University of Zurich[UZH]

Agent-based Financial Economics
Lesson 6: Flow

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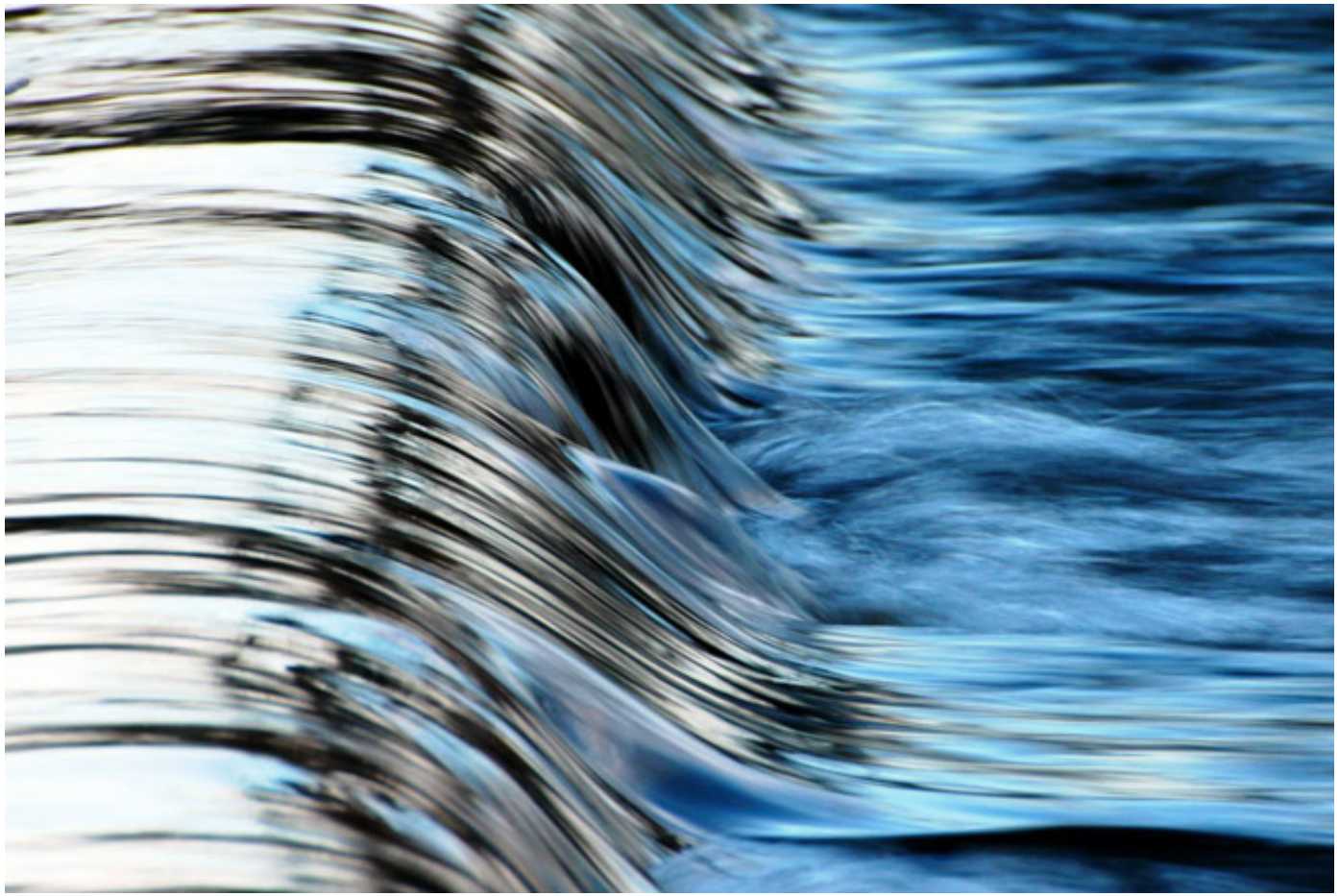
"What I cannot create, I do not understand."

- Richard Feynman

Today

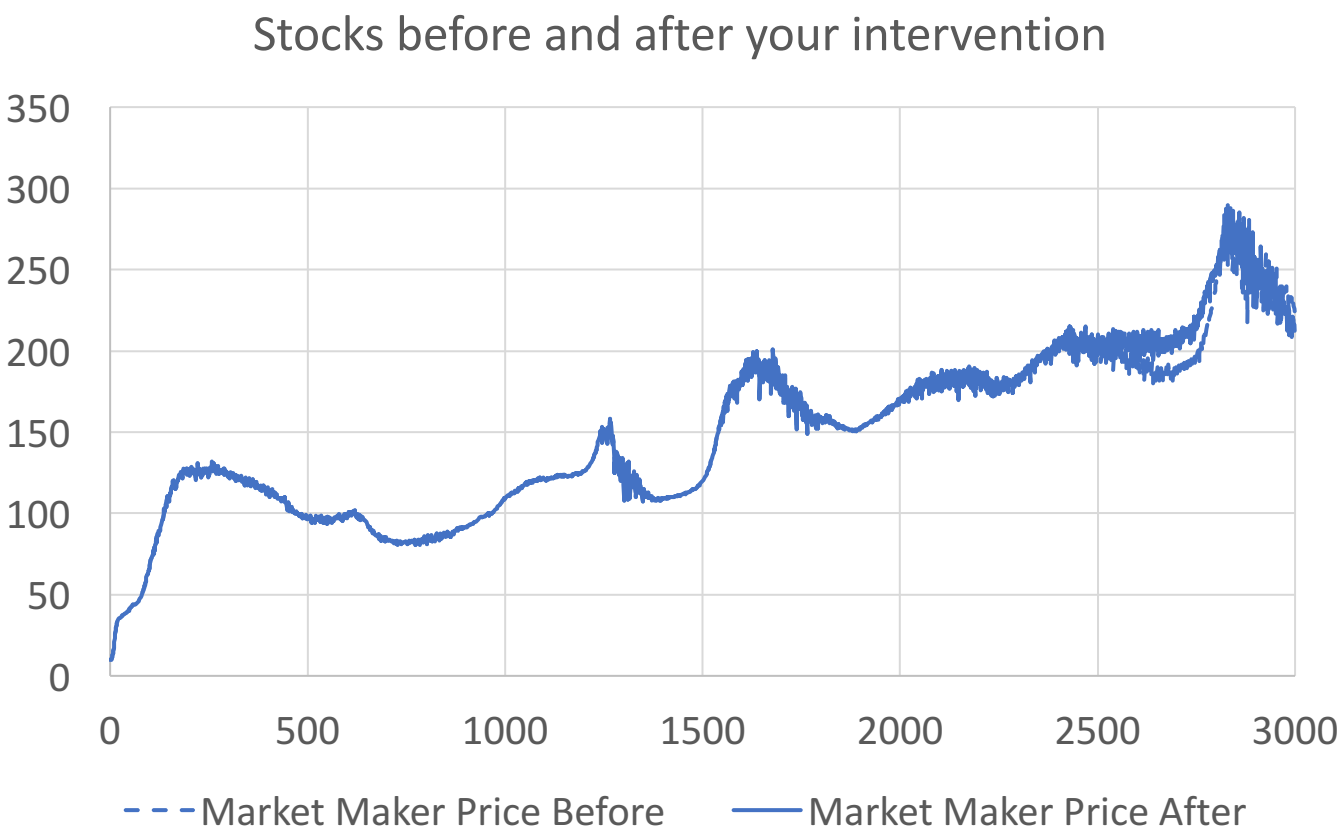


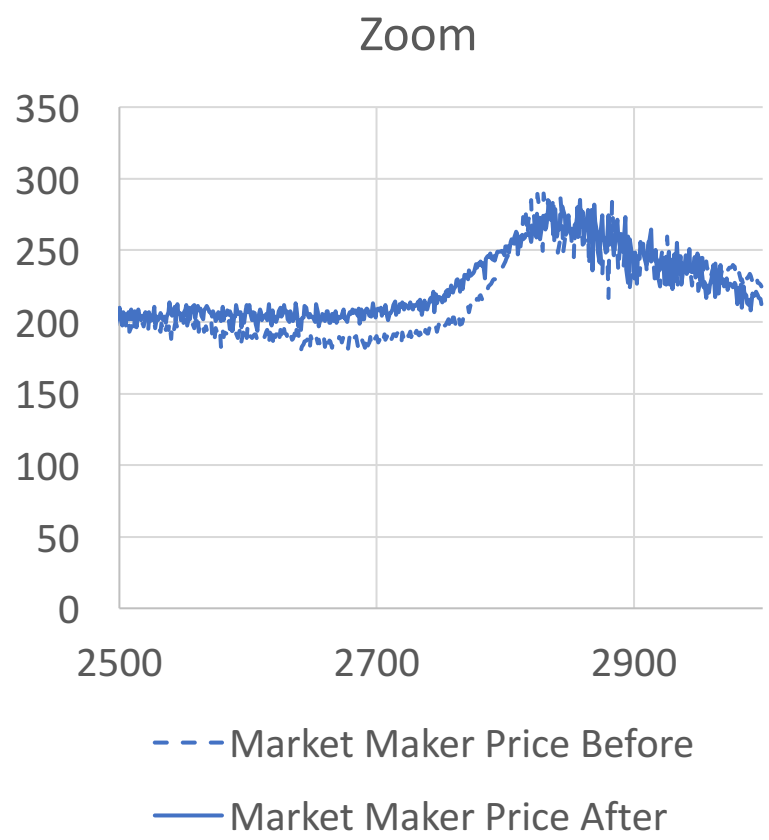
- Discussion of exercise 5
- Stock valuation
- Stock Flow Consistency
- The MOSES Model
- Exercise 6: Flow

