# Nowcasting Norwegian Household Consumption with Debit Card Transaction Data

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  - sampled at high frequency
  - released without delays
  - not revised
  - cover large proportion of hh consumption expenditure

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- Evaluate point and density forecast accuracy of debit card data for quarterly household consumption over the sample 2011Q4-2019Q4
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  - alternatives: standard benchmark and several high frequency indicators
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# Related literature

- Nowcasting: Evans (2005), Giannone et al. (2008), Banbura et al. (2011)
- Density Nowcasting: Aastveit et al. (2014), Mazzi et al. (2014), Carriero et al. (2015), Aastveit et al. (2017), Aastveit et al. (2018)
- Nowcasting with Payments Data: Denmark: Carlsen and Storgaard (2010), Bentsen and Gorea (2021), US: Barnett et al. (2016), Portugal: Duarte et al. (2017), Netherlands: Verbaan et al. (2017), Canada: Galbraith and Tkacz (2018), Chapman and Desai (2020), Italy: Aprigliano et al. (2019), Delle Monache and Nobili (2021)
- Nowcasting the Norwegian economy: Aastveit et al. (2011), Aastveit and Torvik (2012), Luciani and Ricci (2014)
- Forecasting/Consumption Behavior during COVID-19 pandemic: Aaronson et al. (2020), Carriero et al. (2020), Cascaldi-Garcia et al. (2020), Foroni et al. (2020), Lahiri and Yang (2020), Primiceri and Tambalotti (2020), Lenza and Primiceri (2020), Bounie et al. (2020), Hacioglu Hoke et al. (2020)

# Debit Card Transaction Data

- Norway near cashless economy:
  - cash withdrawals only 8% of total card usage in 2019
  - 8/10 card transactions made with debit cards, 71% of the total value
  - debit card transactions cover 39% of hh consumption ▸ Share

- Debit Card Data:
  - all debit card transactions via BankAxept, national payment system owned by the Norwegian banks → includes 'on-us' transactions
  - BankAxept: all debit card payments in physical domestic terminals
  - VISA/Mastercard: payments abroad, online or mobile (3% of hh consumption)
  - both value and volume of transactions
  - availability:
    - weekly: Jan 2006 - Dec 2018
    - daily: Jan 2019 onwards

- Household Consumption
  - = goods + services + (direct purchase abroad by resident hh − direct purchase by non-residents) $> 0$
  - last term about 4% of hh consumption

