Coronavirus: Impact on Stock Prices and Growth Expectations

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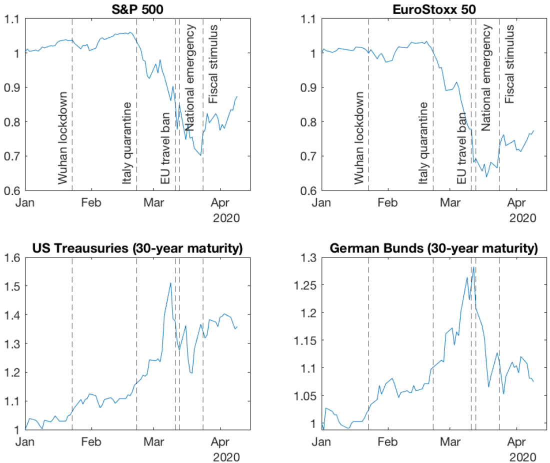
Motivation

- The outbreak of the new coronavirus has caused a pandemic of respiratory disease (COVID-19) for which vaccines and targeted therapeutics for treatment are unavailable.
- The impact that "pausing" the economy may have on supply chains and the financial stability of firms, the financial sector, and households is largely unknown.
- Models based on macro data may be slow to update or get the sign wrong (e.g., stock piling may suggest an increase in economic activity).
- Asset prices, stocks, government bonds, and corporate bonds, are forward looking and encode investors' expectations.

THE BEHAVIOR OF STOCK AND BOND MARKETS



- Stock markets fall as much as 30%, while long-term bond markets rally by the same amount.
- However, the first 10 years of dividends amount to only 20% of the market.

Decomposing the decline in the market

- We decompose the value of the stock market, S_t, as

$$S_t = \sum_{n=1}^{\infty} \frac{\mathbb{E}_t \left[D_{t+n} \right]}{1 + \mu_t^{(n)}},$$

  where $\mathbb{E}_t \left[D_{t+n} \right]$ is the expected dividend in n years from today and $\mu_t^{(n)}$ the cumulative discount rate for that cash flow.
- Define

$$P_t^{(n)} = \frac{\mathbb{E}_t \left[D_{t+n} \right]}{1 + \mu_t^{(n)}},$$

  as the $n-$period dividend strip price.
- If we sum all dividend strip prices, they add to the market, $S_t = \sum_{n=1}^{\infty} P_t^{(n)}$.
- We observe the dividend prices for the first 10 years.

What we do

1. Summarize facts about the dynamics of the stock market and dividend futures prices.
2. Use dividend futures to study the evolution of dividend and GDP growth expectations.
3. Simple asset pricing model of pandemics to explore how different shocks are reflected in prices.

Selected related literature

- Pricing of dividends across maturities:
  Brennan (1998), Lettau and Wachter (2007), Hansen, Heaton, and Li (2008), Binsbergen, Brandt, and Koijen (2012), Binsbergen, Hueskes, Koijen, and Vrugt (2013), Binsbergen and Koijen (2017), and Gormsen (2020).
- Asset prices and growth expectations (large literature):
  Harvey (1989) for equities and bonds, and Gilchrist and Zakrajsek (2012) for credit spreads.
- Pandemics and economic growth:
  Atkeson (2020), Eichenbaum, Rebelo, and Trabandt (2020), Stock (2020), Jones, Philippon, and Venkateswaran (2020), Correia, Luck, and Verner (2020), and Baker, Farrokhnia, Meyer, Pagel, and Yannelis (2020).

Selected related literature

- The impact of the current crisis on asset prices: Ramelli and Wagner (2020), Alfaro, Chari, Greenland, and Schott (2020), Sinagl (2020), Onali (2020), Gerding, Martin, and Nagler (2020), Ru, Yang, and Zou (2020), Hassan, Hollander, van Lent, and Tahoun (2020), and Cejnek, Randl, and Zechner (2020).

Dividend futures prices

- Write $P_t^{(n)} = \frac{\mathbb{E}_t[D_{t+n}]}{1+\mu_t^{(n)}}$ as

$$P_t^{(n)} = D_t \frac{G_t^{(n)}}{1+\mu_t^{(n)}},$$

with $G_t^{(n)} = \mathbb{E}_t\left[\frac{D_{t+n}}{D_t}\right]$ the expected growth rate from t to $t+n$.