Exercise 5 - Ranking

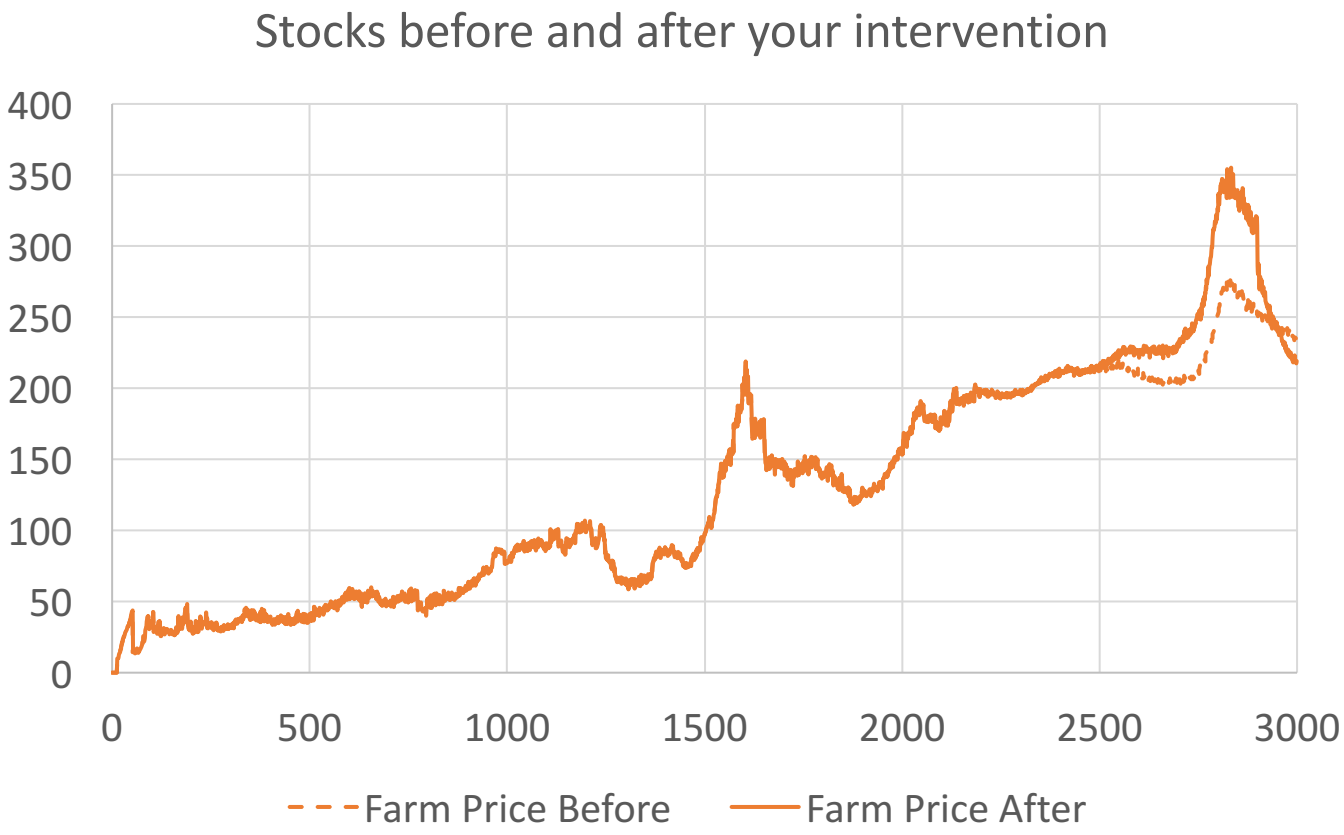
Rank	Agent	Utility	Source	Version
1	team010-Investor	7.929976499005746	source	Robin Stohler on 2017-10-26T18:21:45Z
2	team001-Investor	7.775414586259561	source	Harun on 2017-10-26T21:51:50Z
3	team007-Investor	7.358567736585804	source	Timothy Zemp on 2017-10-26T21:48:16Z
4	team003-Investor	7.118292148864874	source	DESKTOP-CRT5F4J\\Nico-PC on 2017-10-26T12:45:55Z
5	team005-Investor	6.704105391886587	source	julsto93 on 2017-10-26T12:55:06Z
6	team002-Investor	6.630688440921873	source	claude on 2017-10-26T18:12:39Z
7	course-InvestingConsumer	6.292591419976606	source	Luzius Meisser on 2017-10-26T08:21:29Z

