Economics 701: Macroeconomics II

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Lecture 4: Asset Pricing

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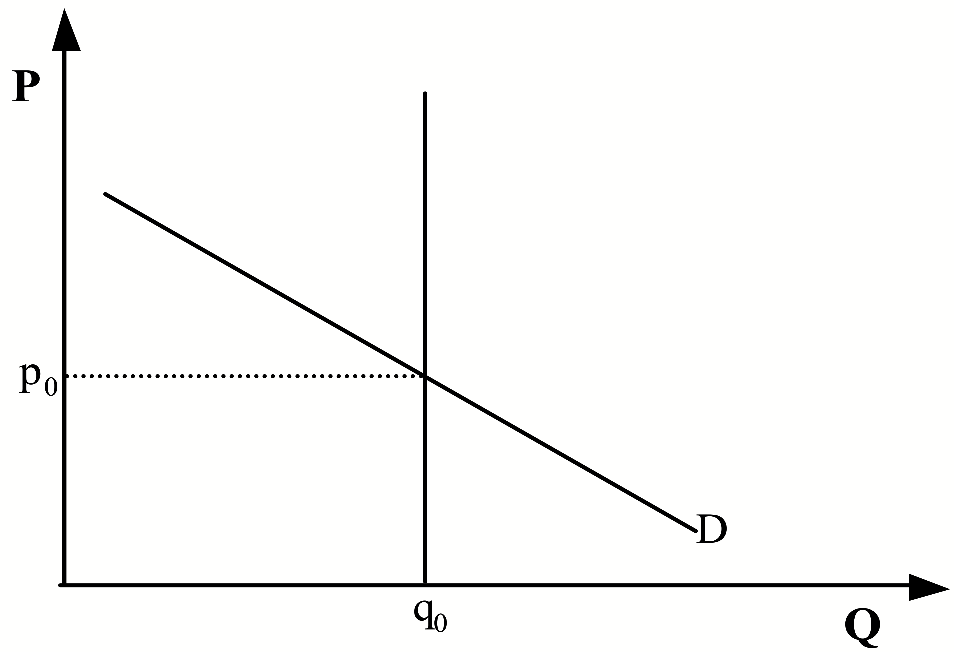
1. Rational Expectations (Competitive) Equilibrium
   Given the set of exogenous stochastic process $\{x_t\}$, and initial conditions a_0, a rational expectations equilibrium is a set of stochastic processes for prices $\{p_t\}$ and quantities $\{q_t\}$ such that:
   (a) Given $\{p_t\}$, $\{q_t\}$ is consistent with optimal behavior on the part of consumers, producers and (if relevant) the government.
   (b) Given $\{p_t\}$, $\{q_t\}$ satisfies the government's budget constraints and borrowing restrictions.
   (c) $\{q_t\}$ satisfies any market-clearing conditions.

2. Lucas “Tree” Model—Introduction

(a) Basic idea

- We are given equilibrium quantities and equilibrium demand functions—back out equilibrium prices.



we know the function D(p) and the quantity q_0: now find p_0.

2. Lucas “Tree” Model—Introduction (continued)

(a) Basic idea

- Compare with Literature on Consumption
  - Consumption: Take rates of return as given, solve for consumption.
  - Asset Pricing: Take consumption as given, solve for rates of return.

2. (b) Model Structure

- Preferences: n identical consumers, maximizing

$$E_0 \left(\sum_{t=0}^{\infty} \beta^t u(c_t) \right),$$

$$\beta \in (0,1), \quad u'(\cdot) > 0, \quad u''(\cdot) \leq 0.$$

- Endowment: one durable "tree" per individual. Each period, the tree yields some "fruit" ($d_t \equiv$ dividends).
- Technology: Fruit cannot be stored. Dividends are exogenous and follow a time-invariant Markov process

$$\Pr\left(d_{t+1} \leq y \mid d_t = x\right) = F(y,x), \ \forall t,$$

with density $f(y,x)$.

