

# ESG Risks

Thomas Lorans

June 8, 2024



# Contents

<b>Introduction</b>	<b>v</b>
<b>1 ESG Risks Factor</b>	<b>1</b>
<b>2 Sources of ESG Risks</b>	<b>3</b>
2.1 Cash-Flows and Discount Rate Channels . . . . .	3
<b>3 Practical Implications of ESG Risks</b>	<b>7</b>
3.1 Measuring ESG Risks . . . . .	7
3.2 Exposure to ESG Risks . . . . .	7



# Introduction



# Chapter 1

## ESG Risks Factor

Retake model from PST 2021





# Chapter 2

## Sources of ESG Risks

### 2.1 Cash-Flows and Discount Rate Channels

Pastor *et al.* (2021) propose a simple one-period (period 0 and 1) overlapping generation (OLG) model to study the impact of climate risk on asset prices, through both the cash-flows and discount rate channels. To make it possible, PST (2021) splits the time 1 between  $1^-$  and  $1^+$ , close to each other.

In the OLG model, there are two generations,  $Gen - 0$  and  $Gen - 1$ .  $Gen - 0$  borins at time 0 and invests in the stock of a firm. It dies at the beginning of period 1 ( $1^-$ ).  $Gen - 1$  borins at the beginning of period 1 ( $1^-$ ) and dies at the end of period 1 ( $1^+$ ).  $Gen - 0$  sells the stock to  $Gen - 1$  at the beginning of period 1 ( $1^-$ ). Figure 2.1 shows the timeline of the model.

#### 2.1.1 Cash-Flows Channel

We denote  $X_1$  the payoff (profit) by the firm in period 1. It is known at  $1^-$  (the beginning of period 1) but received at  $1^+$  (the end of period 1). We denote  $\tilde{X}_1$  this payoff per dollar invested in period 0:  $\tilde{X}_1 = \frac{X_1}{P_0}$ .

As in PST (2021), we have two sources of risk (uncertainty),  $\tilde{M}_1$  a macroeconomic factor and  $\tilde{C}_1$  a climate risk factor. Those factors correspond to an unanticipated state of the world. For example, we could have  $C$  to be a carbon tax. In that case:

$$\tilde{C}_1 = C_1 - E_0(C_1) \tag{2.1}$$

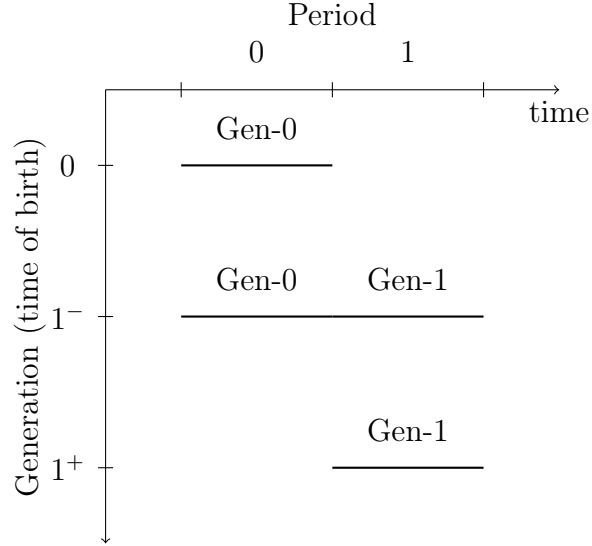


Figure 2.1: The One-Period Overlapping Generation Model

is interpreted as the difference between the expected carbon tax  $E_0(C_1)$  and the realized carbon tax  $C_1$ . These shocks occurs at  $1^-$ .

The unexpected payoff in period 1 is:

$$\tilde{X}_1 - E_0(\tilde{X}_1) = \beta_m \tilde{M}_1 + \beta_c \tilde{C}_1 + \varepsilon_1 \quad (2.2)$$

where  $\beta_m$  and  $\beta_c$  are the sensitivities of the payoff to the macroeconomic and climate risk factors, respectively, and  $\varepsilon_1$  is the idiosyncratic shock to the payoff.