Exercise 5 - Observations

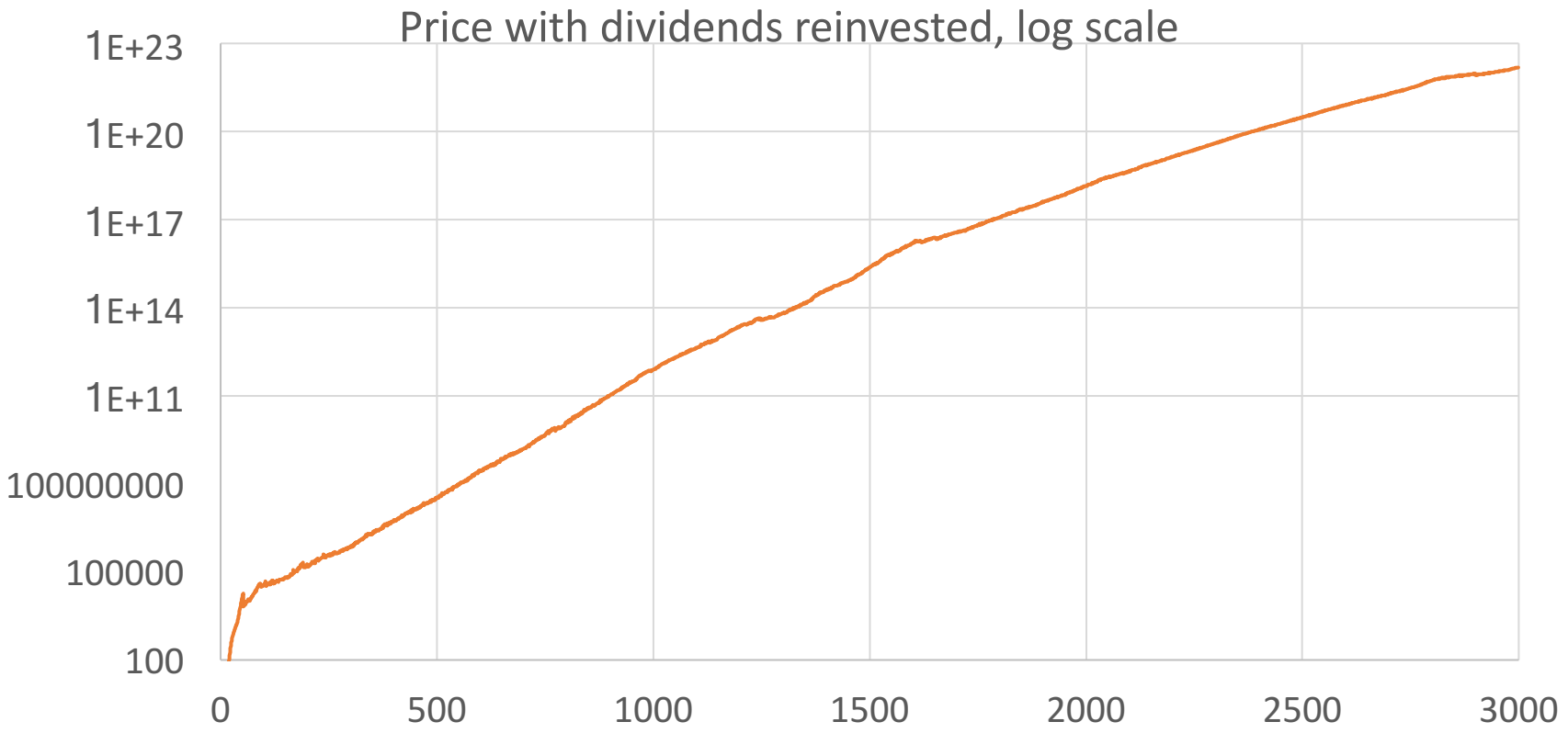




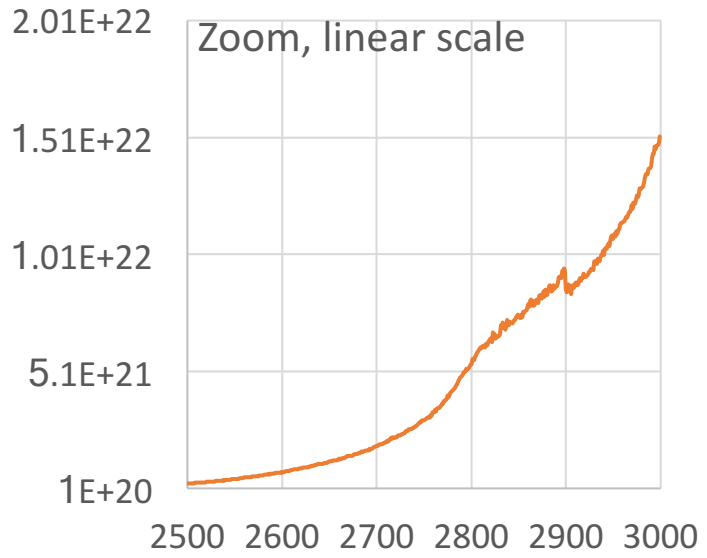
Exercise 5 - Observations



Exercise 5 – Farm total return

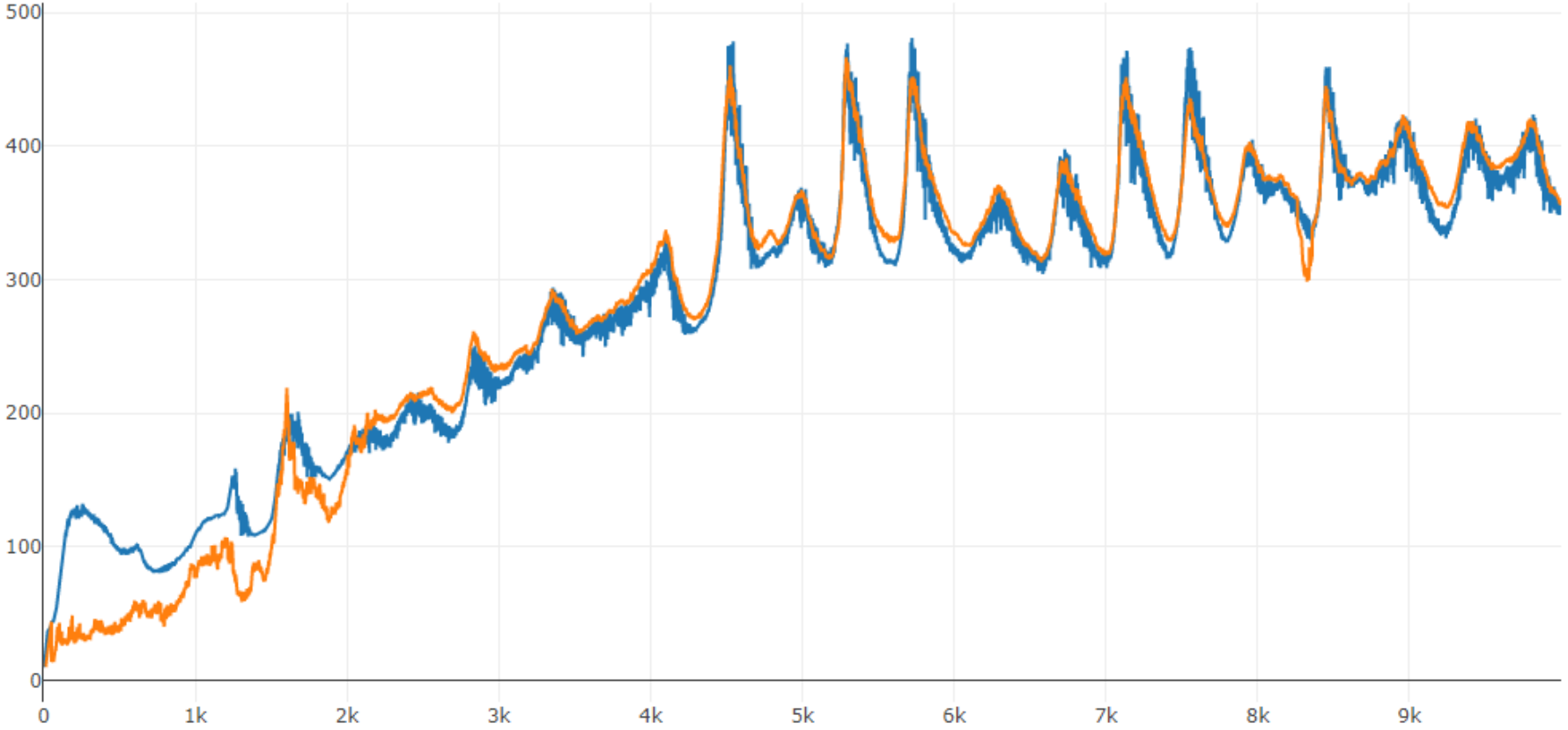


What would the return look like with dividends reinvested?



Exercise 5 – Where does it end?

Running the simulation for longer…

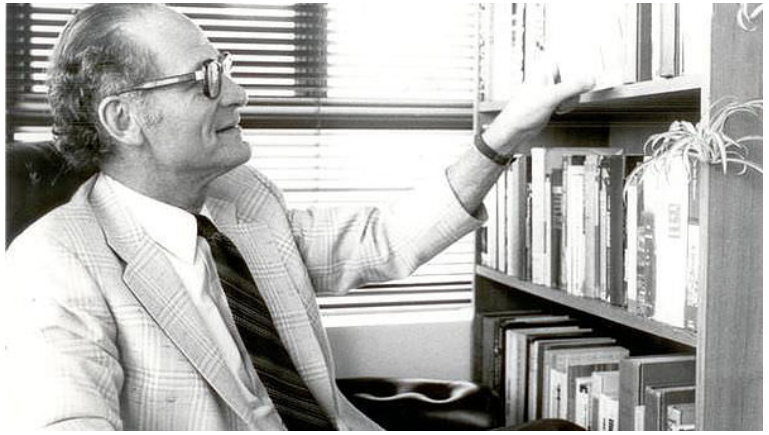


Seems to oscillate around 400 for both shares.

Dividend yield around 1% per day.

Stock Valuation - Gordon

Idea: calculate the net present value of the stock by summing all future discounted dividends. This leads to the Gordon growth formula:



Myron J. Gordon

base dividend | growth rate

$$V = \frac{D(1+g)}{1+r} + \frac{D(1+g)^2}{(1+r)^2} + \frac{D(1+g)^3}{(1+r)^3} + \dots = D \cdot \sum_{i=1}^{\infty} \left(\frac{(1+g)}{(1+r)}\right)^i$$

V: net present value; r: interest rate / discount rate

$$= D \cdot \frac{1}{1-\frac{1+g}{1+r}} = D \frac{1}{1+r-(1+g)} = \frac{D}{r-g} \quad \text{for } g < r,$$

using geometric sum; ∞ for $g \geq r$

Does this work in our model?
With a growth rate g=0, a price V=400 and dividends D=4, this implies a discount rate of 1% per day.

Stock Valuation - Gordon

What is the actual discount rate in our model?

- Is it 0% because agents do not discount the future for as long as they live?
- Is it 0.2% because that is the agent's mortality rate?

Either way, we do not get to the 1%.
(Even without knowing the Gordon growth formula, a dividend yield of 1% is way too high when agents discount the future with 0% or 0.2%.)

The Gordon growth formula is provably correct, so there must be something wrong with our simulation:

- Are the agents not behaving optimally?
  Yes, they could buy more stocks when they are young, as your agents do. But that does not help enough.
- So what is holding the agents back from investing more?
  As we will see later, it is because they lack of access to credit. If they could leverage their position, they would buy much more.

→ We will have a closer look at discount rates and leverage in one of the future lessons.

Stock Valuation - Flow

So what other method could be used to explain the observed price?

The law of supply and demand: the equilibrium price is where supply and demand are in balance.

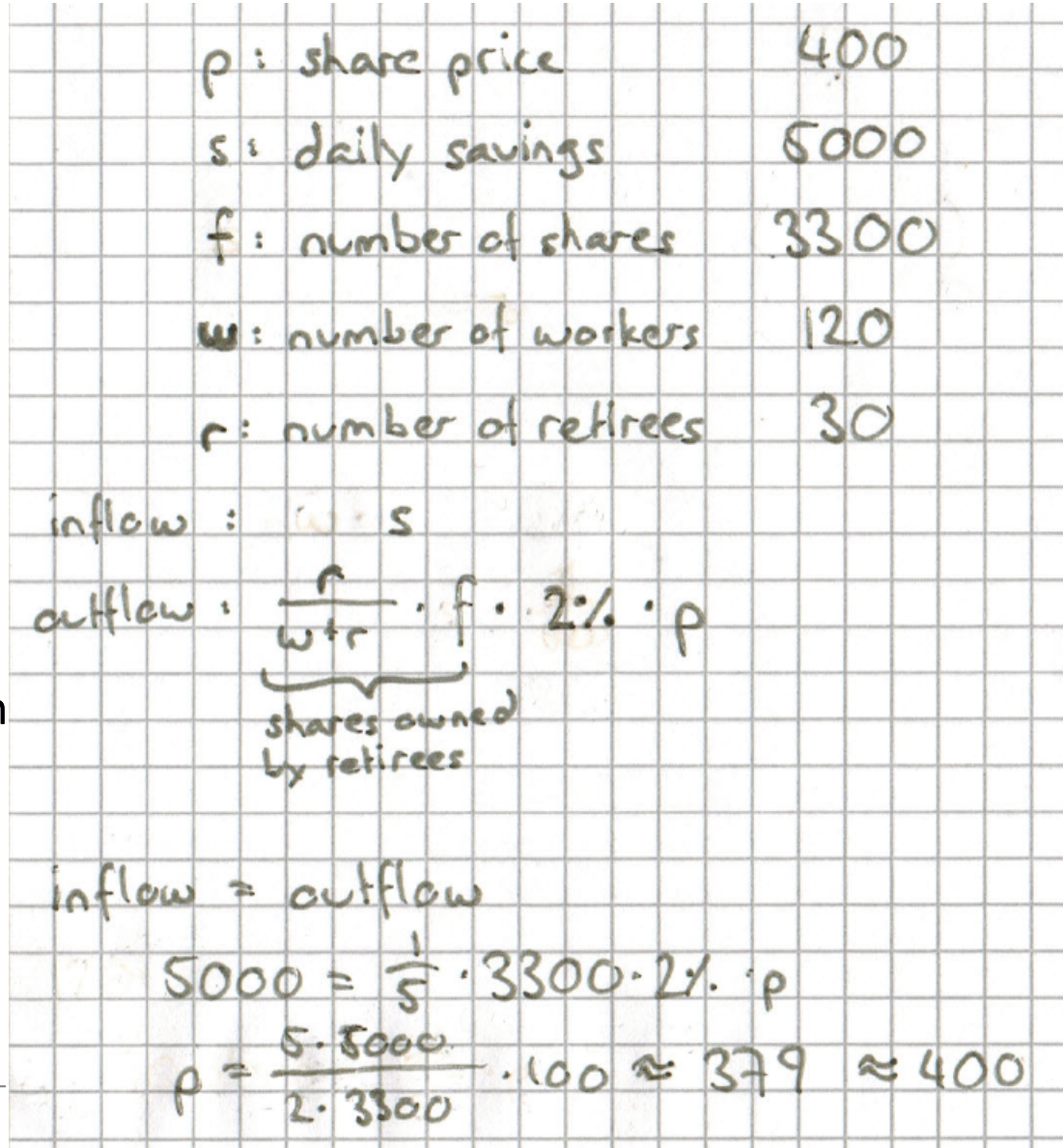
Inflow: the amount of money invested into stocks