2. (c) Solution strategy

- Find the competitive equilibrium allocation via the social planner's problem. Assume equal weights on each person's utility (parallel to equal endowments).
- Calculate the FOC for individuals with the opportunity to buy/sell specific assets.
- Evaluate FOC at the competitive equilibrium allocation.

2. (d) Step 1: Social planner's problem

- Use a representative agent
- Social planner solves

$$\max_{\{c_t\}_{t=0}^{\infty}} E_0 \left(\sum_{t=0}^{\infty} \beta^t u\left(c_t\right) \right)$$
$$s.t. \quad c_t \leq d_t.$$

- Solution: $c_t = d_t$, $\forall t$ (*non-storable good!*).

2. (e) Step 2: Representative consumer's problem.

$$\max_{\{c_t, b_{t+1}, s_{t+1}\}_{t=0}^{\infty}} E\left(\sum_{t=0}^{\infty} \beta^t u(c_t) \middle| I_0\right)$$

$$\begin{aligned} s.t. \quad & c_t + p_t s_{t+1} + R_t^{-1} b_{t+1} = x_t, \\ & x_t = (p_t + d_t) s_t + b_t, \\ & \lim_{J \to \infty} \beta^J E_t \left(u'(c_{t+J}) p_{t+J} s_{t+J+1}\right) = 0 \\ & \lim_{J \to \infty} \beta^J E_t \left(u'(c_{t+J}) b_{t+J+1}\right) = 0, \\ & s_0,\ b_0 \text{ given}, \end{aligned}$$

2. (e) Step 2: Representative consumer's problem (continued)

where

$$
\begin{aligned}
c_t &= \text{consumption}, \\
p_t &= \text{price of a tree} = \text{price of stock}, \\
&\quad \text{taken as given by consumer}, \\
s_{t+1} &= \text{number of trees/shares of stock}, \\
R_t &= \text{return on one-period risk-free bond}, \\
R_t^{-1} &= \text{price of a one-period, risk-free } \underline{\text{discount bond}}, \\
b_{t+1} &= \text{risk-free discount bonds.}
\end{aligned}
$$

2. (e) Step 2: Representative consumer's problem (continued)

- Consumer i picks c_t^i, b_{t+1}^i and s_{t+1}^i on the basis of

$$I_t^i = \left\{ \begin{array}{l} \{d_{t-m}, p_{t-m}, R_{t-m}\}_{m=0}^{t}, \\ \left\{s_{t+1-m}^j, b_{t+1-m}^j\right\}_{m=0}^{t+1}, \ \forall j \neq i, \\ \left\{c_{t-m}^j, x_{t-m}^j\right\}_{m=0}^{t}, \ \forall j \neq i, \\ \{s_{t-m}^i, b_{t-m}^i, x_{t-m}^i\}_{m=0}^{t}, \{c_{t-m}^i\}_{m=1}^{t}, \end{array} \right\},$$

- It turns out that d_t summarizes the state of the aggregate economy, with $p_t = p(d_t)$ and $R_t = R(d_t)$.
- Because d_t is a time-invariant Markov process, the consumer's problem is time-invariant.

2. (e) Step 2: Representative consumer's problem (continued)

Bellman's functional equation:

$$V(x_t, d_t) =$$

$$\min_{\lambda_t \geq 0} \max_{c_t \geq 0,\ s_{t+1},\ b_{t+1}} u(c_t) + \lambda_t \left(x_t - c_t - p_t s_{t+1} - R_t^{-1} b_{t+1} \right)$$

$$+ \beta \int V\Big(\left(p\left(d_{t+1}\right) + d_{t+1}\right) s_{t+1} + b_{t+1}, d_{t+1} \Big) dF\left(d_{t+1}, d_t\right).$$