- Dividend futures prices, $F_t^{(n)}$, are linked to spot prices via $F_t^{(n)} = P_t^{(n)}(1+y_t^{(n)})$, which implies

$$F_t^{(n)} = D_t \frac{G_t^{(n)}}{1+\theta_t^{(n)}},$$

where (i) $y_t^{(n)}$ the cumulative $n-$year risk-free interest rate and (ii) $1+\theta_t^{(n)} = \frac{1+\mu_t^{(n)}}{1+y_t^{(n)}}$ the dividend risk premium.

Data

- The dividend futures are exchange-traded products, traded on the Chicago Mercantile Exchange in the US and on the Eurex Exchange in EU, and also to a large extent on over-the-counter markets.
- Because the contracts expire in December, the maturity of the available contracts varies over the calendar year, and we therefore interpolate prices across the different contracts to obtain constant maturity prices.
- We use the mid-quotes at close as pricing data in the US and settlement prices, which is the volume-weighted average price during the day, in the EU.

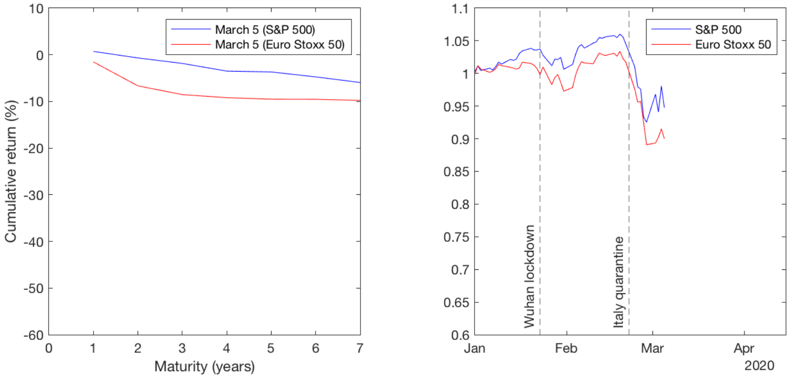
Key events

- January 15 - January 31: The outbreak in Wuhan.
- January 31 - March 5: The coronavirus spreads internationally, with Italy, Iran, and South Korea hit particularly hard.
- March 5 - March 12: Governments in the EU respond with partial lockdowns. The US limits travel from the EU on March 11. On March 12, stock markets experience the largest daily drop since 1987.
- March 13: The US declares a national emergency at 3pm EST. Stock prices surge in the last few hours of trading.
- March 16: Stock markets drop by as much as 11%.
- March 18: Stock markets drop by 5 to 6%.
- March 25: Congress comes close to approving a $1.8 trillion stimulus package. Stock markets rally on March 24 and 25 by almost 10%.
- March 25-30: Stock markets continue to trend up.

Events

Early phase	Outbreak/crash	Stimulus	Rebound

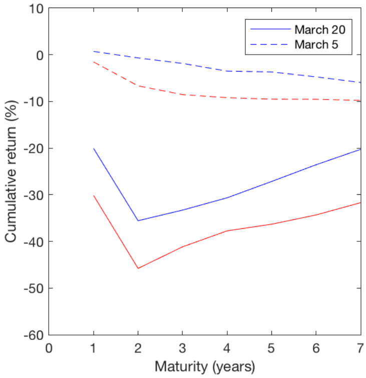
Jan 1 — March 5 — March 20 — March 26 — April 9

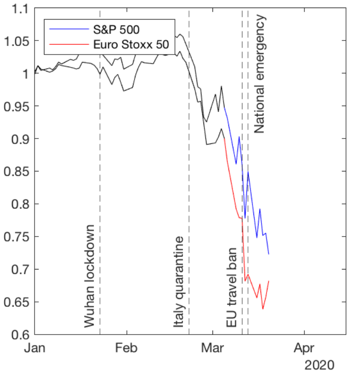


Events

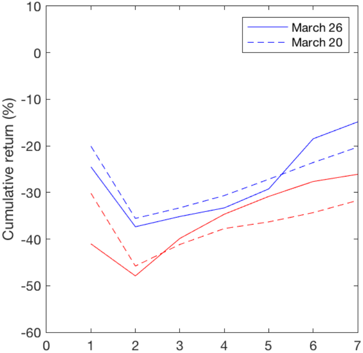
Early phase | **Outbreak** | Stimulus | Rebound