Outflow: the number of shares sold multiplied by their price

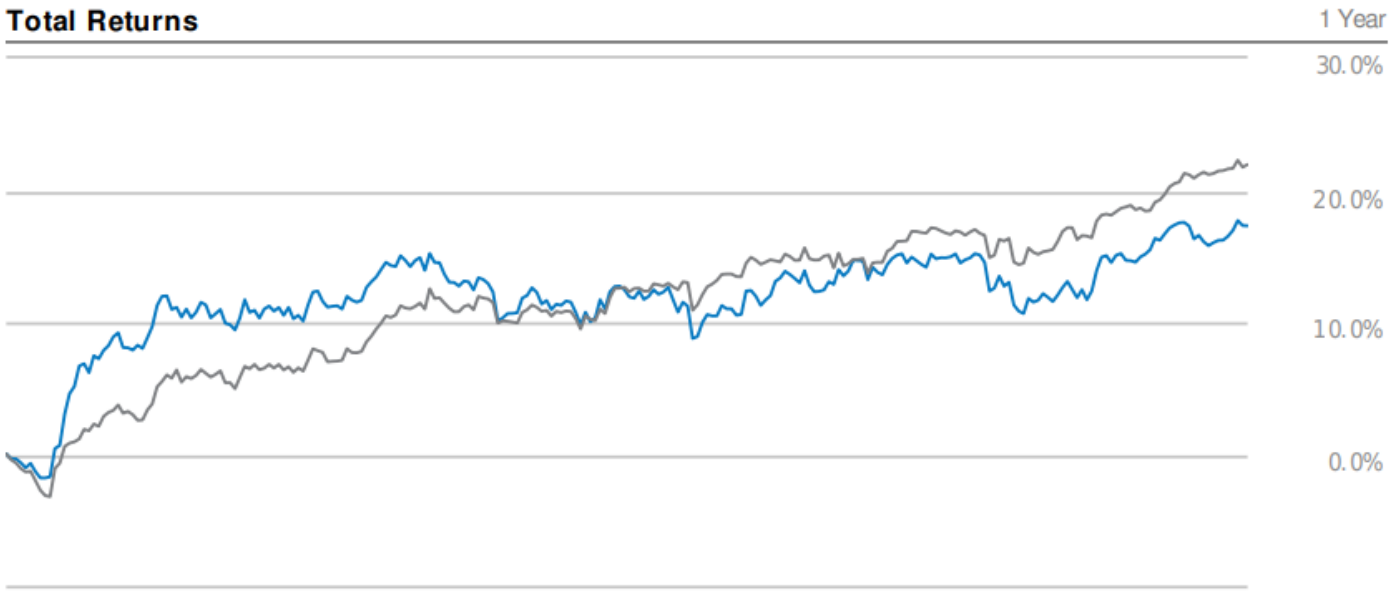
Equilibrium: inflow = outflow

Seems to work pretty good at explaining the observed prices in the simulation.

→ Next exercise: Can inflow and outflow also explain price movements?



Could you use this for investing?



performance	1 Month	3 Month	YTD	1 Year	3 Years	5 Years	10 Years
TTFS	--	--	--	--	--	--	--
TTFS	2.05%	2.76%	7.23%	17.31%	10.52%	16.09%	--
No Underlying Index	--	--	--	--	--	--	--
MSCI USA Investable Markets_net	2.78%	4.46%	16.22%	21.96%	11.55%	15.17%	7.97%

The Trimtabs Flow Shrink ETF (TTFS) by Charles Biderman tries that.
It buys stocks of firms that have announced to buy back their own shares, so there is a known “inflow”.

Does not seem to outperform index.

List of stock valuation metrics

- Dividend yield
- Gordon's formula: includes growth
- P/E-ratio (price/earnings)
  Captures the value of firms that reinvest profits instead of paying a dividend
- Praktikermethode:
  1/3 Substanzwert + 2/3 Ertragswert
  Used by Swiss tax authorities.
- Sharpe-ratio: adjusts returns for risks
- Many many others…

Shiller P/E Ratio

Exercise 5 – Stock Picking

Two ways to improve the utility of the agent:

1. Buy stocks with high dividend yield
2. Buy more stocks, i.e. save more

→ Looking at the code of the best performing teams.

Reinvesting dividends – good enough

```java
public void managePortfolio(IStockMarket stocks) {
    boolean retired = isRetired();
    if (retired) {
        int daysLeft = getMaxAge() - getAge() + 1;
        double proceeds = getPortfolio().sell(stocks, this, 1.0d / daysLeft);
        listeners.notifyDivested(this, proceeds); // notify listeners for inflow / outflow statistics
    } else {
        double dividends = getPortfolio().getLatestDividendIncome();
        double workFraction = 1.0d / getMaxAge() * getRetirementAge(); // 80%
        double retirementFraction = 1 - workFraction; // 20%
        double toInvest = (getDailySpendings() - dividends) / workFraction * retirementFraction + dividends;
        double actualInvestment = getPortfolio().invest(strategy, stocks, this, toInvest);
        listeners.notifyInvested(this, actualInvestment); // notify listeners for inflow / outflow statistics
    }
}
```

Improves utility from 6.390 to 6.694.

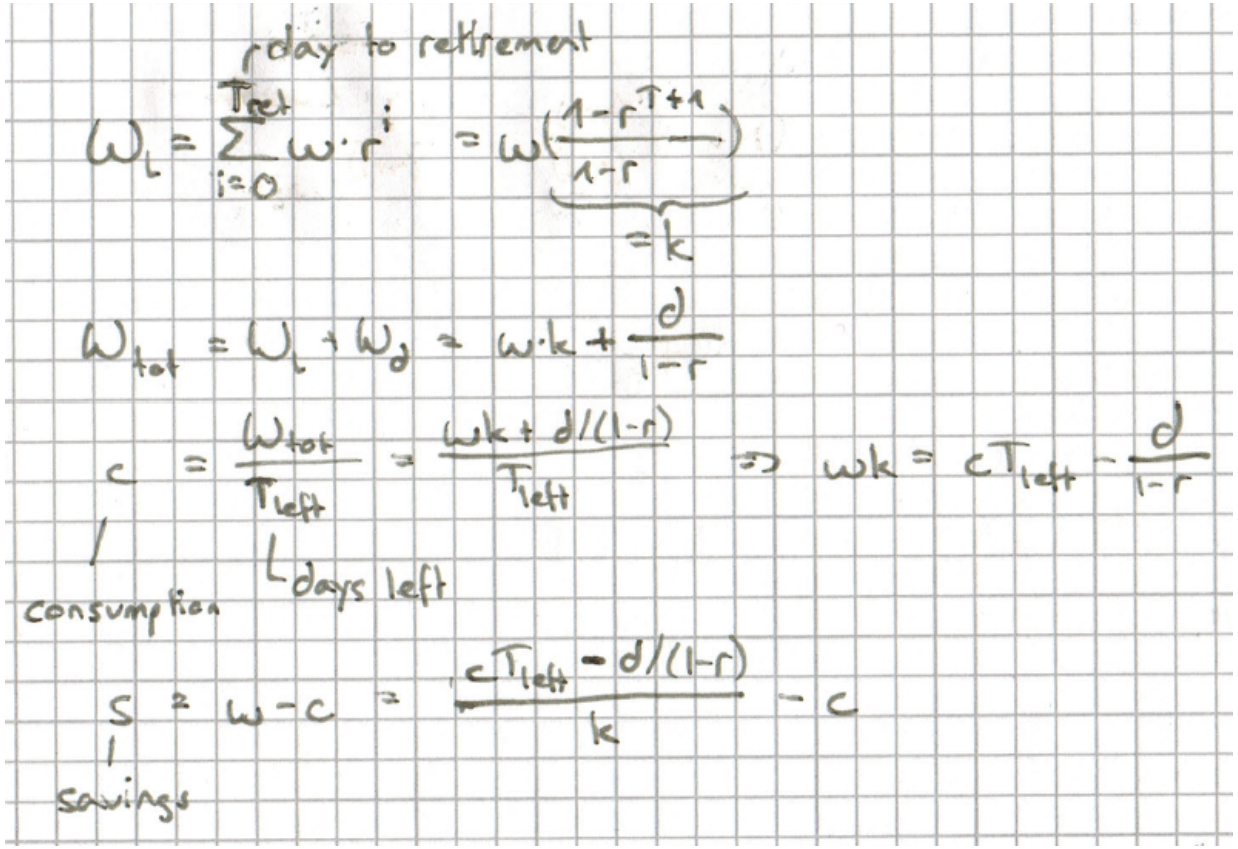
Reinvesting dividends – optimal rule

To behave optimally, the agent should spend an equal share of his life-time wealth W_tot every day.

We use the dividend yield to derive the right discount rate, because that's how much we get from saving. Here, Gordon works. We disregard capital gains.

Dividend yield farm: 1%
→ Discount rate r = 0.99

Improves utility from 6.694 to 7.060.