The FOC for an interior solution are:

$$\begin{aligned} u'(c_t) &= \lambda_t, \\ \lambda_t p_t &= \beta \int \frac{\partial V[t+1]}{\partial x_{t+1}} \left(p\left(d_{t+1}\right) + d_{t+1}\right) dF\left(d_{t+1}, d_t\right), \\ \lambda_t R_t^{-1} &= \beta \int \frac{\partial V[t+1]}{\partial x_{t+1}} dF\left(d_{t+1}, d_t\right). \end{aligned}$$

2. (e) Step 2: Representative consumer's problem (continued)

Note that (by Benveniste-Scheinkman)

$$\frac{\partial V[t]}{\partial x_t} = \lambda_t,$$

so that

$$\begin{aligned} p_t &= \beta E_t \left(\frac{u'(c_{t+1})}{u'(c_t)} (p_{t+1} + d_{t+1}) \right), \\ R_t^{-1} &= \beta E_t \left(\frac{u'(c_{t+1})}{u'(c_t)} \right). \end{aligned}$$

2. (f) Step 3: Equilibrium

- Intuition
  - Agents allocate resources on the basis of their beliefs about future prices and consumption
  - These decision rules determine processes for market clearing prices and quantities.
  - In a rational expectations equilibrium, the actual processes must be consistent with the beliefs.

2. (f) Step 3: Equilibrium

- **Sequential** definition: Given the stochastic process $\{d_t\}_{t=0}^{\infty}$ and the initial endowments $s_0 = 1$ and $b_0 = 0$, a rational expectations equilibrium consists of the stochastic processes $\{c_t, s_{t+1}, b_{t+1}, p_t, R_t\}_{t=0}^{\infty}$ such that:
  - Given the process for prices $\{p_t, R_t\}$, $\{c_t, s_{t+1}, b_{t+1}\}$ solves the consumer's problem.
  - All markets clear: $c_t = d_t$, $s_{t+1} = 1$, and $b_{t+1} = 0$, $\forall t$.

2. (f) Step 3: Equilibrium

- **Recursive definition**: given the random variable d_0, the conditional distribution $F\left(d_{t+1}, d_t\right)$, and the initial endowments $s_0 = 1$ and $b_0 = 0$, a recursive rational expectations equilibrium consists of pricing functions $p\left(d\right)$ and $R\left(d\right)$, a value function $V\left(x, d\right)$, and decision functions $c\left(x, d\right)$, $s\left(x, d\right)$, and $b\left(x, d\right)$ such that:
  - Given the pricing functions $p\left(d\right)$ and $R\left(d\right)$, the value and policy functions $V\left(x, d\right)$, $c\left(x, d\right)$, $s\left(x, d\right)$, and $b\left(x, d\right)$ solve the consumer's problem.
  - Markets clear: for $x = p\left(d\right) + d$, $c\left(x, d\right) = d$, $s\left(x, d\right) = 1$, and $b\left(x, d\right) = 0$.

2. (f) Step 3: Equilibrium

- Find $R(d_t)$: impose the equilibrium allocation, $c_t = d_t$, to get

$$R_t^{-1} = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} \right)$$
$$= \beta \frac{1}{u'(d_t)} E_t \left(u'(d_{t+1}) \right). \qquad \text{(EE)}$$

- Find $p(d_t)$: impose the equilibrium allocation, $c_t = d_t$, to get

$$p_t = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} (p_{t+1} + d_{t+1}) \right). \qquad \text{(EE}'\text{)}$$

4. Lucas "Tree" Model—Interpretation

(a) Bond prices

- Recall equation (EE):

$$R_t^{-1} = \beta \frac{1}{u'(d_t)} E_t \left(u'(d_{t+1}) \right), \qquad \text{(EE)}$$

$$R_t = \frac{u'(d_t)}{\beta E_t (u'(d_{t+1}))}.$$

- The price of a discount bond increases (return falls) in β.
- The price increases (return falls) in expected future marginal utility, and decreases in current marginal utility: reflects consumption smoothing motive.