Jan 1 | **March 5** | **March 20** | March 26 | April 9

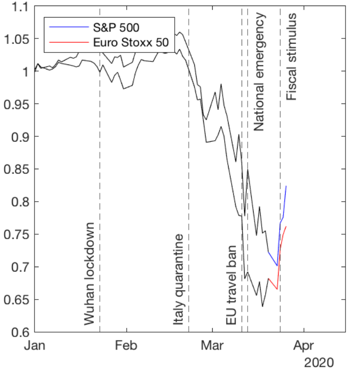




Events



Cumulative return (%)
March 26
March 20
10
0
-10
-20
-30
-40
-50
-60
0
1
2
3
4
5
6
7

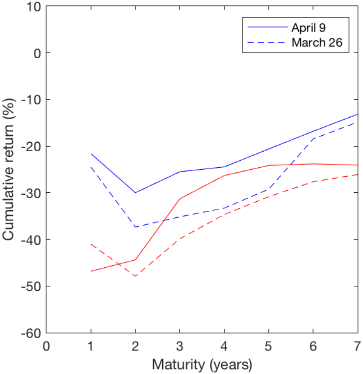


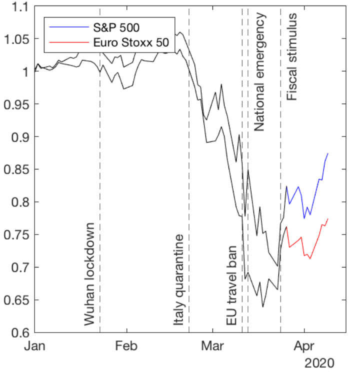
S&P 500
Euro Stoxx 50
Wuhan lockdown
Italy quarantine
EU travel ban
National emergency
Fiscal stimulus
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
Jan
Feb
Mar
Apr
2020

Events

Early phase	Outbreak	Stimulus	Rebound

Jan 1 · March 5 · March 20 · March 26 · April 9





A lower bound on dividend growth

- Consider a change in the price over short period of time from t to t', $t' > t$,

$$\Delta F_{t'}^{(n)} = \frac{\Delta G_{t'}^{(n)}}{\Delta \Theta_{t'}^{(n)}},$$

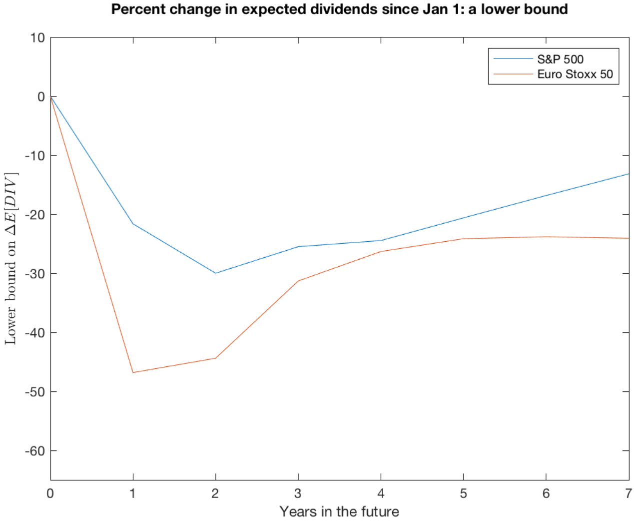
where $\Delta x_{t'} = \frac{x_{t'}}{x_t}$ and $\Theta_t^{(n)} = 1 + \theta_t^{(n)}$.

- To obtain a lower bound on the change in growth expectations, we assume that the expected excess return, which for instance reflects investors' risk aversion, did not go down since the outbreak, $\Delta \Theta_{t'}^{(n)} \geq 1$.
- This implies that we can bound the change in expected growth from below by