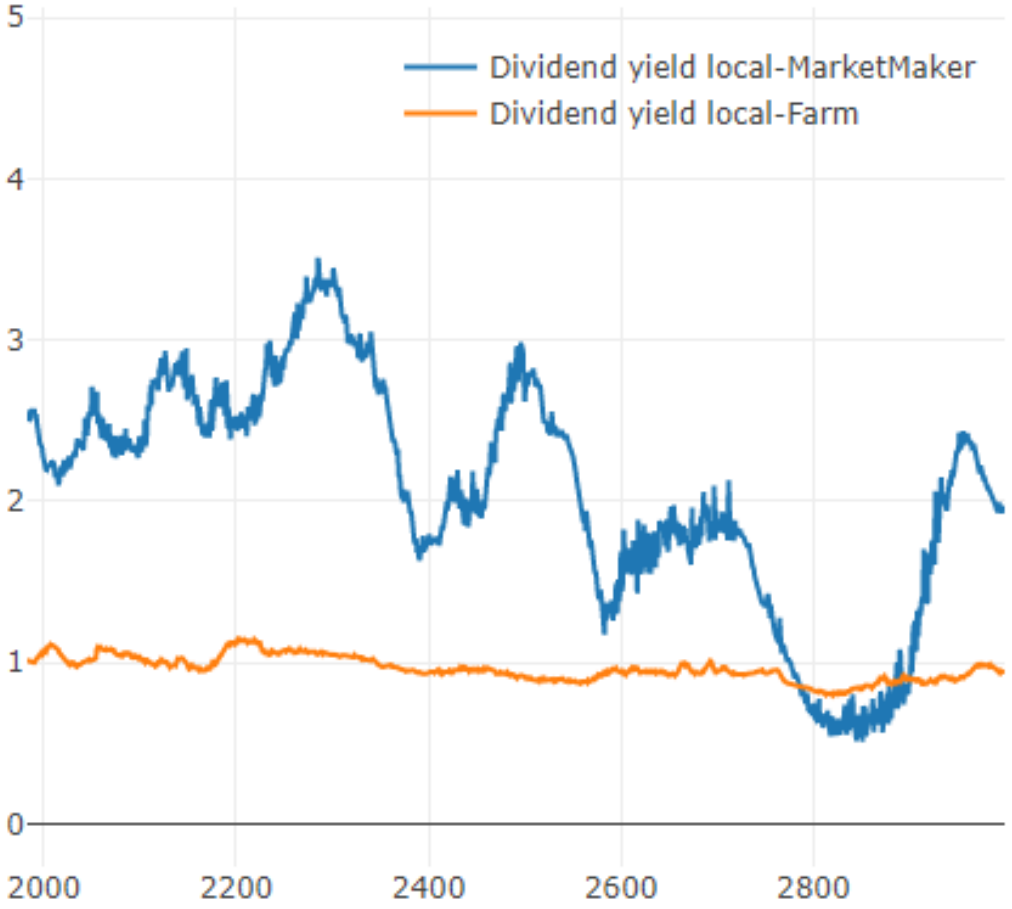


Stock picking

Observe that dividend yields of market makers are much better than those of farms.

→ Only buy market maker stocks. Utility jumps to 7.648.

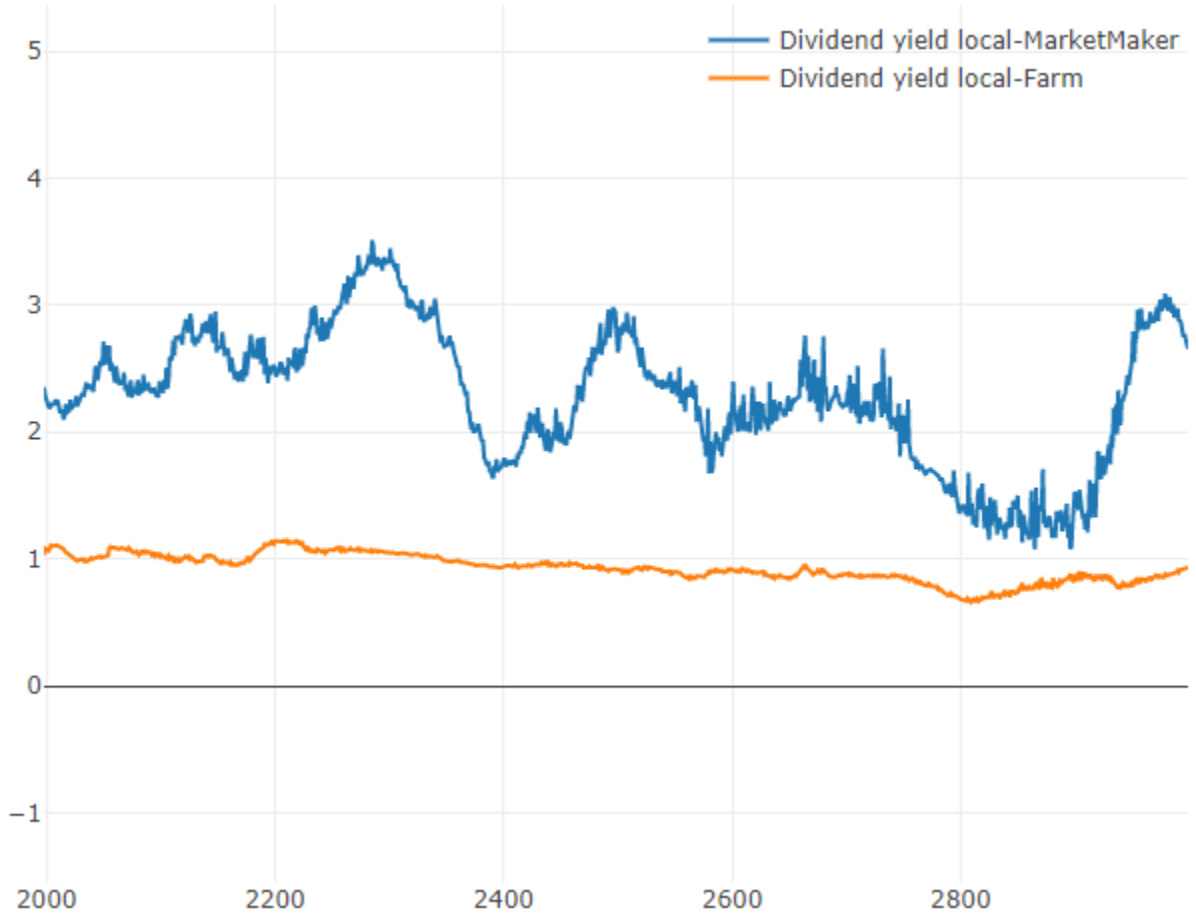
Um… but our buying spree seems to have pushed up the stock price and thereby suppressed dividend yields.



Stock picking

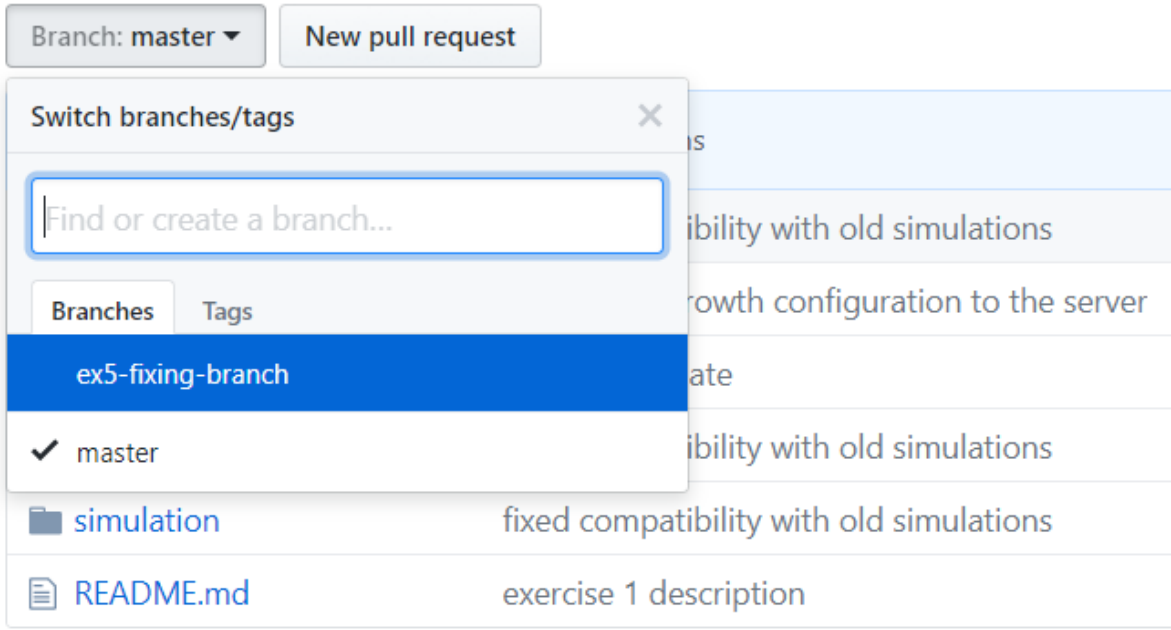
And this finally brings us to 8.077 (when running without other competing agents).

```
public Ticker findStockToBuy(IStockMarket stocks) {
    Collection<Ticker> listedStocks = stocks.getTradedStocks();
    Ticker best = null;
    double bestYield = 0.0;
    for (Ticker ticker: listedStocks) {
        Ask ask = stocks.getAsk(ticker);
        if (ask != null) {
            double price = ask.getPrice().getPrice();
            FirmFinancials fin = stocks.getFirmData(ticker);
            double div = fin.getDailyDividendPerShare();
            double dividendYield = div / price;
            if (dividendYield > bestYield) {
                best = ticker;
                bestYield = dividendYield;
            }
        }
    }
    return best;
}
```



Exercise 5 – Solution Branch

- All the discussed code can be found in a separate branch “ex5-fixing-branch” in the git repository
- The “what if everyone does it?” scenario discussed next is tagged “ex5-market-maker-chaos”
- github.com/meisser/course/tree/ex5-fixing-branch
- meissereconomics.com/vis/simulation?sim=ex5-market-maker-chaos



What if everyone does it?

Unfortunately, I can't tell in this basic simulation as population growth is not deterministic enough in the current version. But let's do it in a slightly different configuration with deterministic growth.

First, here is the ranking as usual with a single Investor agent born on day 2499:

1	local-Investor	8.700978723666449	source	local version Thu Oct 26 17:17:27 CEST 2017
2	local-InvestingConsumer	6.311796867926084	source	local version Thu Oct 26 17:17:25 CEST 2017

And that's what happens when every agent born after day 2000 is an Investor with the good strategy?

1	local-InvestingConsumer	6.3842821315008464	source	local version Thu Oct 26 17:18:41 CEST 2017
2	local-Investor	5.92297682886852	source	local version Thu Oct 26 17:18:57 CEST 2017

What is going on here? Isn't that strategy supposed to be better?