4. Lucas "Tree" Model—Interpretation

(b) Stock prices

- Recall equation (EE′):

$$p_t = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} (p_{t+1} + d_{t+1}) \right). \qquad \text{(EE}'\text{)}$$

(c) Equity premium

- The expected rate of return on stocks is

$$E_t(R_t^s) = E_t \left(\frac{p_{t+1} + d_{t+1}}{p_t} \right).$$

4. (c) Equity premium

- Recall that

$$E_t(XY) = E_t(X)\,E_t(Y) + Cov_t(X,Y).$$

- Rewrite (EE′):

$$\begin{aligned}
1 &= \beta E_t\left(\frac{u'(d_{t+1})}{u'(d_t)}\left(\frac{p_{t+1}+d_{t+1}}{p_t}\right)\right) \\
&= \beta E_t\left(\frac{u'(d_{t+1})}{u'(d_t)} R_t^s\right) \\
&= \beta E_t\left(\frac{u'(d_{t+1})}{u'(d_t)}\right) E_t\left(R_t^s\right) \\
&\quad + Cov_t\left(\beta \frac{u'(d_{t+1})}{u'(d_t)}, R_t^s\right).
\end{aligned}$$

4. (c) Equity premium

- Insert (EE) and rearrange:

$$1 = R_t^{-1} E_t \left(R_t^s \right) + Cov_t \left(\beta \frac{u' \left(d_{t+1} \right)}{u' \left(d_t \right)}, R_t^s \right),$$

$$\begin{aligned}
E_t \left(R_t^s \right) &= R_t - R_t Cov_t \left(\beta \frac{u' \left(d_{t+1} \right)}{u' \left(d_t \right)}, R_t^s \right), \\
&= R_t - \frac{u' \left(d_t \right)}{\beta E_t \left(u' \left(d_{t+1} \right) \right)} Cov_t \left(\beta \frac{u' \left(d_{t+1} \right)}{u' \left(d_t \right)}, R_t^s \right), \\
&= R_t - \frac{Cov_t \left(u' \left(d_{t+1} \right), R_t^s \right)}{E_t \left(u' \left(d_{t+1} \right) \right)}.
\end{aligned}$$

- The expected return on stocks equals the return on the risk-free bond plus the risk-premium $-\frac{Cov_t(\cdot,\cdot)}{E_t(\cdot)}$.

4. (c) Equity premium

- If the covariance $Cov_t(\cdot,\cdot)$ is negative, which we normally expect, there is an equity premium.
- Interpretation
  - The most desirable assets yield well when marginal utility is high ($Cov_t(\cdot,\cdot) > 0$). Risk-aversion means that agents prefer assets that act like insurance.
  - Investors are willing to sacrifice return if $Cov_t(\cdot,\cdot) > 0$, and they will demand higher returns if $Cov_t(\cdot,\cdot) < 0$.
- Mehra and Prescott (1985): the observed equity premium is difficult to reconcile with this formula. No accepted resolution.

4. (d) Consumption capital-asset pricing model (CAPM)

- If utility is quadratic:

$$u'(d_{t+1}) = a - bd_{t+1}.$$

the expected return on stock is given by

$$E_t(R_t^s) = R_t + \frac{b}{E_t(a - bd_{t+1})} Cov_t(d_{t+1}, R_t^s).$$

- $Cov_t(d_{t+1}, R_t^s)$ is the consumption beta.
- The standard CAPM focuses on the market beta $= Cov_t(R_t^m, R_t^s)$, where R_t^m is the return on the market portfolio.

