

### Problem Set 2

Due in class, week 3

In this problem, you'll explore VAR representations, such as Figure 20.4 and 20.5 in *Asset Pricing*.

1. Assemble annual log dividend yield, dividend growth and return data. Contrast actual dividend growth with dividend growth implied by the approximate identity  $\Delta d_{t+1} = r_{t+1} + \rho dp_{t+1} - dp_t$ .
2. Fit a simple VAR to your data. Later we will explore whether you leave out a lot by ignoring lags of  $dp$ ,  $r$  and  $\Delta d$ .

$$\begin{aligned} r_{t+1} &= b_r \times (d_t - p_t) + \varepsilon_{t+1}^r \\ \Delta d_{t+1} &= b_d \times (d_t - p_t) + \varepsilon_{t+1}^d \\ d_{t+1} - p_{t+1} &= \phi \times (d_t - p_t) + \varepsilon_{t+1}^{dp} \end{aligned}$$

Use both actual and implied dividend growth and see if there is a substantial difference. Report coefficients, t statistics, and the correlation matrix of the shocks.

3. Plot responses of returns, dividend yield, dividend growth, level of (log) dividends, and level of log prices to each of two shocks, i) A shock to dividend growth with no change in  $dp$  and ii) a shock to  $dp$  with no change in dividend growth. Note, you have to have a contemporaneous response of returns to these shocks in order to satisfy the identity  $r_{t+1} = -\rho dp_{t+1} + dp_t + \Delta d_{t+1} \rightarrow \varepsilon_{t+1}^r = -\rho \varepsilon_{t+1}^{dp} + \varepsilon_{t+1}^d$ .

In thinking how to interpret the impulse response function, note here too that causality does not flow in the usual way. Mechanically, the impulse-response function of  $y_{t+j}$  to an  $x_t$  shock represents the change in expectations about  $y_{t+j}$  that occurs when you see a shock to  $x_t$ . In macro, we often think of this relationship as, e.g. “if a shock to productivity occurs today, how does that cause effect unemployment in year  $t+5$ .” However, in finance we can think about the same mathematical result as “what change in expected returns  $E_t r_{t+j}$  caused prices to change today?” Here too, the presence of the response function does not prove causality – it’s consistent with causality from price fads to subsequent returns as well as causality from expected returns and dividend growth to prices. But it is possible to read the response function as “reverse causality” from expectations to the initial price shock.