# Information Aversion

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# This Paper

Why don't agents pay attention to information?

- Micro founded models of risk $\rightarrow$ attitude towards information
- **Information aversion**
- Preference-based explanation of the cost of information

Characterize risk and information decisions when information costs are endogenous:

- Properties of optimal attention to savings:
  - Consumer Expenditure Survey (Dynan and Maki 2000): through a 15% rise in the market, 1/3 of stockholders report no change to their portfolio value.
  - Alvarez, Guiso and Lippi (2012): household surveys in Italy, observe portfolios 4 times a year.
- Portfolio choice: home bias, underdiversification

# Information Aversion Model

## Disappointment aversion

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**Disappointment aversion**

**Ability to close your eyes**

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**Disappointment aversion**

- Recursive dynamic implementation of piecewise linear case of Gul (1991)
- Partial releases of information have a utility cost (Dillenberger 2010)
- Micro evidence and successful macro applications (Ang et al. 2005,2006, Routledge and Zin 2010, Bonomo et al. 2011, Lettau et al. 2013)

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### Ability to close your eyes

- No monetary or time cost of information
- No limited cognition
- Bayesian updating

# Results

- Natural theory of the cost side of information acquisition
- Which information flows are more costly?
  - Higher frequency
  - Higher risk
  - Infinite aversion to continuous Brownian flow, not to jumps

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  - Infrequent observation of portfolio position
  - Tradeoff for optimal frequency of information. At lower frequency:
    - Misallocation of savings
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    - Misallocation of savings
    - Less “stressful” flow of information
  - More inattention in risky environments
- Other features of portfolio allocation
  - Diversification
  - Background risk
  - Information delegation
  - Asymmetry between good and bad news

## Some Related Literature

- Frequency of utility evaluation matters with loss aversion: Benartzi and Thaler (1995)
- Preference for one-shot resolution of uncertainty: Dillenberger (2010)
- Lab experiments: Gneezy and Potters (1997), Thaler et al. (1997), Benartzi and Thaler (1999), Barron and Erev (2003), Gneezy et al. (2003), Bellemare et al. (2005), Haigh and List (2005), Fellner and Sutter (2009) and Anagol and Gamble (2011), ...
- Field and natural experiments: Beshears et al. (2012), Shaton (2014)
- Reference-dependent preferences and role of information for portfolio decisions: Koszegi and Rabin (2006), Pagel (2013)

- Consumption-saving decisions with exogenous fixed cost of information: Duffie and Sun (1990), Gabaix and Laibson (2002), Abel, Eberly and Panageas (2007, 2013), Alvarez et al. (2013)

# Outline

1. Disappointment aversion and information aversion
2. Role of observation frequency
3. Consumption-savings decisions
   - Basic setup
   - Other dimensions
4. Conclusion

# Plan

# Disappointment Aversion

- Piecewise linear case of Gul (1991)
- Lottery over final outcome $X$
- Certainty equivalent:

$$\mu(X) = \frac{\mathbb{E}\left[\left(1 + \theta 1_{X \leq \mu(X)}\right) X\right]}{\mathbb{E}\left[1 + \theta 1_{X \leq \mu(X)}\right]}$$

- Overweight "disappointing outcome"
  - $\theta > 0$, coefficient of disappointment aversion
  - only source of aversion to risk comes from disappointment aversion
- Certainty equivalent $\mu(X)$ is unique solution to a fixed-point problem