4. (e) Stock prices: fundamentals and bubbles

- Rearrange equation (EE′):

$$p_t = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} (p_{t+1} + d_{t+1}) \right),$$
$$E_t \left(\left(1 - \beta L^{-1}\right) u'(d_t) p_t \right) = \beta E_t \left(u'(d_{t+1}) d_{t+1} \right).$$

- Recalling section 3, with $x_t = u'(d_t) p_t$, $z_t = -E_t (u'(d_{t+1}) d_{t+1})$, and $\lambda = \beta^{-1}$, we get

$$\begin{aligned} u'(d_t) p_t &= \beta E_t \left(\sum_{j=0}^{\infty} \beta^j u'(d_{t+1+j}) d_{t+1+j} \right) + b_t, \\ E_t (b_{t+1}) &= \beta^{-1} b_t, \end{aligned}$$

so that b_t is a bubble term.

4. (e) Stock prices: fundamentals and bubbles

- It follows from the transversality condition,

$$\lim_{J\to\infty} \beta^J E_t \left(u'\left(d_{t+J}\right) p_{t+J}\right) = 0, \qquad \text{(TVC)}$$

that $b_t = 0$, and

$$p_t = E_t \left(\sum_{j=1}^{\infty} \beta^j \frac{u'\left(d_{t+j}\right)}{u'\left(d_t\right)} d_{t+j} \right).$$

- Interpretation: The price of a share of stock equals the expected marginal-utility-adjusted PDV of its dividends.
- This is the fundamental (equilibrium) expression for stock prices.

4. (e)
- Special case 1: Linear utility
  - Linear utility implies that

$$
\begin{aligned}
u'(d_t) &= a, \\
p_t &= E_t\left(\sum_{j=1}^{\infty} \beta^j d_{t+j}\right).
\end{aligned}
$$

  - This is the usual "fundamentals" solution.

4. (e) Special case 1: Linear utility

- Equation (EE′) becomes

$$p_t = \beta E_t \left(p_{t+1} + d_{t+1}\right).$$

Over short time periods (e.g., weeks), $\beta \approx 1$, and $d_{t+1} \approx 0$, so that

$$E_t \left(p_{t+1}\right) \approx p_t,$$

and stock prices follow a martingale. This is the "random walk" theory of stock prices.

4. (e)
- Special case 1: Linear utility
  - Shiller (1981) Test: Compare expected and realized dividend streams.
  - Define

$$
\begin{aligned}
p_t^* &= \sum_{j=1}^{\infty} \beta^j d_{t+j} \\
&= p_t + \sum_{j=1}^{\infty} \beta^j \left(d_{t+j} - E_t d_{t+j} \right) \\
&\equiv p_t + u_t,
\end{aligned}
$$

with $E\left(u_t | \, p_t \right) = 0 \Rightarrow C\left(u_t, p_t \right) = 0$.

4. (e) • Special case 1: Linear utility
   - Then

$$V\left(p_t^*\right) = V\left(p_t\right) + V\left(u_t\right) > V\left(p_t\right),$$

   - Shiller finds $V\left(p_t\right) \gg V\left(p_t^*\right)$.
   - Possible explanations include bubbles and misspecified utility.
   - Emerging consensus: volatility of p_t driven in large part by volatility in $E_t\left(\sum_{j=1}^{\infty} \beta^j u'\left(d_{t+j}\right)/u'\left(d_t\right)\right)$ = risk-free rates of return.

4. (e) Stock prices: fundamentals and bubbles

- Special case 2: logarithmic utility

$$
\begin{aligned}
p_t &= E_t\left(\sum_{j=1}^{\infty}\beta^j \frac{u'\left(d_{t+j}\right)}{u'\left(d_t\right)} d_{t+j}\right) \\
&= E_t\left(\sum_{j=1}^{\infty}\beta^j \frac{d_t}{d_{t+j}} d_{t+j}\right) \\
&= \frac{\beta}{1-\beta} d_t .
\end{aligned}
$$

5. Contingent Claims

(a) Background

- Suppose that the state of the economy $\{I_t\}$ is a time invariant Markov process, following:

$$\begin{aligned} F(I_1, I_0) &= \Pr(I_{t+1} \leq I_1 | \, I_t = I_0) \\ &= \int_{-\infty}^{I_1} f(I_{t+1}, I_0) \, dI_{t+1}, \end{aligned}$$

when $F()$ is continuous and

$$F(I_1, I_0) = \sum_{I_{t+1} \leq I_1} f(I_{t+1}, I_0),$$

when $F()$ is discrete.