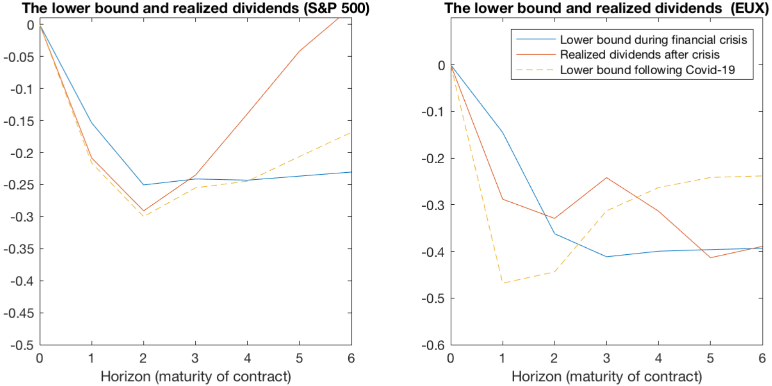
$$\Delta G_{t'}^{(n)} - 1 \geq \Delta F_{t'}^{(n)} - 1,$$

which depends only on market prices.

Dividend expectations: Lower bound



Comparison to the 2008 financial crisis

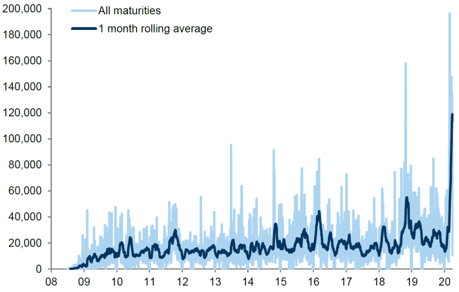


On the liquidity of dividend futures

- In some markets, most of the trading takes places in OTC markets, which makes it harder to obtain market statistics.
- Euro volume: $200,000 \times 100 \times 66 = 1.32bn$ per day.

Exhibit 28: Trading volumes for EURO STOXX 50 dividend futures reached a new record

Contracts

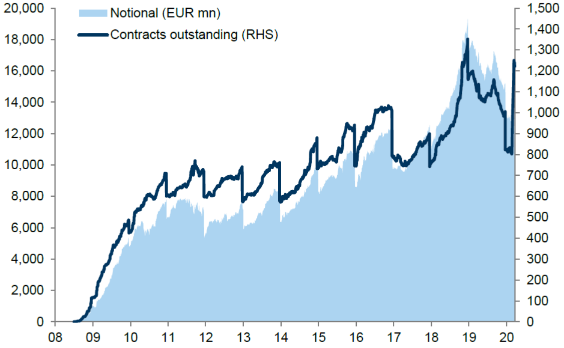


Source: Bloomberg, EUREX, Goldman Sachs Global Investment Research

On the liquidity of dividend futures

- Euro open interest: $20bn$.

Exhibit 30: Sharp increase in open interest for EURO STOXX 50 dividend futures



Source: Bloomberg, EUREX, Goldman Sachs Global Investment Research

On the liquidity of dividend futures

- Bid-ask spreads:

Latest | Trading | Parameters | **Orderbook**

ᴉisplayed data is 15 minutes delayed.Last trade:**Mar 24, 2020 12:40:27 PM**

Contract (maturity)	Quantity	Bid	Ask	Quantity	Last Price	NetChange	Cumulative Volume (QTY)	Open Interest
	Bid		Ask					
Dec 2020	1	**76.80**	**76.90**	9	76.80	-9.43%	**11,299**	219,174
Dec 2021	21	**61.50**	**61.60**	31	61.50	-0.81%	**6,734**	390,207
Dec 2022	22	**63.40**	**64.00**	100	64.00	+0.00%	**7,049**	222,183
Dec 2023	5	**64.60**	**65.40**	59	64.70	-1.97%	**1,417**	126,397
Dec 2024	70	**66.10**	**67.20**	112	66.90	+1.67%	**1,108**	159,084
Dec 2025	100	**67.20**	**67.80**	100	67.80	+1.19%	**148**	49,831
Dec 2026	5	**67.50**	**68.80**	100	66.90	+1.06%	**319**	16,870
Dec 2027	100	**68.00**	**69.70**	100	66.90	+0.91%	**130**	16,932
Dec 2028	2	**67.90**	**69.50**	100	66.10	-6.11%	**296**	5,657
Dec 2029	2	**68.00**	**69.30**	100	65.90	-5.45%	**234**	14,314

- In progress: Intra-day patterns on EuroStoxx50 futures and bid-ask spreads to further explore these questions.