## Disappointment Aversion, dynamic implementation

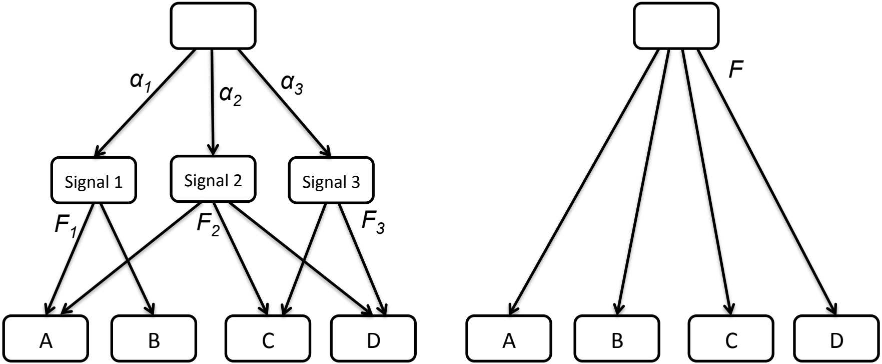
- Dynamic implementation: recursion on certainty equivalents
- Value at time $t$, $V_t$, of lottery over continuation value $V_{t+1}$: $V_t = \mu\left(V_{t+1}\right)$

$$V_t = \frac{\mathbb{E}\left[\left(1+\theta 1_{V_{t+1}\leq V_t}\right)V_{t+1}|\mathcal{I}_t\right]}{\mathbb{E}\left[1+\theta 1_{V_{t+1}\leq V_t}|\mathcal{I}_t\right]}$$

- If no news is revealed: $V_t = V_{t+1}$
- In continuous time: take the limit of discrete time sampling of information

# Two-stage Lottery

$$\sum \alpha_i F_i = F$$



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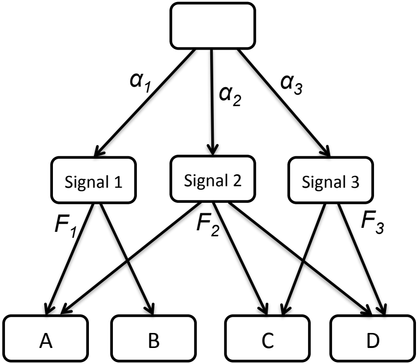


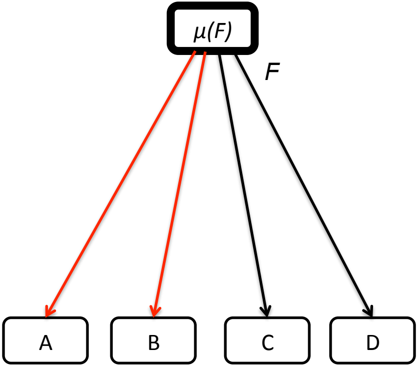

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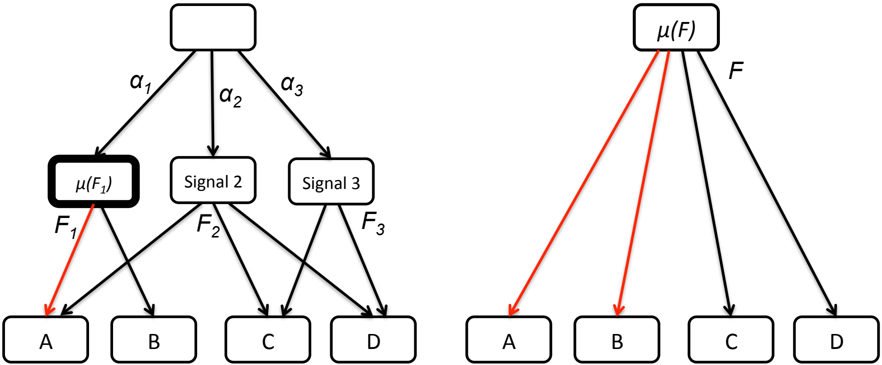

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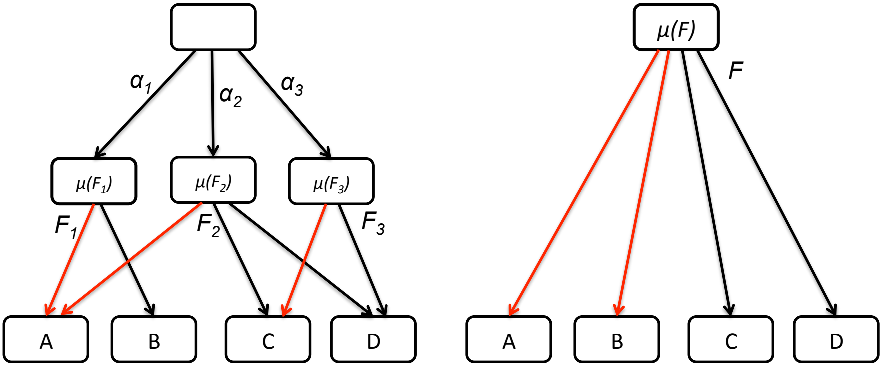