5. Contingent Claims

(a) Background

- Consider an asset that pays 1 unit of consumption when $I_{t+1} \in \mathcal{A}$.
- We will price the collection of such assets by a "pricing kernel" $q\left(I_{t+1}, I_t\right)$ that generates:

$$p_t^A = \int_{I_{t+1} \in \mathcal{A}} q\left(I_{t+1}, I_t\right) dI_{t+1}.$$

5. Contingent Claims

(b) The consumer's problem

- Let I' denote a realization of I_{t+1}, and let $y(I')$ denote the amount of state I' claims that the consumer buys.
- The consumer's wealth follows

$$x_{t+1}(I') = \left(p_{t+1}(I') + d_{t+1}(I')\right) s_{t+1} + y(I'),$$

- The consumer's flow budget constraint is:

$$c_t + p_t s_{t+1} + \int y(I_{t+1})\, q(I_{t+1}, I_t)\, dI_{t+1} = x_t.$$

- The consumer chooses scalars for c_t and s_{t+1}, but a <u>function</u> for $y(I_{t+1})$.

5. Contingent Claims

(b) The consumer's problem

$$
\begin{aligned}
V(x_t, I_t) = & \min_{\lambda_t \geq 0} \max_{c_t \geq 0,\ s_{t+1},\ y(\cdot)} u(c_t) \\
& + \lambda_t \left(x_t - c_t - p_t s_{t+1} - \int y(I_{t+1}) \, q(I_{t+1}, I_t) \, dI_{t+1} \right) \\
& + \beta \int V\left(\left(p_{t+1}(I_{t+1}) + d_{t+1}(I_{t+1}) \right) s_{t+1} + y(I_{t+1}), I_{t+1} \right) \\
& \qquad \times f(I_{t+1}, I_t) \, dI_{t+1},
\end{aligned}
$$

5. (b) The consumer's problem

- In this case, we can pick $y(\cdot)$ as if we were picking a scalar for each value of I_{t+1}.
- The FOC for an interior solution are

$$u'(c_t) = \lambda_t,$$

$$\lambda_t p_t = \beta \int \frac{\partial V[t+1]}{\partial x_{t+1}} [p_{t+1}(I_{t+1}) + d_{t+1}(I_{t+1})] \times f(I_{t+1}, I_t)\, dI_{t+1},$$

$$\lambda_t q(I', I_t) = \beta \frac{\partial V[t+1]}{\partial x_{t+1}} f(I', I_t), \ \forall I',$$

5. (b) The consumer's problem

- Since $\frac{\partial V[t]}{\partial x_t} = \lambda_t$, we have

$$
\begin{aligned}
p_t &= \beta E_t \left(\frac{u'(c_{t+1})}{u'(c_t)} (p_{t+1} + d_{t+1}) \right), \\
q(I_{t+1}, I_t) &= \beta \frac{u'(c_{t+1}(I_{t+1}))}{u'(c_t)} f(I_{t+1}, I_t), \ \forall I_{t+1}.
\end{aligned}
$$

5. Contingent Claims

(c) Equilibrium

- Impose $c_t = d_t$, $s_{t+1} = 1$, and $y(I_{t+1}) = 0, \forall I_{t+1}$.
- One can see that $I_t = d_t$, so that

$$p_t = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} (p_{t+1} + d_{t+1}) \right).$$

$$q(d_{t+1}, d_t) = \beta \frac{u'(d_{t+1})}{u'(d_t)} f(d_{t+1}, d_t). \qquad \text{(EE}''\text{)}$$

5. (c) Equilibrium

- Using (EE$''$), we can price any arbitrary asset.
- If an asset pays $w(d)$ units of consumption goods when $d_{t+1} = d$, its price is

$$\begin{aligned} p_t^w &= \int w(d_{t+1})\, q(d_{t+1}, d_t)\, dd_{t+1} \\ &= \int w(d_{t+1})\, \beta \frac{u'(d_{t+1})}{u'(d_t)} f(d_{t+1}, d_t)\, dd_{t+1} \\ &= \beta E_t \left(w(d_{t+1}) \frac{u'(d_{t+1})}{u'(d_t)} \right). \end{aligned}$$

- If this were not the case, there would be arbitrage opportunities.