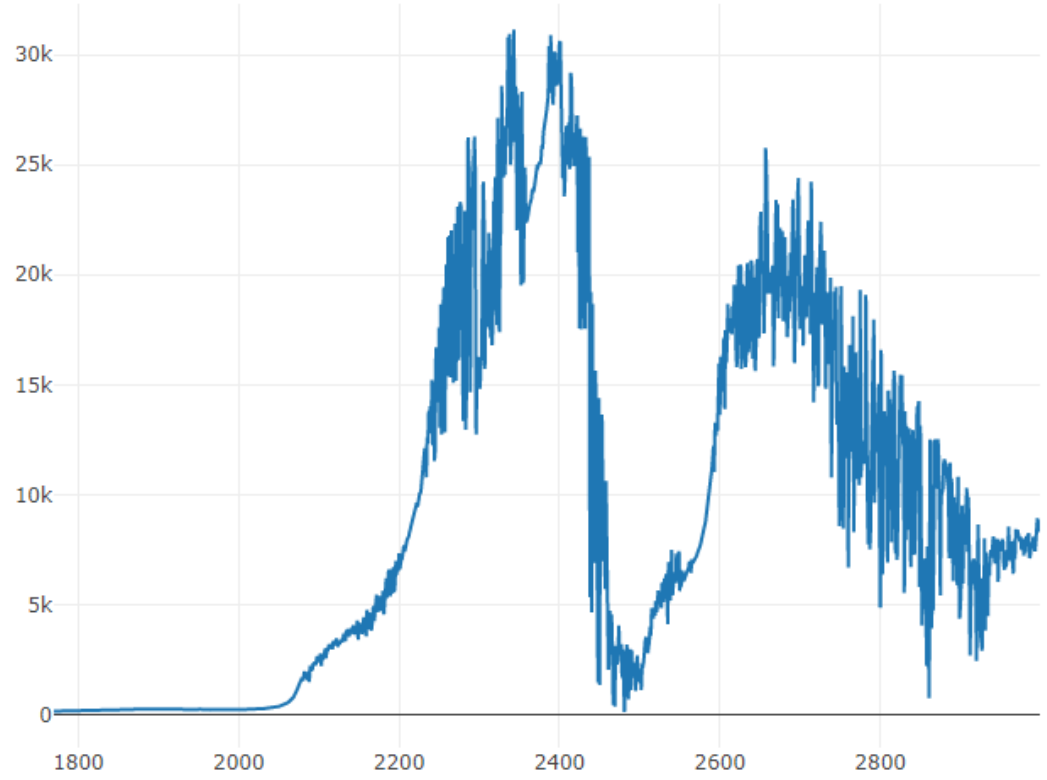
What if everyone does it?

What went wrong?

How could it come to such a bubble?

Market maker stock price goes from 200 to 30’000, and back down again.

Why do our “value investors” that only look at dividend yield invest in such an overpriced stock?

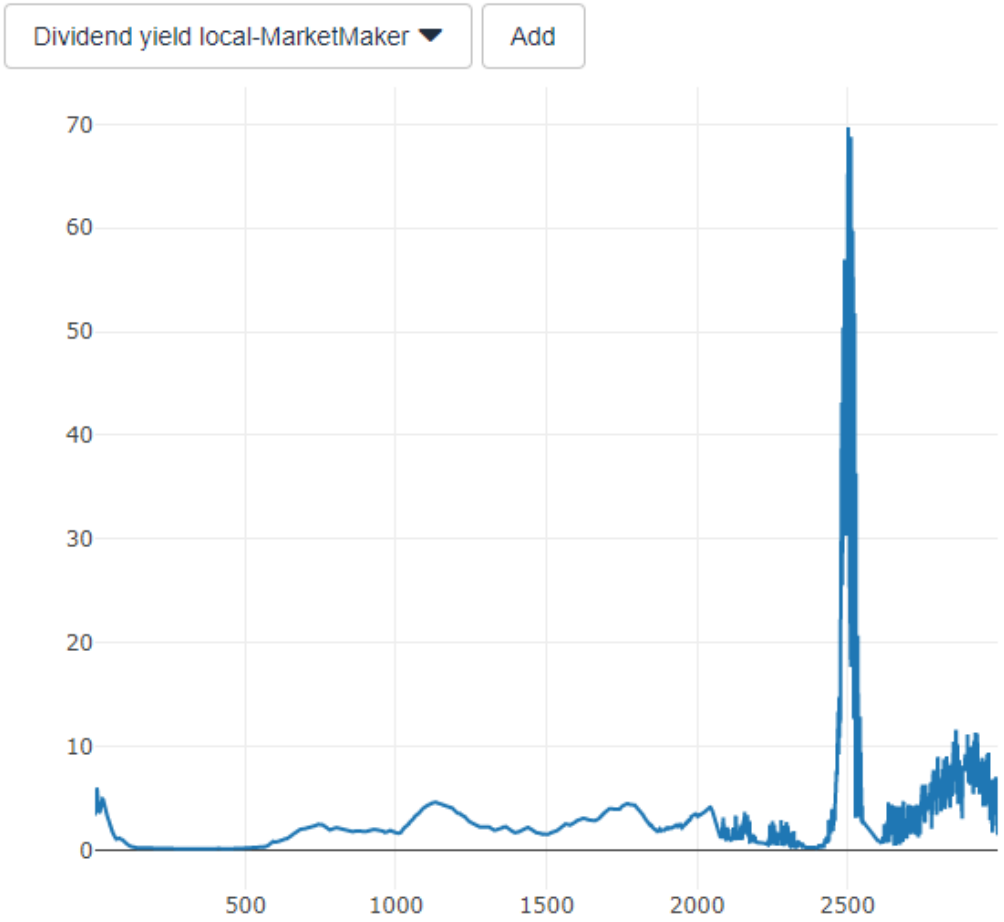


What if everyone does it?

They invest because the dividend yield actually is that high! The high prices are justified under the assumption that the dividend yield stays constant.

Which it does not. ☺

But why is the dividend yield spiking?

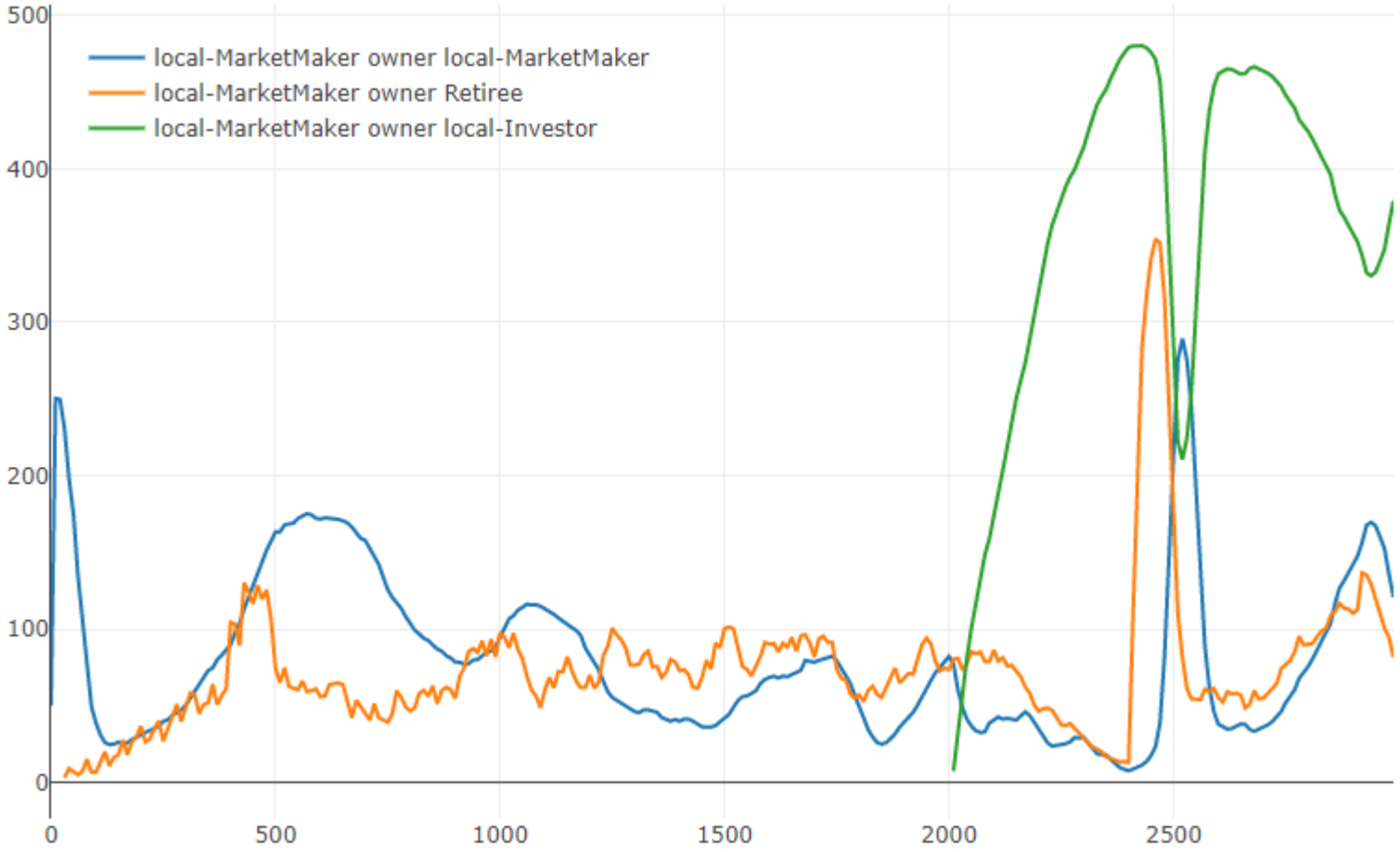


What if everyone does it?

When the first Investor agents were born on day 2000, they started buying as much market maker stocks as they could, because that's where they got the best yield.

And when they retired, they dumped it all on the market, ending up in the hands of the market makers themselves due to a lack of buyers.