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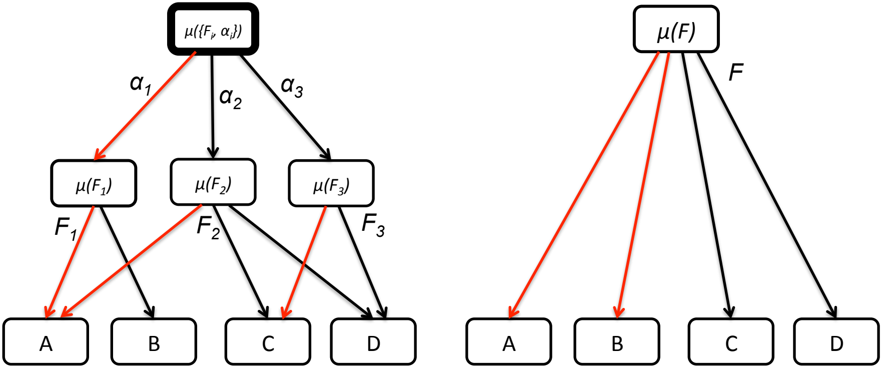

# Information Aversion

**Disappointment aversion $\Rightarrow$ information aversion**

- Agent prefers not to observe the signal

$$\mu(\{F_i, \alpha_i\}) \leq \mu(F)$$

  - Dillenberger (2010): Negative Certainty Independence $\Leftrightarrow$ Preference for One-Shot Resolution of Uncertainty

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- Agent fears possibility of repeated changes in certainty equivalent

$$\mu(\{F_i, \alpha_i\}) = \mu(F) \Leftrightarrow \forall i, \begin{cases} \mu\left(F_i\right) = \mu\left(F\right) \text{ or} \\ F_i \text{ is degenerate} \end{cases}$$

## Endogenous Information Costs

- **Cost not monotone in Blackwell ordering**
- **Information aversion versus exogenous costs models**
  - Endogenous information cost is zero if all or no information is revealed
  - Not monotonic increasing in quantity of information
- **Information aversion versus cognitive constraints**
  - Endogenous information cost is zero for either fully informative or fully uninformative signals
  - For any level of mutual information, we can construct signals with zero endogenous cost: reveal the final value of the lottery with some probability

# Plan

# Information Structure

- Process $X_t$ with i.i.d. growth
- Observe its value at intervals of length $T$
- Receive value of the process $X_\tau$ at time $\tau$

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Information aversion

- Prefer never to observe the intermediate values
- Gneezy and Potters (1997), ...

How is the valuation of the lottery affected by

- the observation interval?
- the distribution of the process?

Input for consumption-savings problem

## Information Structure

- Process $X_t$ with i.i.d. growth
- Observe its value at intervals of length $T$
- Receive value of the process $X_\tau$ at time $\tau$

- Because growth is i.i.d

$$\mu\left(\frac{X_T}{X_0}\right) = \mu\left(\frac{X_{2T}}{X_T}\right) = \ldots = \mu\left(\frac{X_{(k+1)T}}{X_{kT}}\right)$$