5. (c) Equilibrium

- One-period risk-free bonds: $w(d_{t+1}) = 1$, so that

$$R_t^{-1} = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} \right).$$

- Stocks: $w(d_{t+1}) = p_{t+1} + d_{t+1}$, so that

$$p_t = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} (p_{t+1} + d_{t+1}) \right).$$

- This shows us one way to price multi-period assets:

$$p_t^w = \beta E_t \left(\frac{u'(d_{t+1})}{u'(d_t)} \left(p_{t+1}^w + d_{t+1}^w (d_{t+1}) \right) \right).$$

5. (d) Modigliani-Miller Theorem

- Consider a one-period "firm" that has acquired the rights to sell the dividends of one tree at time $t+1$.
- At time t, the firm sells two types of claims, corporate bonds (b_t) and equities (e_t).
- The payoff function for a bond is

$$w^b(d_{t+1}) = \begin{cases} R, & \text{if } Rb_t \leq d_{t+1} \\ d_{t+1}/b_t, & \text{if } Rb_t > d_{t+1} \end{cases},$$

which implies that

$$\begin{aligned} p_t^b &= \int_{d_{t+1} \geq Rb_t} Rq(d_{t+1}, d_t)\, dd_{t+1} \\ &\quad + \int_{d_{t+1} < Rb_t} \frac{d_{t+1}}{b_t} q(d_{t+1}, d_t)\, dd_{t+1}. \end{aligned}$$

5. (d) Modigliani-Miller Theorem

- The payoff function for an equity is

$$w^e\left(d_{t+1}\right)=\begin{cases}\left(d_{t+1}-Rb_t\right)/e_t, & \text{if } Rb_t \leq d_{t+1} \\ 0, & \text{if } Rb_t > d_{t+1}\end{cases},$$

which implies that

$$p_t^e=\int_{d_{t+1}\geq Rb_t}\frac{d_{t+1}-Rb_t}{e_t}q\left(d_{t+1},d_t\right)dd_{t+1}.$$

5. (d) Modigliani-Miller Theorem

- Value of the firm:

$$
\begin{aligned}
V_t^F &= b_t p_t^b + e_t p_t^e \\
&= b_t \left[\int_{d_{t+1} \geq R b_t} R q\left(d_{t+1}, d_t\right) d d_{t+1} \right. \\
&\qquad \left. + \int_{d_{t+1} < R b_t} \frac{d_{t+1}}{b_t} q\left(d_{t+1}, d_t\right) d d_{t+1} \right] \\
&\quad + e_t \left[\int_{d_{t+1} \geq R b_t} \frac{d_{t+1} - R b_t}{e_t} q\left(d_{t+1}, d_t\right) d d_{t+1} \right] \\
&= \int d_{t+1} q\left(d_{t+1}, d_t\right) d d_{t+1}.
\end{aligned}
$$

5. (d) Modigliani-Miller Theorem

- The value of the firm, $V_t^F = \int d_{t+1} q\left(d_{t+1}, d_t\right) dd_{t+1}$, is independent of the number of bonds and equities outstanding.
- Modigliani-Miller Theorem: the value of a firm does not depend on how it is financed.
- If the firm issues more or less corporate bonds, the prices of bonds and equity change accordingly.
- Note that this result holds only under very restrictive assumptions: complete markets, symmetric information, no taxes.