FROM DIVIDENDS TO GDP

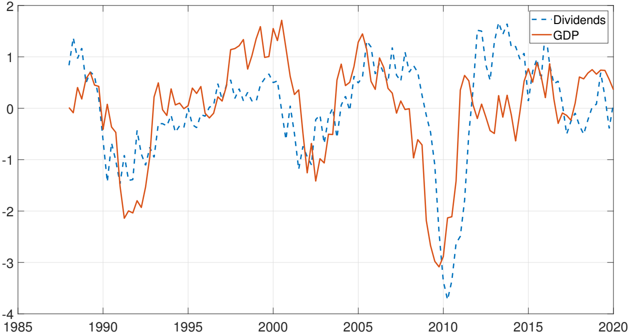
- To illustrate the tight connection between dividends and GDP, we extract the cyclical component of log real dividends and log real GDP using the Hamilton (2018) filter,

$$y_t = d_0 + \sum_{i=8}^{11} d_i y_{t-i} + c_t,$$

  where y_t corresponds to either log real dividends or log real GDP.
- The residual, c_t, corresponds to the cyclical component.

From dividends to GDP

- The time-series correlation is 56%.



Deriving a lower bound for GDP growth expectations

- We multiply our lower bound on dividend growth by a constant b that maps dividends into GDP

$$E_t\left[\Delta_n Y_{it}\right] - 1 \geq \left(\Delta F_{i,t'}^{(n)} - 1\right) \times b_i,$$

where $E_t\left[\Delta_n Y_{it}\right]$ is changes in expected GDP growth at horizon n for country i.

- The constant b_i measures how much GDP changes when dividends change.

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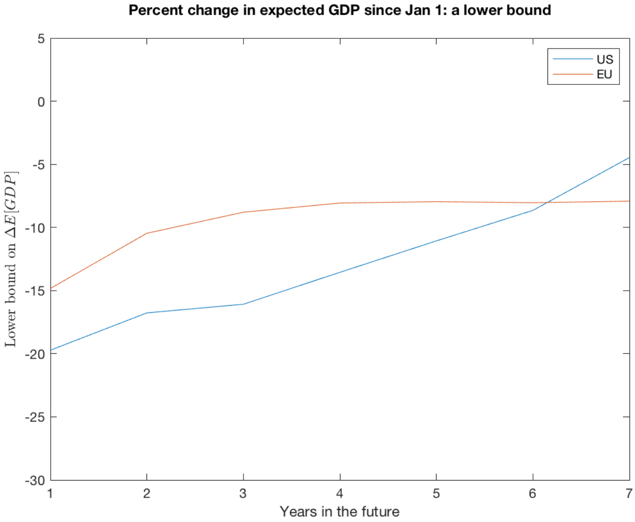
- The constant b_i measures how much GDP changes when dividends change.
- To ensure that our lower bound is conservative, we instead run the regression

$$\Delta_1 D_{it} = a_{0i} + a_{1i}\Delta_1 Y_{it} + \varepsilon_{t+4},$$

and use $b_i = \frac{1}{a_{1i}}$.

- Estimates: $b_{US} = 0.67$, $b_{EU} = 0.33$, where the US estimate benefits from a longer sample.
- We provide more formal conditions in the paper for this to be a valid lower bound.

Lowerbound on GDP growth expectations



Dividend growth expectations

- Define the equity yields on index i as

$$e_{it}^{(n)} = \frac{1}{n} \ln \left(\frac{D_t}{F_t^{(n)}} \right),$$

where n is measured in years.

- Run a pooled regression of realized dividends on S&P 500 and Euro Stoxx 50 on the 2-year equity yield on the associated index

$$\Delta_1 D_{i,t} = \beta_{0i}^D + \beta_1^D e_{it}^{(2)} + \epsilon_{i,t+4},$$

where t is measured in quarters, i refers to either S&P 500 or Euro Stoxx 50, and $\Delta_n x_t \equiv \frac{x_{t+4n}}{x_t} - 1$.

- The R^2 in this forecasting regression is 0.65.

GDP growth expectations

- Map real GDP growth to real dividend growth using the following regression in the 1985-2019 US sample

$$\Delta_n Y_t = A_n + B_n \Delta_n D_t + e_{t+4n},$$

only using data when $\Delta_n D_t < \overline{\Delta_n D_t}$.

- Notes
  1. Focus on the co-movement during downturns.
  2. Larger n mitigates the impact of small asynchronicities.
- We estimate B_n using 2-year growth ($n = 2$) in the 1985 to 2019 US sample $\Rightarrow B_2 = 0.22$.