Define **instantaneous certainty equivalent rate** $v(T)$:

$$\mu\left(\frac{X_T}{X_0}\right) = \exp(v(T)T)$$

- Value at time $0$ for payoff at time $\tau$:

$$V_{0,\tau}(T) = \exp(v(T)\tau)$$

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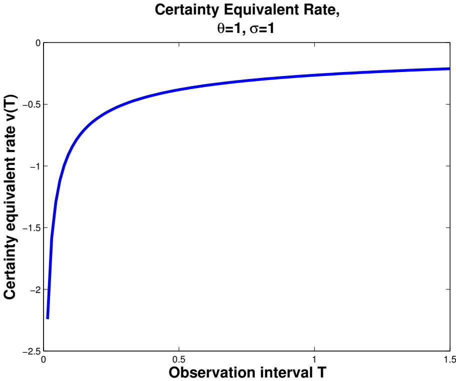
- With drift $g$ and martingale component $Y$:

$$v_X(T) = g + v_Y(T)$$

# Geometric Brownian Motion

$$\frac{dX_t}{X_t} = \sigma dW_t$$

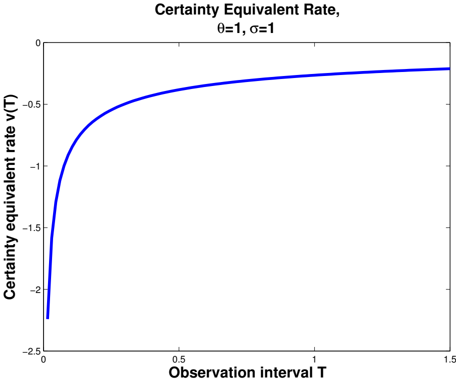



Equivalent rate as a function of observation interval

# Geometric Brownian Motion

$$\frac{dX_t}{X_t} = \sigma dW_t$$

- **Distaste for frequent partial information:**
  - equivalent rate increasing in observation interval
  - optimally choose never to look at any information

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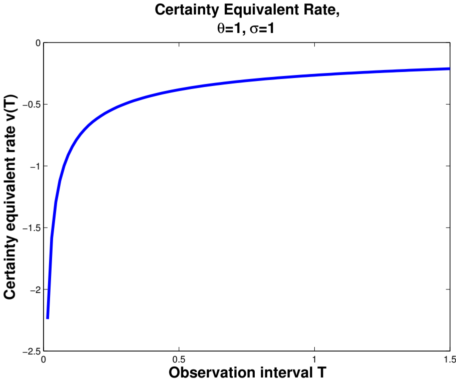
- **Risk aversion:**
  - equivalent rate decreasing in risk $\sigma$
  - equivalent rate decreasing in risk aversion $\theta$

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# Geometric Brownian Motion

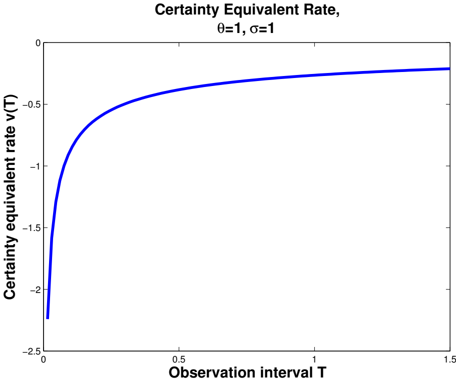
$$\frac{dX_t}{X_t} = \sigma dW_t$$

- **Infinite risk aversion at high frequency:**
  - Value for $t = \tau$ payoff equals lowest possible outcome in the continuous information limit
  - expansion around $0$:

$$v(T) \approx_0 -\frac{\kappa(\theta)\sigma}{\sqrt{T}}$$

  - first-order risk aversion:

$$\underbrace{-\sigma\sqrt{T}}_{\text{observation discount}} \times \underbrace{\tau/T}_{\#\text{ observations}}$$



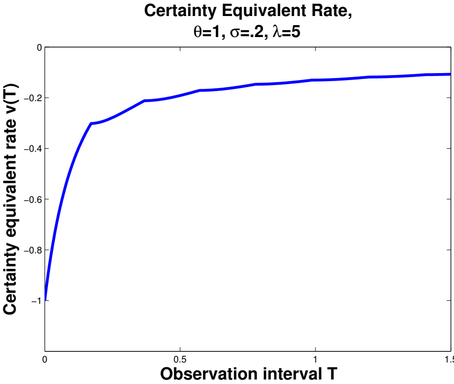

Equivalent rate as a function of observation interval

# Jump process

$$\frac{dX_t}{X_t} = \lambda\sigma dt - \sigma dN_t$$

$N_t$: Poisson counting process, intensity $\lambda$

- **Distaste for frequent partial information**
- **Risk aversion**

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# Jump process

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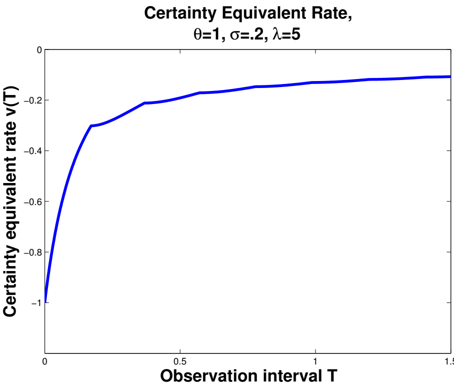
$N_t$: Poisson counting process, intensity $\lambda$

- **Finite limit at high frequency:**
  - limiting behavior

    $$v(T) \xrightarrow[T\to 0]{} -\theta\sigma\lambda$$

  - no first order risk aversion: infrequent large risks vs. frequent small risks




Equivalent rate as a function of observation interval

# Plan

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# Portfolio problem

How does the disappointment averse agent decide to consume, save, and observe information?

- Choice between risk-free and risky savings
- Setup of the fixed cost of information/transaction literature:
  - Duffie and Sun (1990), Gabaix and Laibson (2001), Abel et al. (2007, 2013), Alvarez et al. (2013).
  - Baumol-Tobin model (1952, 1956)
- No exogenous cost of information/transaction, but agent free to close her eyes

# Setup

**Preferences:**

$$\frac{\mathcal{V}_t^{1-\alpha}}{1-\alpha} = \frac{C_t^{1-\alpha}}{1-\alpha}dt + (1-\rho dt)\,\frac{\left(\mu_\theta\left[\mathcal{V}_{t+dt}|\mathcal{F}_t\right]\right)^{1-\alpha}}{1-\alpha}.$$

- $\theta$: coefficient of disappointment aversion
- $1/\alpha$: intertemporal elasticity of substitution
- $\rho$: rate of time discount

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**Opportunity sets:**

- *Information*: choose time until next observation $T$
- *Investment*:
  - Instantaneous consumption $C_t$
  - Buy $S_t$ shares of the risky asset, price $X_t$, instantaneous certainty equivalent rate $v(T)$
  - Remainder in risk-free asset, rate of return $r$

Budget constraint:

$$dW_t = -C_t dt + S_t dX_t + r(W_t - S_t X_t)dt$$

Formal problem

# Setup

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$$\frac{\mathcal{V}_t^{1-\alpha}}{1-\alpha} = \int_0^T e^{-\rho\tau} \frac{C_{t+\tau}^{1-\alpha}}{1-\alpha} d\tau + e^{-\rho T} \frac{\left(\mu_\theta \left[\mathcal{V}_{t+T} | \mathcal{F}_t\right]\right)^{1-\alpha}}{1-\alpha}.$$

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Formal problem

# Basic Properties

- Homothetic preferences
- Linear opportunity set for consumption
- i.i.d. dynamics

$\Rightarrow$

- Constant observation interval $T$
- Consumption-wealth ratio and asset allocation functions of wealth at last observation and time since last observation

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- *Remark:* Fixed cost models lose homotheticity or use *ad hoc* assumptions on the scaling of the cost

# Consumption and Investment Decisions

Given observation interval $T$:

- Consumption between observations deterministic, financed at the risk-free rate $r$
- Inter-observation savings:
  - all risk-free if $r > v(T)$
  - all risky if $r < v(T)$

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- Fraction of wealth allocated to consumption:

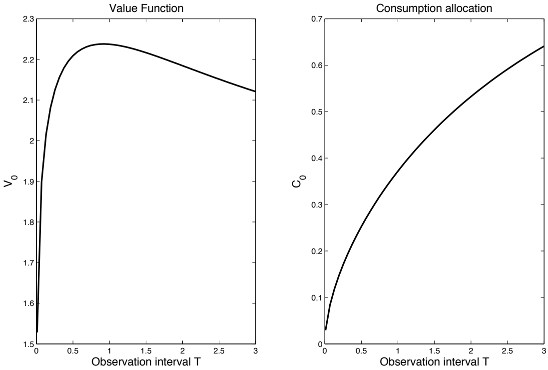
$$\mathcal{C}(T) = 1 - \exp\left[\left(-\frac{\rho}{\alpha} + \frac{1-\alpha}{\alpha}\max(v(T), r)\right) T\right]$$

- Consumption path, for $\tau \in [0, T]$:

$$C_{t+\tau} \propto \mathcal{C}(T) e^{\frac{-\rho+r}{\alpha}\tau}$$

# Role of Observation Interval

Geometric brownian motion: $dX/X = gdt + \sigma dW_t$




Parameters values: $\theta = 1, \alpha = 0.5, \sigma = 1, g - r = 1, \rho = 0.1.$

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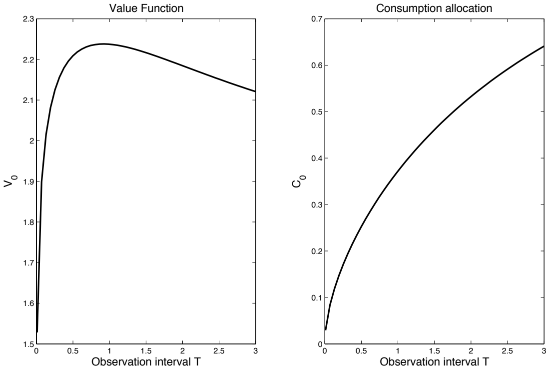


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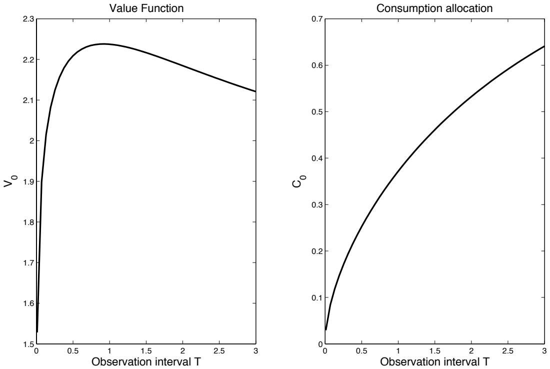


Parameters values: $\theta = 1, \alpha = 0.5, \sigma = 1, g - r = 1, \rho = 0.1.$

$\rightarrow$ Infrequent observation and investment in risky asset iff $g > r$
More generally, need $v(0) < r < v(\infty)$

## Optimal Information Choice

**Key result:** Optimal observation interval exists and is such that:

$$\frac{\partial v(T)}{\partial \log(T)} f\left(v\left(T\right) - \frac{\rho}{1-\alpha}\right) = \left(v\left(T\right) - \frac{\rho}{1-\alpha}\right) f\left(v\left(T\right) - \frac{\rho}{1-\alpha}\right) - \left(r - \frac{\rho}{1-\alpha}\right) f\left(\left(r - \frac{\rho}{1-\alpha}\right)\right)$$

where $f\left(x\right) = -\exp\left(\frac{1-\alpha}{\alpha} xT\right) / \left(1 - \exp\left(\frac{1-\alpha}{\alpha} xT\right)\right)$

