by the term in brackets in Eq. (26). Numerical simulations show that the progressive redistribution scheme leads to lower aggregate emissions.³ This is intuitive as the progressive redistribution scheme distorts the occupational choice decision, while the uniform per capita transfer is neutral, see Eq. (9). This leads to lower aggregate income, which, for a given emissions tax, is proportional to aggregate emissions according to Eq. (14).

We can summarise these results as follows:

Proposition 2. *Aggregate emissions decline in the emissions tax due to a reduction in economic activity. For any given emissions tax, aggregate emissions are smaller in case of the progressive redistribution scheme.*

3.3 Distributional effects

Finally, we turn to the distributional effects and analyse the inter-group inequality between managers and employees. The ratio of average manager and worker income is given by

$$\Psi = \frac{\bar{\pi} + (1 - \mathbb{I})b}{w + b} = \frac{\theta\pi(\varphi^*) + (1 - \mathbb{I})b}{w + b}, \quad (27)$$

where the second equality directly follows from the assumption of Pareto distributed abilities. By means of the occupational choice condition, Eq. (9), to substitute for the employees' income level in the denominator, this gives:

$$\Psi = \theta \frac{\pi(\varphi^*) + (1 - \mathbb{I})b\theta^{-1}}{\pi(\varphi^*) + (1 - \mathbb{I})b}. \quad (28)$$

³ The formal proof needs to be revised.

It directly follows, that this term collapses to the constant θ in case of the progressive redistribution scheme ($\mathbb{I} = 1$), whereas in case of a uniform transfer ($\mathbb{I} = 0$) it is smaller than θ , as the fraction in Eq. (28) is smaller than one.

Technically, in case of the uniform transfer, we add a positive term (transfer b) to both the nominator (average profits) and the denominator (wage rate) in Eq. (27). As average profits are higher than the wage rate (which is equal to the profits of the marginal firm), the ratio is reduced by the mere addition of the same per capita transfer. Of course, the difference between the groups' income levels is not affected by a lump-sum transfer of equal size to all individuals. In case of the progressive transfer, the income of the low-income employees (composed of the wage plus transfer) is necessarily equal to the profits of the marginal firm as dictated by the occupational choice condition, Eq. (9). Due to the assumed Pareto distribution, average profits are a multiple of the marginal profits, i.e. scaled by θ , which constitutes the inter-group inequality defined as in Eq. (27).

Proposition 3. *For any given emissions tax, in general equilibrium, the progressive redistribution scheme leads to higher inter-group income inequality.*

4 An Open Economy Extension

To be completed ...

5 Conclusions

In this paper, we analyse the (distributional) effects of taxing emissions subject to different redistribution schemes. We focus on two systems of lump-sum transfers of tax revenues: first, a uniform transfer to all individuals independent of their income position and, second, a progressive redistribution scheme with transfers only to employees, who form the low-income group of individuals in the economy.

We develop a general equilibrium model that builds around the occupational choice decision of individuals. Being differently able to run a firm, each individual can decide to become a manager, earning firm profits, or an employee, earning the economy-wide wage. This self-selection leads to a continuum of heterogeneous firms with different productivity levels and different emissions intensities.

Accounting for general equilibrium effects, we find that the redistribution scheme is crucial for the aggregate factor allocation as it may distort an individual's occupational choice. This holds

even in a setting where the emission tax does not distort this individual decision. Accordingly, for any given emissions tax rate a progressive redistribution scheme leads to fewer but, on average, more able managers. Aggregate emissions are smaller than in the setting of a uniform transfer. However, and unexpectedly, the progressive redistribution scheme leads to a relatively larger inter-group income inequality.

The next steps in this project are the following.⁴ First, we analyse alternative redistribution schemes. It appears interesting to analyse a scheme with the entire tax revenues being transferred to firms according to their level of emissions. Accordingly, a higher emitting firm would be compensated to a larger amount. This tries to mimic grandfathering in emissions trading systems. Second and related, a comparison with other environmental policy instruments seems appropriate to complement the existing literature. Third, in the current setup we do not allow for labour market frictions and, hence, unemployment. Integrating a rent-sharing mechanism following [Egger and Kreickemeier \(2012\)](#), we analyse how the emissions tax and different redistribution schemes affect the labour market. Fourth, the model is embedded in a model of international trade. This allows to analyse the (distributional) effects of coordinated and unilateral policy changes in the more realistic setting of globalisation.

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⁴The presented extensions are work in progress but not yet shown in this version of the manuscript.

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