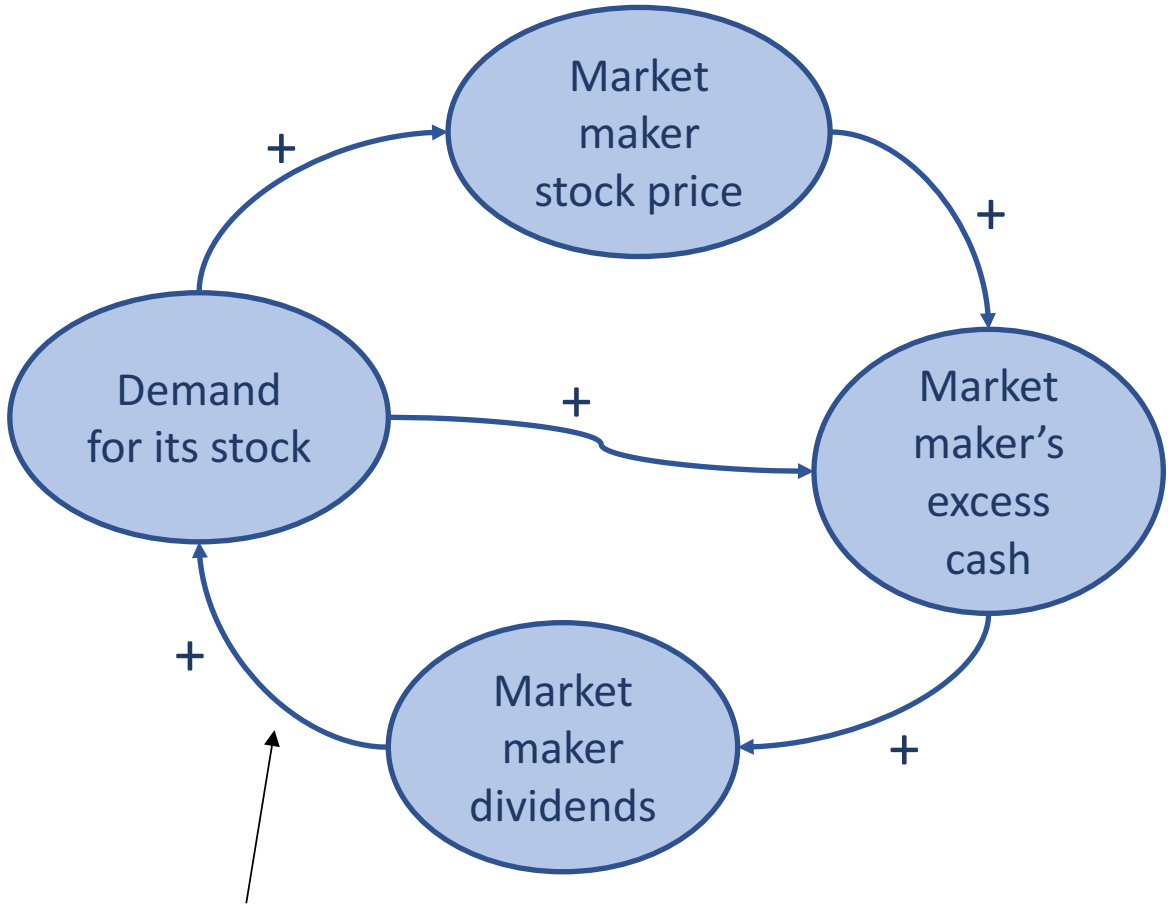
When the young agents started buying these shares again, the market makers suddenly had too much cash, paying it out as a not so sustainable but very high dividend…



What if everyone does it?

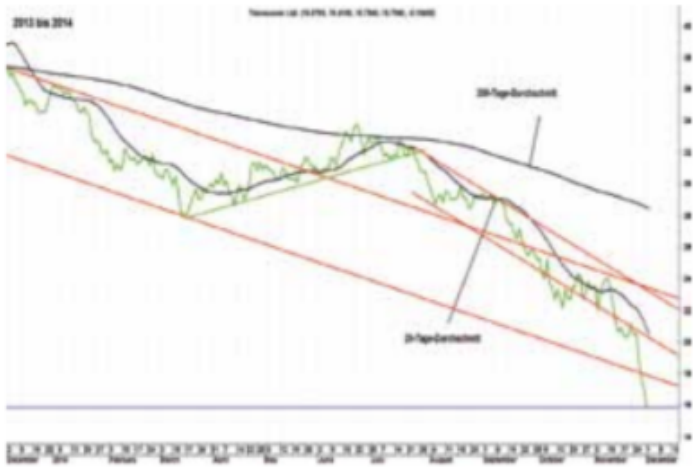
Learnings:

- Seemingly innocuous changes (using a better investment strategy) can have completely unexpected consequences in complex systems.
- I improved the market maker agent, it now operates with much tighter spreads and does not earn such excessive amounts any more.
- When investing, one should be aware of the underlying assumptions, i.e. here that dividends will never decrease. Real-world example of a stock that looked attractive on paper in 2014, but that still tanked: Transocean



Introducing the dividend-yield based strategy introduced this link, closing the self-reinforcing feedback loop.

Transocean | ISIN CH0048265513 | CHF 19.40 **Kaufen**



KGV14: 5.7
Branche: Versorger/Rohst.

Risiko gemäss Silicon Analyst: Sehr Hoch
Marktkapitalisierung: CHF 7.2 Mrd.
Anlagehorizont: 6 bis 12 Monate

Transocean wird in Sippenhaft genommen

Unsere spekulative Kaufempfehlung für Transocean hat sich als Rohrkrepierer entpuppt. Zwar hat sich der Ölpreis mittlerweile im Bereich um USD 80 pro Fass wie erwartet stabilisiert, für die Aktie von Transocean ging es jedoch steil bergab. Seit Jahresanfang hat das Papier gut 47% an Wert verloren, wobei sich der Baisse zuletzt nochmals beschleunigte. Zwischen dem 10.11. bis zum 27.11. sackte der Kurs um fast 20% ab. Wir halten die erlebten Kursabschläge in dieser Höhe für eine Marktübertreibung, zumal die Papiere von Transocean in Sippenhaft genommen wurden, nachdem der amerikanische Konkurrent Seadrill die Dividendenzahlungen einstellte. Auch bei Transocean kursieren nach den milliardenschweren Wertberechtigungen Gerüchte über eine Dividendenkürzung oder sogar einer Kapitalerhöhung. Darüber hinaus wird immer wieder darüber diskutiert, ob Grossaktionäre Carl Icahn dem Unternehmen seine Treue entzieht und zumindest Teile seines Aktienengagements auf den Markt wirft. Wir halten die Aktie des in Zug ansässigen Ölserviceunternehmens für massiv unterbewertet: Das Papier wird derzeit mit einem 12-Monats-KGV von gerade noch 5.4 gehandelt. Selbst bei einer schlechtmöglichsten Geschäftsentwicklung im kommenden Jahr erscheint uns dieses Bewertungsniveau als nicht gerechtfertigt. Entsprechend halten wir an unserer ursprünglichen Empfehlung fest und raten weiter zum spekulativen Positionsaufbau.

Konklusion:
Wir halten das Transocean-Papier mit einem KGV von gerade 5.4 für massiv unterbewertet. Der Kursrutsch der letzten Wochen erscheint uns masslos übertrieben.

The “Schweizer Börsenbrief» from 15.12.2014 falls into a «value trap» and recommends to buy Transocean at CHF 20.

ZKB already did the same in summer when it was at 40 CHF.

Today, the stock trades at 10 CHF.

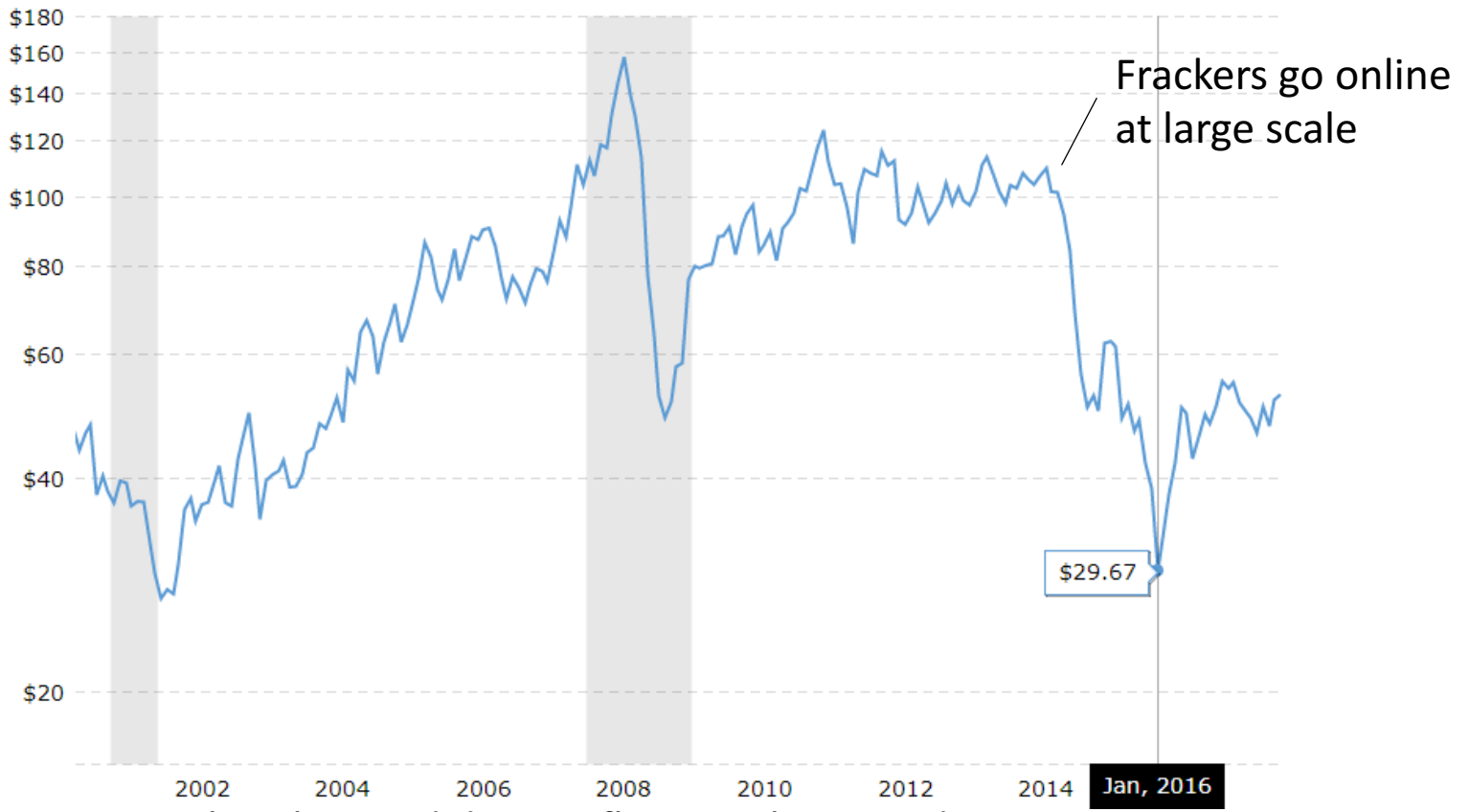
Problem: earnings declined and dividends went to zero.

