PREDICTING INVESTOR BEHAVIOUR IN EUROPEAN BOND MARKETS

A Machine Learning Approach

Martin Hillebrand, joint work with Bastien Winant, Marko Mravlak, Peter Schwendner
Zurich, 5 September 2019
What is the European Rescue and Stability Framework?

The Euro Area rescue framework consists of mainly two institutions: EFSF and ESM.

Together they have lent 264.5 billion euros to five countries: Greece, Spain, Portugal, Ireland and Cyprus.

These loans are financed by bonds that are guaranteed by all Euro Area countries.

Thus ESM / EFSF have as much debt as a small European country.
**ESM needs to Analyse the Investor Base – And yes, we can!**

Understanding Investor behaviour is particularly important for ESM:

<table>
<thead>
<tr>
<th>The ESM needs to have market access when sovereigns have lost it</th>
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<tbody>
<tr>
<td>The ESM investor base needs to be able to absorb large volumes within short time frames</td>
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<td>ESM needs to make sure that its issuance activity is not harming the bond markets of beneficiaries</td>
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The ESM is specifically competent for such an analysis:

<table>
<thead>
<tr>
<th>Funding Volume is mainly issued in the syndication format – we see the investors in the orderbook</th>
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<tbody>
<tr>
<td>Investor data are carefully collected and processed – identification, matching, classification</td>
</tr>
<tr>
<td>Analytics tools are continuously enhanced – incorporating cutting edge methodology</td>
</tr>
</tbody>
</table>
Knowing Investor Demand for better Decision Taking

Order Volume Estimate per Investor Type
- Fund Manager
- Bank
- Broker
- Other
- CB&OtherPublic

Decision needed on instrument features:
- Issue Premium,
- Tenor, Notional,…

Investor Specific Information
Market Environment
Macro Data

Machine Learning Tool for Predicting Investor Demand
Input and covariates

**Instrument Characteristics**
- Tenor
- Tranche
- Transaction Size
- Reoffer Yield

**Market Characteristics**
- Benchmark Spreads
- Issue Premium
- Orderbook Size
- Basis Swap Spreads
- Competing Issuance Volumes
- Total Demand
- Issue Month (Seasonality)

**Global Macro**
- National GDP Growth
- Trade Balance
- Oil Price

**Investor Characteristics**
- Investor Type
- Investor Country
- Assets under Management
- Portfolio Currency
- CB Reserves

**Investor Types**
• Asset Managers
• Banks
• Bank Trading
• Central Banks and other Public Institutions
• Hedge Funds/Brokers
• Pension Funds/Insurances

**Global Regions**
• Euro Area
• UK/Switzerland
• Rest of Europe
• Asia
• Middle East/Africa
• Americas

- 1700 Investors from 85 countries
- 14,000 Orders in 119 Transactions
- 646bn Orders

Aggregated Demand per Investor Type and Region
Demand per Single Investor
Methodology: Regression Trees and Ensemble Trees

**Simple Regression Trees**

![Simple Regression Trees Diagram](image)

**Bagged Trees:** Generating sub-samples through bootstrapping, generating trees, averaging results.

Trees are trained on investor demand data: 13,000 orders of 109 transactions. The out-of-sample validation is using the 10 most recent transactions.
Forecasting Aggregated Investor Demand per Type and Region

Investor Types
- Asset Managers
- Banks
- Bank Trading
- Central Banks and other Public Institutions
- Hedge Funds /Brokers
- Pension Funds/Insurances

Global Regions
- Euro Area
- UK / Switzerland
- Rest of Europe
- Asia
- Middle East /Africa
- Americas
Feature Importance: Measuring the weight of covariates

For a simple tree: the increase of the prediction error after permuting the feature values.

For a bagged tree: average of the simple tree feature importances.

<table>
<thead>
<tr>
<th>Overall most important features:</th>
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</thead>
<tbody>
<tr>
<td>Investor Type</td>
</tr>
<tr>
<td>Notional</td>
</tr>
<tr>
<td>New Issuance Premium</td>
</tr>
<tr>
<td>Time to maturity/Tenor</td>
</tr>
</tbody>
</table>
Demand per Investor Type in separate models
Investor Types show a heterogeneous behaviour

<table>
<thead>
<tr>
<th>Investor Type</th>
<th>Main Important Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Manager</td>
<td>Notional, Yield and Spread Levels</td>
</tr>
<tr>
<td>Bank</td>
<td>Notional, New Issuance Premium</td>
</tr>
<tr>
<td>Bank Trading</td>
<td>Market Spreads</td>
</tr>
<tr>
<td>Broker/Hedge Fund</td>
<td>Macro Indicators, Market Spreads</td>
</tr>
<tr>
<td>Central Bank/Other Public</td>
<td>Notional, Tenor</td>
</tr>
<tr>
<td>Pension Funds/Insurances</td>
<td>Tenor, Yield Levels</td>
</tr>
</tbody>
</table>
Investor Types may slightly differ by Region

**Important Features**
- Notional
- Yield Level
- New Issuance Premium

**Important Features**
- Notional
- Tenor
- Yield Level
Individual Investors: A Few Patterns Detected

Investor demand on a name basis is less accurate due to smaller data amount.

Yet, the direction of demand change seems to be forecasted very well.
Outlook: How to obtain a Better Forecast?

- Limitation: available data
- We suggest: integrate primary dealer investor data and issuance data of peers
- Problem: confidentiality
- Possible solution: Federated / Transfer Learning
**Summary**

**Predicting Investor Behaviour using Regression Tree Methodology**

- Bagged Tree methodology delivers already some useful forecasts
- Feature impact studies help characterizing behaviour of different investor types.
- On some single investors, the direction of demand change can be forecasted
- Forecast quality is expected to improve considerably when enhancing database and refining technology
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