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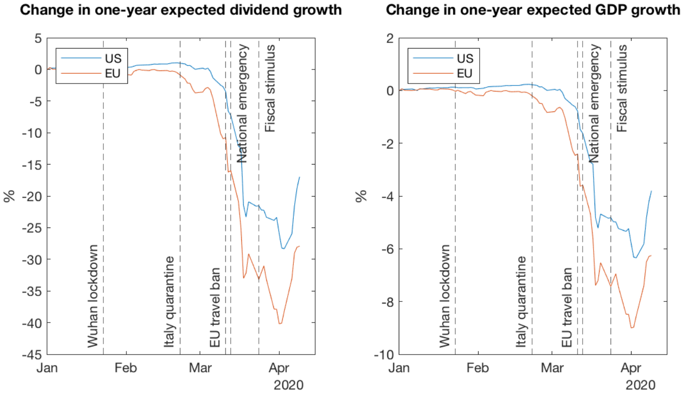
- Notes
  1. Focus on the co-movement during downturns.
  2. Larger n mitigates the impact of small asynchronicities.
- We estimate B_n using 2-year growth ($n = 2$) in the 1985 to 2019 US sample $\Rightarrow B_2 = 0.22$.
- Having estimated the relation between GDP and dividends, we forecast GDP growth as

$$E_t\left[\Delta_1 Y_{it}\right] = A_i + B_2 \beta_1^D e_{i,t}^{(2)}.$$

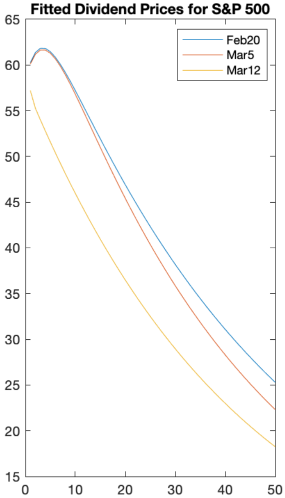
- Note: these estimates are based on a forecasting model estimated using historical data. In unprecedented times, there is a risk that historical relations change, implying that these estimates come with uncertainty.

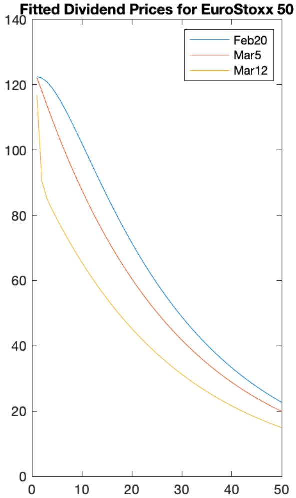
DIVIDEND AND GDP GROWTH EXPECTATIONS



The market and dividend strip prices

- We can fit a Nelson and Siegel (1987) pricing model to fit the dividend prices and the stock market simultaneously.





A simple asset pricing model of the pandemic (in progress)

- Why we want a model
  1. Clarify the nature of shocks, and risk prices, to explain the facts.
  2. Uncover structural parameters of interest, such as the economic cost of social distancing.
  3. An alternative approach to uncover growth expectations.
- Facts that we want the model to match:
  1. Modest news about short-term cash flows leads to a large decline in the market, but not in short-term dividend prices.
  2. Bad news about short-term cash flows results in a decline of short- and long-term dividend prices.
  3. News about fiscal policy hardly impacts short-term dividend prices, but has a large impact on long-term dividend prices.

Outline

- Time is discrete $t = 0, 1, \ldots$
- $t = 0$:
  - Investors do not anticipate the pandemic.
- $t = 1, \ldots, \tau - 1$:
  - The pandemic develops and social distancing measures are used to flatten the pandemic curve.
  - First source of uncertainty: Investors learn about the economic cost of "pausing" the economy.
- $t = \tau$:
  - Investors learn the damage done to firms and financial institutions.
  - Second source of uncertainty: There is a possibility that the deep recession escalates into a financial crisis
  - Third source of uncertainty: During the recession ($t = 1, \ldots, \tau - 1$), government policies (fiscal and monetary policies) can be used to lower the disaster probability.