Sidenote: this is my favorite “analyst” at the moment: ” www.backstagenews.de (in German)

Oil price

What happened to Transocean?

Transocean is profitable for oil prices above roughly 50$ (wild guess). Story was “Peak oil”: oil will get more and more scarce, thus prices can only go up, including the price of Transocean stocks.



Interestingly, oil price did not reflect Fracking in advance.
Was the spot market inefficient?
No: Why selling oil at a cheap price if people need it now?

Stock-Flow Consistent Modelling

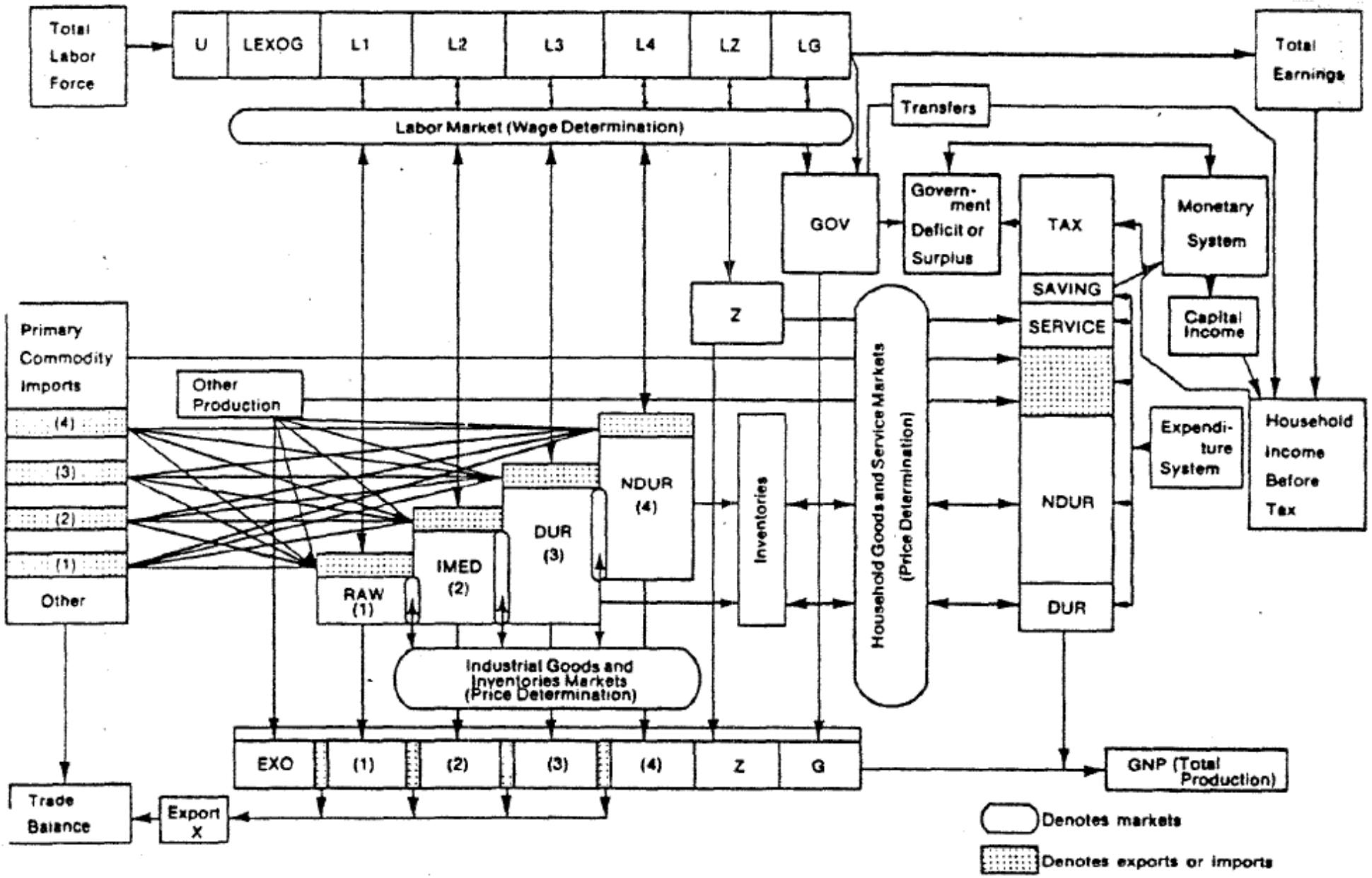
- Stock as in “stockpile” or “inventory”
- Flow: flow of goods and money
- Often, economic models do not keep track of stocks and flows, at least not explicitly
- Stock-flow consistent models explicitely do so
- Our model is stock-flow consistent. Nothing can appear or disappear out of the blue unless we specifically say so.
- Many financial agent-based models are not. For example: the seminal model of Lux and Marchesi from “Scaling and criticality in a stochastic multi-agent model of a financial market” is not, as it contains “noise traders” that never go bankrupt.

The MOSES model by Eliasson

- Model of Swedish economic studies
- Built an agent-based model of Sweden in the 80ies
- Consumers modeled in aggregate
- Large firms modeled individually
- Asked managers about how they decide and used these answers to model firm behavior
- Used to advise government on decisions such as “should Sweden build the Gripen?”, “should Sweden bailout its shipping industry?”, etc.

Gunnar Eliasson, author of MOSES model, as described in “THE MOSES MODEL Database and Applications”, 1989

Figure II:1 Macro Delivery and Income Determination Structure of Swedish Model



The MOSES model by Eliasson

Outputs look similarly chaotic as ours. ☺

But we have much better computers now, can model much larger and more complex models with much nicer, automatically generated charts.

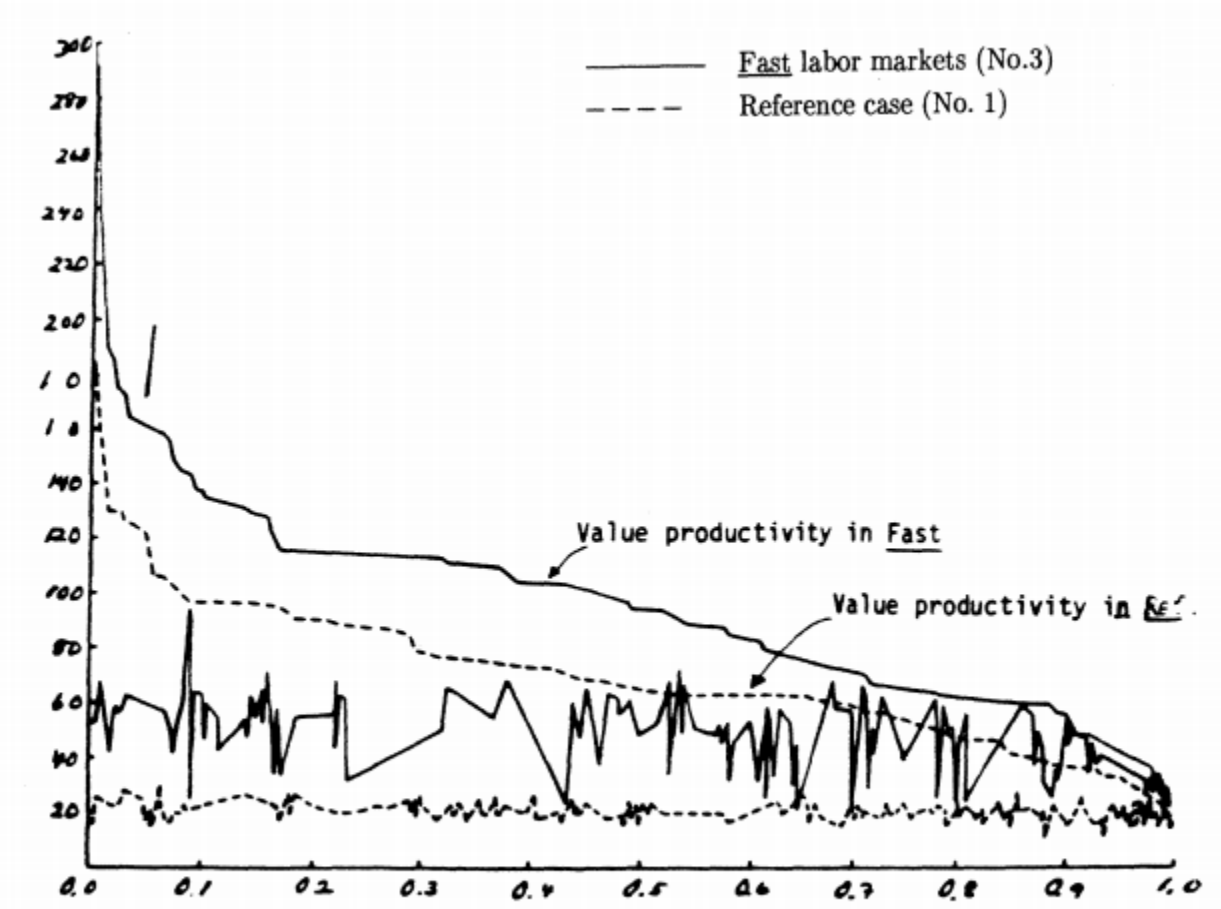


Figure 4 Wage cost and value productivity distributions 1992 in reference case and in fast market experiment

Exercise 6 – Inflow vs Outflow

See exercise 6 on github: