Deep Learning in Asset Pricing

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Overview

1. Basic Conception
   - Stochastic Discount Factor
2. Models
   - Neural Networks: SGD, LSTM, GAN
3. Backtesting Results

Basic Conception

Stochastic Discount Factor in Asset Pricing

- What is the Stochastic Discount Factor(SDF)?
- Implementation in finance area: By No-Arbitrage Pricing Theory, Stochastic Discount Factor(SDF) explains why the different expected returns come from different assets

Challenges:

- SDF includes all avaliable economic information
- The function form of SDF is unknown and complicated
- SDF needs to capture time-variation in economic conditions
- Risk premium in stock return has a low signal-to-noise ratio

Basic Conception

Goals of this project

- Using deep neural networks to estimate SDF function, generate non-linear pricing model, and construct a optimal portfolio

Contribution

- Empirically outperforms all benchmark models
- Optimal portfolio has out-of-sample Sharp ratio of XXXX
- Take into account non-linearities and interaction between firm information
- Most relevant firm characteristics are price trends, profitability, and capital structure variables.

Models

- Fundamental no-arbitrage condition:

$$E\left[M_{t+1}R^e_{t+1,i}\hat{I}_{i,t}\right] = 0$$

- For a set of conditioning varibales$\hat{I}_{i,t} = \hat{g}(I_t, I_{i,t})$, the approach is to minimizes the corresponding loss function:

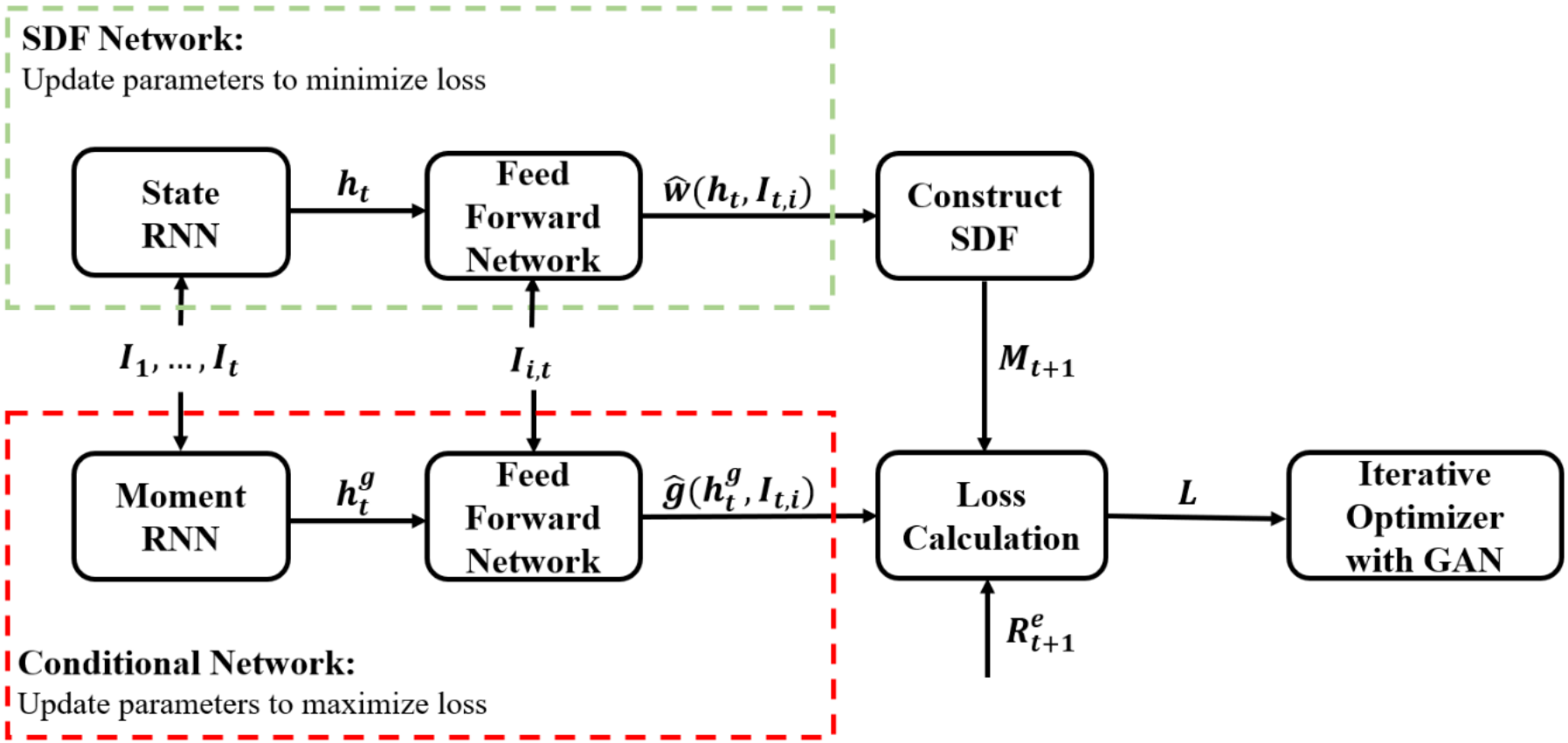
$$\min_{\omega}\max_{g}\frac{1}{N}\sum_{j=1}^{N}\left\|\mathbb{E}\left[\left(1-\sum_{i=1}^{N}\omega\left(I_t, I_{t,i}\right)R^e_{t+1,i}\right)R^e_{t+1,j}g\left(I_t, I_{t,j}\right)\right]\right\|^2$$

- Create SDF network for the SDF M_{t+1}
- Generate conditional network(FFN) for conditioning variableS$\hat{I}_{i,t}$
- Implement Generative Adversarial Network(GAN) to minimize loss function

Models

Model Architecture:

architecture.png

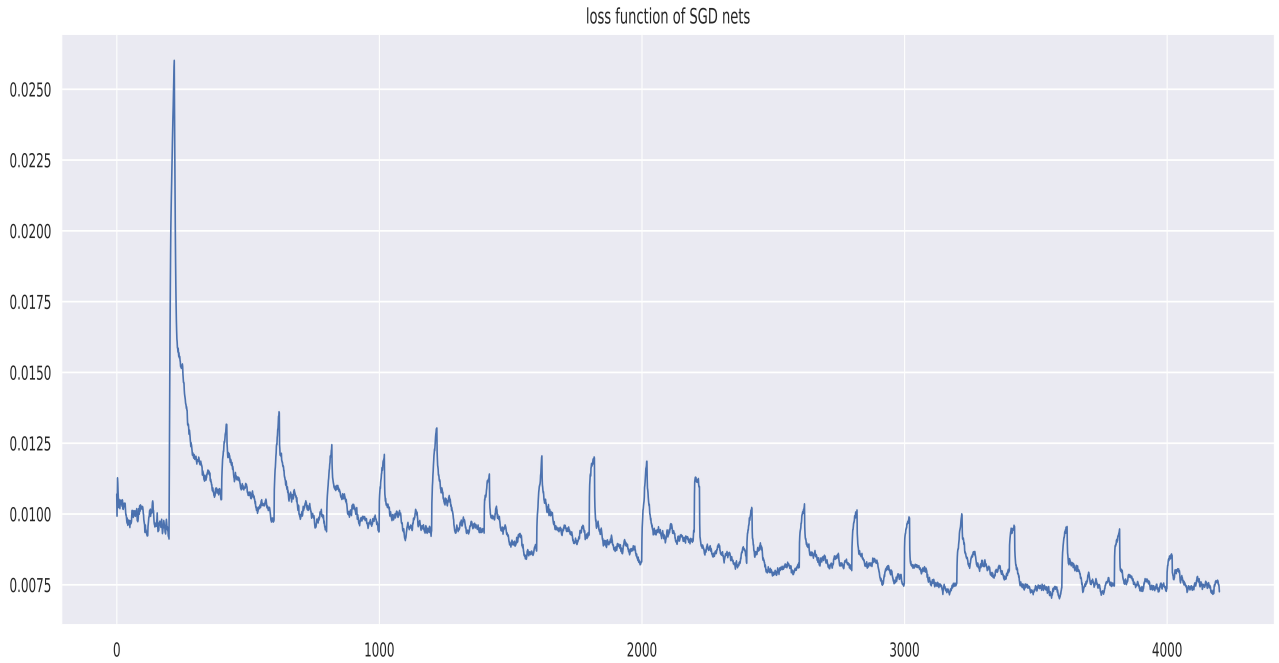


Data

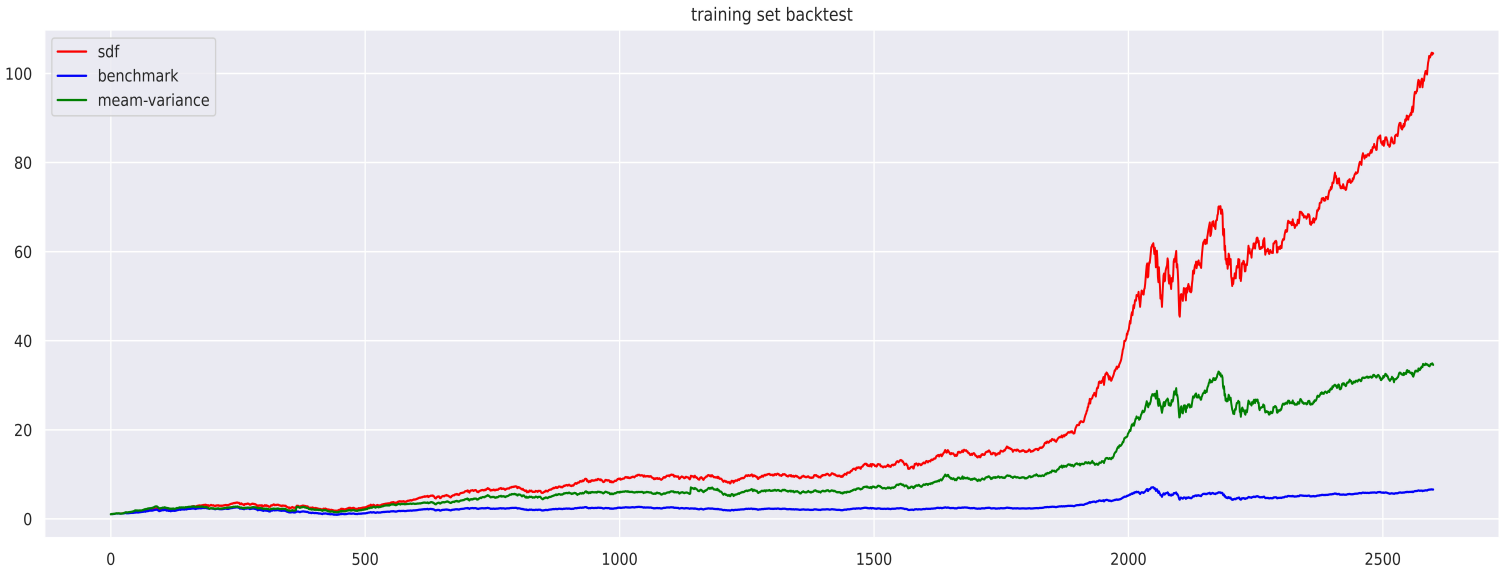
Macro_data		Micro_data	
GDP		**Valuation**	P/S、P/E
Industry	CPI、RPI、PPI	**Risk**	Beta
Import and Export		**Profitability**	ROA、ROE
Consumption		**Revenue quality**	Operating income
Investment		**Capital Structure**	Debt Asset ratio
Rate & Monetary	M0、Exchange Rate、Loan Rate	**Solvency**	Operating profit/Liability
Fiscal	Fiscal Revenue & Fiscal Expenditure	**Operating Capacity**	Total Assets Turnover
Employment & Salary	Employment rate、Average Salary Level	**Cash Flow**	FCFF

From Wind database, acquire macroeconomic data and firm-specific data since 20070101 up to now. Re-sample and normalize to construct input for our model.

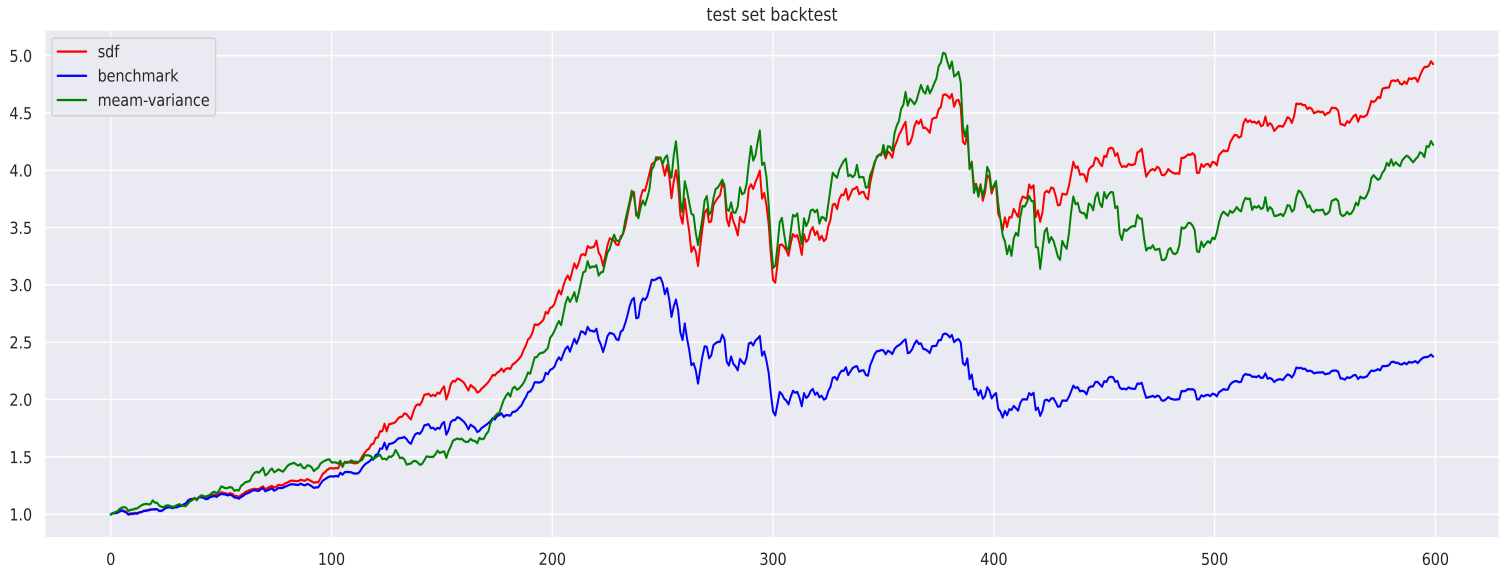
Backtesting Results



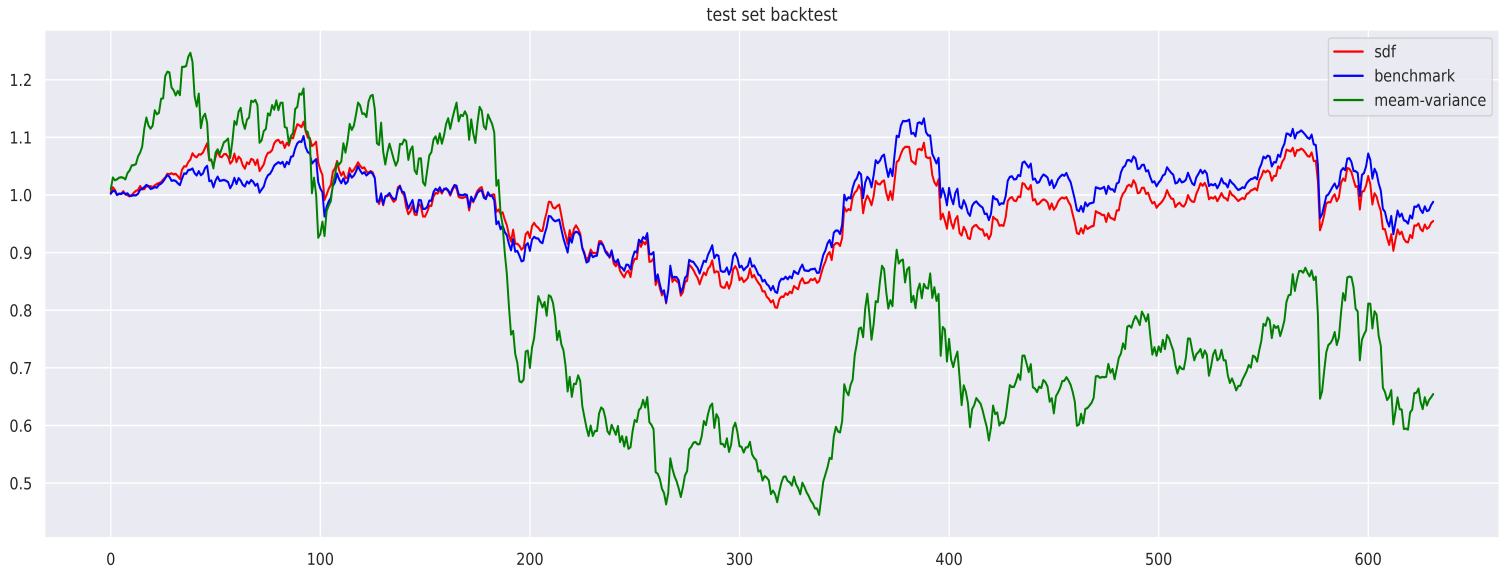
Backtesting Results



Backtesting Results



Backtesting Results



Backtesting Results

	Train	Va1	Testing
Benchmark	0.801714	1.354198	0.080040
MV	1.336177	1.929056	-0.093803
GAN	1.801015	2.458797	0.15558

Table: Result

References

Luyang Chen, Markus Pelger, Jason Zhu (2019)

Deep Learning in Asset Pricing(December 4, 2019), Stanford University

Available at SSRN: https://ssrn.com/abstract=3350138 or http://dx.doi.org/10.2139/ssrn.3350138

Conclusion

Thanks for listening