The price  $p_1$  is calculated at  $1^-$  when shocks associated with  $\tilde{X}_1$  have been realized. Therefore, between  $1^-$  and  $1^+$ , the payoff is riskless (everything is known). Stockholders will receive the payoff at  $1^+$ . The payoff is known at  $1^-$ , so we can compute the price of the stock:

$$\tilde{P}_1 = \frac{\tilde{X}_1}{1 + R^e} \quad (2.3)$$

where  $R^e$  is the excess expected return from PST (2021):

$$R^e = \mu_m \beta_m - \frac{D}{\gamma} \beta_c \quad (2.4)$$

As PST (2021), we assume the risk free rate  $r_f = 0, \beta_m = 0$  and the investor risk aversion parameter  $\gamma$  and the firm sensitivity to climate risk  $\beta_c$  doesn't change between  $Gen - 0$  and  $Gen - 1$ . We assume for the moment that the average investor sensitivity to climate risk  $D$  doesn't change between  $Gen - 0$  and  $Gen - 1$ . We have:

$$\begin{aligned}\tilde{P}_1 &= \frac{\tilde{X}_1}{1 - \frac{D}{\gamma}\beta_c} \\ &\approx \tilde{X} + \frac{\beta_c}{\gamma}D\end{aligned}\tag{2.5}$$

This is the payoff for  $Gen - 0$  at  $1^-$ .

It's expected value when  $Gen - 0$  invested in period 0 was:

$$E_0(\tilde{P}_1) = E_0(\tilde{X}_1) + \frac{\beta_c}{\gamma}D\tag{2.6}$$

Because  $\tilde{P}_1$  is the price of the payoff per unit of dollar invested in period 0, we have:

$$\begin{aligned}\tilde{P}_1 &= \frac{P_1}{P_0} \\ &= R_1\end{aligned}\tag{2.7}$$

that is,  $P_1$  is the (gross) return  $R_1$  for  $Gen - 0$ . So the unexpected change in price for the  $Gen - 0$   $\tilde{P}_1 - E_0(\tilde{P}_1)$  is in fact the unexpected return  $R_1 - E_0(R_1)$ :

$$\begin{aligned}R_1 - E_0(R_1) &= \tilde{X}_1 + \frac{\beta_c}{\gamma}D - E_0(\tilde{X}_1) - \frac{\beta_c}{\gamma}D \\ &= \tilde{X}_1 + \frac{\beta_c}{\gamma}D - E_0(\tilde{X}_1) - \frac{\beta_c}{\gamma}D \\ &= \tilde{X}_1 - E_0(\tilde{X}_1) \\ &= \beta_c\tilde{C}_1 + \varepsilon_1\end{aligned}\tag{2.8}$$

### 2.1.2 Introducing the Discount Rate Channel

To model the discount rate channel, PST (2021) assume that the average perception of climate risk  $D$  shifts unpredictably from time 0 to time 1. We

now have  $D_0$  and  $D_1$ . At time  $1^-$ ,  $Gen - 0$  sell stocks to  $Gen - 1$  at price  $P_1$ , which depends on the average perception of climate risk of  $Gen - 1$ ,  $D_1$  and the payoff  $\tilde{X}_1$ . This setting maintains single-period payoff uncertainty but allows risk stemming from climate risk to enter via both cashflows and discount rates channels.

The price  $P_1$  is now:

$$P_1 = \tilde{X}_1 + \frac{\beta_c}{\gamma} D_1 \quad (2.9)$$

Taking the expectations:

$$E_0(P_1) = \tilde{X}_1 + \frac{\beta_c}{\gamma} E_0(D_1) \quad (2.10)$$

The unexpected return is now:

$$\begin{aligned} R_1 - E_0(R_1) &= \tilde{X}_1 + \frac{\beta_c}{\gamma} D_1 - E_0(\tilde{X}_1) - \frac{\beta_c}{\gamma} E_0(D_1) \\ &= \tilde{X}_1 - E_0(\tilde{X}_1) + \frac{\beta_c}{\gamma} (D_1 - E_0(D_1)) \\ &= \beta_c \tilde{C}_1 + \varepsilon_1 + \frac{\beta_c}{\gamma} (D_1 - E_0(D_1)) \\ &= \beta_c (\tilde{C}_1 + \frac{1}{\gamma} (D_1 - E_0(D_1))) + \varepsilon_1 \end{aligned} \quad (2.11)$$

## Chapter 3

# Practical Implications of ESG Risks

PST 2022

### 3.1 Measuring ESG Risks

### 3.2 Exposure to ESG Risks

