Supplementary material

Derivation of regression equations for forest productivity and risk functions

The development over time of forest biomass per ha in region *i=1,..,n* is expressed in terms of intrinsic growth rate, β_{i1}, and carrying capacity, β_{i2} according to;

$$y_{it+1} = y_{it}\left(1+\beta_{i1}\left(1-\frac{y_{ti}}{\beta_{i2}}\right)\right) - H_{it} + \beta_{i3}Z_{it} + \chi_i X_{it} \tag{S1}$$

From equation (S1), y_{ti} represents the volume of forest per ha at each period after harvest, H_{iti} is the harvest per ha at each period, Z_{it} is site quality index, and X_{it} is a vector of management strategies, such as thinning, scarification and fertilization.

Moving H_{it} to the left hand side and dividing by y_{it} we obtain;

$$\dot{Y}_i = \beta_{i1}\left(1-\frac{y_{ti}}{\beta_{i2}}\right) + \beta_{i3}\frac{Z_{it}}{y_{it}} + \chi_i \frac{X_{it}}{y_{it}} \tag{S2}$$

where $\dot{Y}_i = \frac{y_{it+1} - y_{it} + H_{it}}{y_{it}}$. We refer to the left hand side of equation (S2) as the "adjusted growth rate" in Table 1.

From equation (S2) the empirical model for the linearized logistic function is given as;

$$\dot{Y}_i = \alpha_{i1} + \alpha_{i2}y_{it} + \alpha_{i3}\frac{Z_{it}}{y_{it}} + \alpha_{i4}\frac{X_{it}}{y_{it}} + \varepsilon_{it} \tag{S3}$$

where $\alpha_{i1} = \beta_{i1}$, $\alpha_{i2} = -\frac{\beta_{i1}}{\beta_{i2}}$, and ε_{it} is the error term which is independently and identically distributed with zero mean and equal variance.

With respect to risk, there is a long tradition in economics on measuring risk and assessing the determinants of risk (e.g. Fisher 1959; Damodaran 2016). A common way of measuring risk is to calculate the volatility in the underlying factor of interest, which in our case is the productivity The volatility is, in turn, calculated by the variance

$$\sigma_{it}^2 = \sum_t (y_{it} - E[y_{it}])^2 \tag{S4}$$

Several approaches are used to estimate the determinants of σ_{it}^2, and a common practice is to apply models where σ_{it}^2 is determined by past variances and residuals. These models differ with respect to assumptions on how current risk depends on past risks. Common to most of them is that they consider short term, such as daily, fluctuation in prices. Since our fluctuations are among years, we use a simple approach where the variance in (S4) depends on standing volume, site quality and management practices according to:

$$\sigma_{it}^2 = \alpha_0 + \varphi Z_{it} + \lambda X_{it} + \eta y_{it} + \varepsilon_{it} \tag{S5}$$

References:

Damodaran, Aswath, 2017. Country Risk: Determinants, Measures and Implications – The 2016 Edition (July 14, 2016). Available at SSRN: https://ssrn.com/abstract=2812261 (February 27 2017, date of access)

Fisher L., 1959. Determinants of risk premiums on corporate bonds. Journal of Political Economy 67, 217-237