- Marginal cost of infrequent observation (RHS)
  - lost consumption through financing risk-free rather than risky between observations
  - increasing in equivalent rate differential between $v(T)$ and $r$
- Marginal benefit of infrequent observation (LHS)
  - higher certainty equivalent for higher observation interval
  - increasing in **certainty equivalent elasticity** $\partial v(T)/\partial \log(T)$
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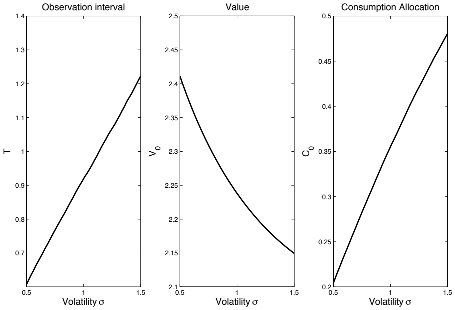
- **Certainty equivalent elasticity**
  - Independent of the drift
  - Typically decreasing in the observation interval
  - Non-trivial dependence to the shape of the return distribution

# Role of risk

Geometric brownian motion: $dX/X = gdt + \sigma dW_t$

$\rightarrow$ Optimal observation interval increasing in risk $\sigma$:

- Standard effect: equivalent rate of return $v(T)$ decreases. Can be compensated by higher average rate $g$
- **Information aversion effect**: less willingness to take on the information flow, higher elasticity $\partial v / \partial \log(T)$



# Predictions

- Observation interval decreasing in expected stock returns
- Observation interval increasing in volatility
  - Even when compensated by higher expected returns
  - "Scary information flow"
  - "Ostrich effect" (Karlson et al. 2009), follow-up paper on VIX level and inattention (Sicherman et al. 2014)
- More disappointment averse agent observe their portfolios less frequently
  - Alvarez et al. (2013): more risk averse agents check their accounts less often

- All else equal, in response to exogenous decrease in observation interval, increase in stock holdings
  - Driven by corner solution in asset holdings
  - Consistant with Beshears et al. (2012), also finding an increase in trading activity

# Plan

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2. Role of observation frequency

3. Consumption-savings decisions
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What if you can get $\frac{1}{2}X_t^{(1)} + \frac{1}{2}X_t^{(2)}$ rather than $X_t^{(1)}$?

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Work in progress:

- Role of background risk: risky portfolio can be decreasing in risk in presence of background risk
- Home/local bias: anchor on forced information flows vs diversification benefits

# More General Information Choices

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## More General Information Choices

- So far, limited to simple information structure: open or closed eyes
- With the help of machines or people, can better taylor the information flow
- **Result**: Simple "alarm" when the risky asset reaches some thresholds provides more utility
  - State-dependent trading rules do better than time-dependent rules, in contrast to fixed information cost (Abel et al. 2013)
- In practice:
  - Useful to have your broker send you an email following extreme performance, good or bad
  - Media reporting large events

# Information Intermediaries

- Other individuals can not only curate information, but also take actions for the agent
  - Portfolio managers, investment funds, ...
  - Optimal opaqueness: complex or illiquid securities hard to mark-to-market, ...
- Information sets differ $\Rightarrow$ need to appropriately incentivize the informed decision maker

# Plan

# Conclusion

**Information aversion**: a novel foundation for inattention

- Disappointment aversion creates information aversion, fear of repeated disappointment
- Without use of information agent always prefers to close her eyes
- More averse to flows:
  - about more risky outcome
  - with frequent small news than infrequent large news
  - about likely bad news than likely good news
- Simple way to summarize information aversion: certainty equivalent rate $v(T)$

More questions:

- Multi-asset decisions, background risk
- Delegated management
- Combined learning and frequency decisions
- Multiple agents

# Optimization problem

$$\max_{\{C_t, S_t, \tau_t\}} \mathcal{V}_0(\{C_t\}|\{\hat{\mathcal{F}}_t\})$$

s.t. $\hat{\mathcal{F}}_t = \mathcal{F}_{\tau_t}$

$\tau_t \leq t, \hat{\mathcal{F}}_t$-measurable, increasing, càdlàg

$dW_t = -C_t dt + S_t dX_t + r(W_t - S_t X_t)dt$

$(C_t, S_t)$ $\hat{\mathcal{F}}_t$-measurable

$W_0 = W, \ W_t \geq 0$

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