The dynamics of the pandemic and social distancing

- SIR (susceptible, infected, and resistant) model is the benchmark model in the literature

$$
\begin{aligned}
s_{t+1} &= s_t - \beta_t s_t i_t, \\
i_{t+1} &= (1-\gamma)\, i_t + \beta_t s_t i_t, \\
r_{t+1} &= r_t + \gamma i_t,
\end{aligned}
$$

  where all are scaled by population size, N.
- Social distancing h_t, $h_t \in [0,1]$, can mitigate the rate of spread.
- We model

$$
\begin{aligned}
\beta_t &= b_0 - b_1 h_t, \\
h_t &= \lambda \beta_t i_{t-1} s_{t-1},
\end{aligned}
$$

  where $b_0, b_1 > 0$ and $b_1 \leq b_0$. The latter constraint ensures that $\beta_t \geq 0$.

Phase 1: Normal times

- At $t = 0$, investors do not anticipate the pandemic and log dividends, $d_t^N = \ln D_t^N$, evolve as

$$\Delta d_t^N = \mu_N - \frac{1}{2}\sigma_N^2 + \sigma_N \epsilon_t^N,$$

where μ_N is the average dividend growth rate and σ_N the volatility of dividend growth in normal times.

- Stochastic discount factor

$$\ln M_t = -y - \frac{1}{2}\lambda_N^2 - \lambda_N \epsilon_t^N,$$

where y is the risk-free rate and λ_N the price of dividend risk in normal times.

Phase 2: Recession

- From $t = 1, ..., \tau - 1$, dividends evolve as

$$d_t^C = \phi_t h_t,$$

where h_t is the degree of social distancing, which we assume depends on the number of infections.

- ϕ_t measures the economic cost of social distancing

$$\phi_t = \phi_{t-1} + \sigma_\phi \epsilon_t^\phi,$$

where $\phi_0 = 0$ and $\phi_1 = 1$.

- The SDF

$$\ln M_t = -y - \frac{1}{2}\lambda_\phi^2 - \lambda_\phi \epsilon_t^\phi,$$

where λ_ϕ is the risk price associated with news about the economic cost of social distancing.

Phase 3: From recession to financial crisis

- At time $t = \tau$, a disaster may happen that permanently lowers dividends by a fraction $\xi < 1$,

$$d_t^C = I_\tau \ln \xi,$$

where I_τ as an indicator variable that equals one if the disaster hits.

- The time-t probability of a disaster equals

$$\pi_t = E_t \left[I_\tau \right] = \exp \left(\pi + \pi_\phi \sum_{s=1}^{t} \left(\epsilon_s^\phi - \frac{1}{2} \right) + \pi_G \sum_{s=1}^{t} \left(\epsilon_s^G - \frac{1}{2} \right) \right).$$

where ϵ_t^G are government policy shocks.

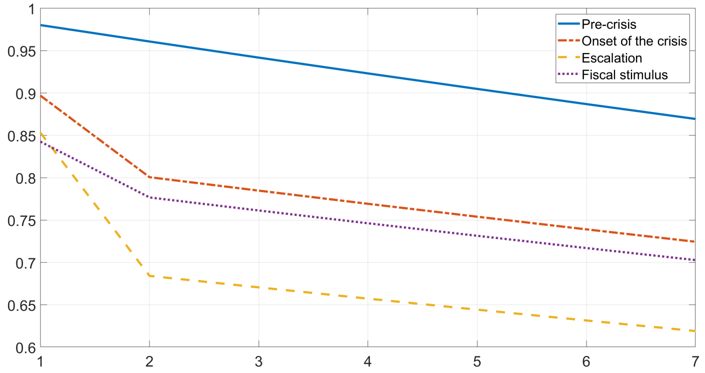
- The disaster shock is priced and we model

$$\ln M_\tau^C = I_\tau \ln W + (1 - I_\tau) \ln \frac{1 - \pi_{\tau-1} W}{1 - \pi_{\tau-1}},$$

where $W > 1$, so that the disaster state corresponds to a high marginal utility state.

Model solution and calibration

- Standard affine model and we solve for prices in closed form.



Conclusions

- Summarize facts about the dynamics of the stock market and dividend futures prices.
- We use dividend futures to estimate dividend and GDP growth expectations.
- Simple asset pricing model of pandemics to explore how different shocks are reflected in prices.
- Latest estimates: https://voices.uchicago.edu/gormsen/gdp-growth-forecasts-from-dividend-futures/