▸ Data

# Consumption and Debit Card Data Categories

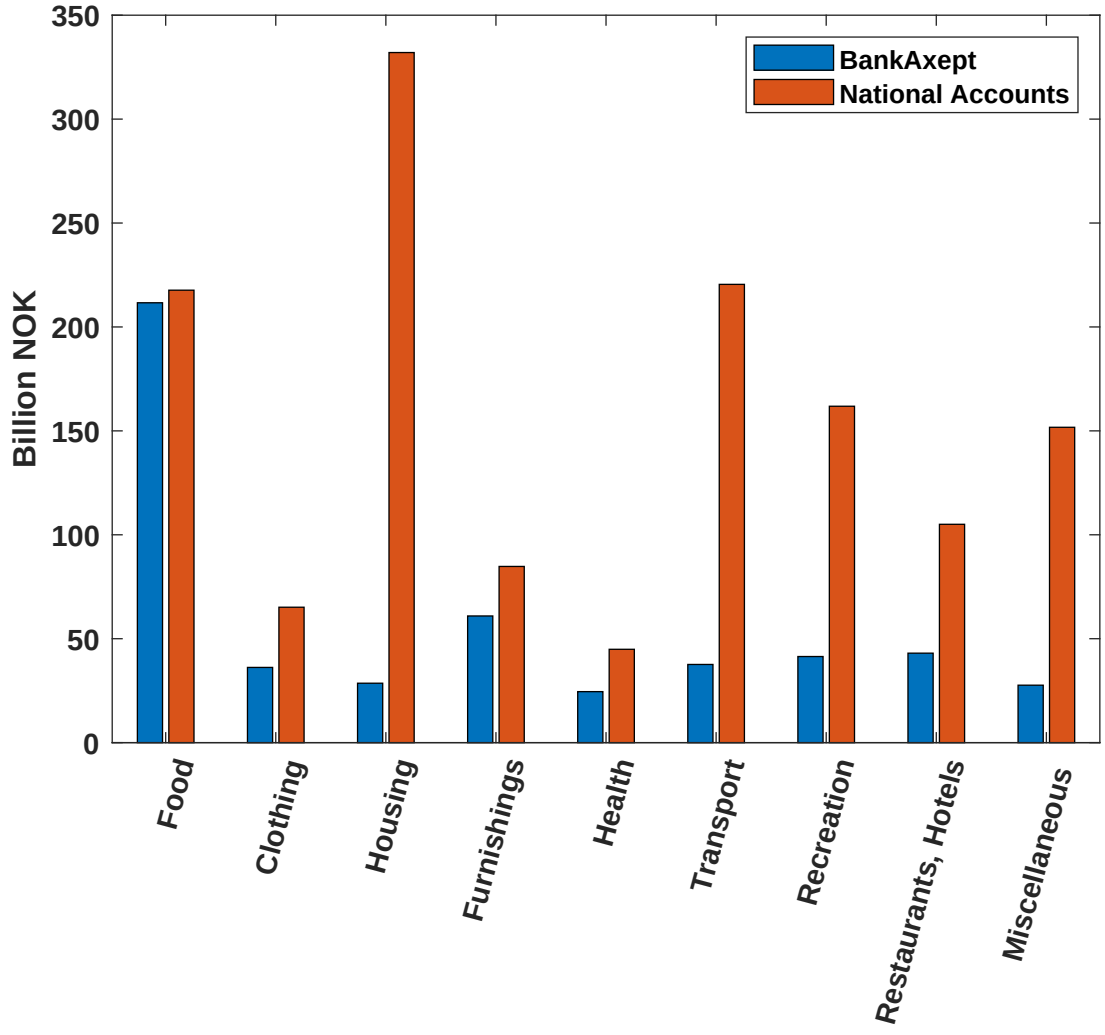



Figure: Value of BankAxept Data and Consumption by subcategories in 2019. 'Food': Food, beverages and tobacco; 'Clothing': Clothing and footwear; 'Housing': Housing, water and heating; 'Furnishing': Furnishings and household equipment; 'Recreation': Recreation and culture; 'Restaurants': Restaurants and hotels; 'Miscellaneous': Miscellaneous goods and services.

# Consumption and Debit Card Data: Correlation

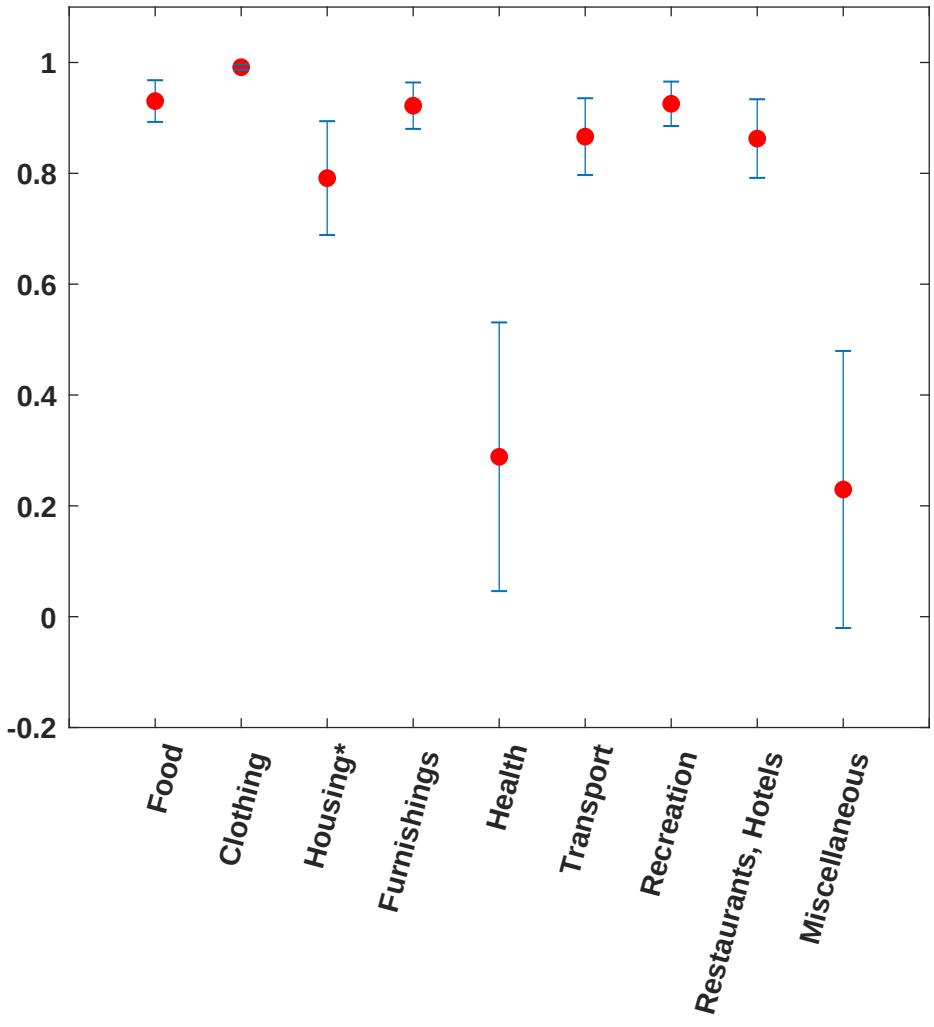



Figure: Correlation between value of BankAxept Data and Consumption by subcategories, quarterly, 2006Q1-2019Q4. 'Food': Food, beverages and tobacco; 'Clothing': Clothing and footwear; 'Housing': Housing, water and heating; 'Furnishing': Furnishings and household equipment; 'Recreation': Recreation and culture; 'Restaurants': Restaurants and hotels; 'Miscellaneous': Miscellaneous goods and services.

# Forecasting Models

- Benchmark Model:

$$y_t = \alpha + \sum_{p=1}^{P} \beta_p y_{t-p} + \varepsilon_t, \qquad \varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right)$$

where $y_t$ is the quarter over quarter growth of consumption

- ARDL-MIDAS Models:

$$y_t = \delta + \sum_{p=1}^{P} \beta_p y_{t-p} + \gamma B\left(L^{1/m}; \theta\right) x_{n,t}^{(m)} + \eta_t, \qquad \eta_t \sim N\left(0, \sigma_\eta^2\right)$$

  - with $x_{n,t}^{(m)}$ the single $n-th$ high frequency indicator or a factor, $m = 3$ for monthly, $m = 13$ for weekly data
  - $B\left(L^{1/m}; \theta\right) = \sum_{k=0}^{K} B\left(k; \theta\right) L^{k/m}$
  - $L^{1/m}$: lag operator such that $L^{k/m} x_{n,t}^{(m)} = x_{n,t-k/m}^{(m)}$
  - $B\left(k; \theta\right)$: lag coefficient associated to the lag operator $L^{k/m}$, parameterized as function of low-dimensional vector of parameters $\theta$

▸ Details ▸ Additional Models

# Forecast Evaluation Exercise

## High Frequency Regressors

| Indicator | Highest Frequency | Transf | Timing | Publication Lag |
|---|---|---|---|---|
| BankAxept Value | W | *Growth* | Every Monday | 1 day |
| BankAxept Volume | W | *Growth* | Every Monday | 1 day |
| Stock Prices | W | *Growth* | Daily | 1 day |
| Google Trends | W | *Level* | Every Monday | 1 day |
| Uncertainty | W | *Level* | Every Thursday | 4 days |
| Unemployment | M | *Level* | 1st wd of month | 1-3 days |
| Car Sales | M | *Growth* | 3-6th of month | 3 to 6 days |
| Financial News | M | *Level* | 1-3rd of month | 1 month |
| PMI | M | *Level* | 3-6th of month | 1 month |
| Retail Sales | M | *Growth* | 25-30th of month | 1 month |

Table: Stock prices: benchmark index at the Oslo stock exchange; Google Trends: Google queries for Norway; Uncertainty: index based on textual data for Norway (Larsen 2017); Car Sales: volume of cars delivered in the month; Financial News: index based on textual data for Norway (Larsen and Thorsrud 2019, Thorsrud 2020); PMI: Purchasing Manufacturing Index for Norway; Retail Sales: survey based index covering food beverages and tobacco, electricity and heating fuels, vehicle and petrol, other goods.

▸ Google Trend Indicators

# Forecast Evaluation Exercise: Implementation Details

- Official statistics released about six weeks after end of reference quarter
- For weekly data evaluation after end of each week in the quarter
- For monthly data evaluation at three forecast origins: ▸ timeline

| Forecast Origin | Monthly Data Available | Quarterly Data Available |
|---|---|---|
| After End of M1 | M1 | Two Quarter Back |
| After End of M2 | M1, M2 | Previous Quarter |
| After End of M3 | M1, M2, M3 | Previous Quarter |

- ARDL-MIDAS model with Legendre lag polynomial and regressors:
  - past 3 months for monthly frequency
  - past 13 weeks for weekly frequency
  - $\theta$ is a two-dimensional vector
  - AR component: $p = 1$
- Rolling window with $R = 22$
- First estimation: 2006Q1-2011Q3; Evaluation: 2011Q4-2019Q4
- Real time data for consumption; other indicators except retail sales not revised
- Nowcast evaluated against first release
- Loss function: RMSFE (point), Log Scores (density)

# Results: Relative RMSE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncer tainty | Google Trends |
|---|---|---|---|---|---|
| 1 | 0.449*** | 0.533*** | 1.064 | 1.091*** | 0.733*** |
| 2 | 0.491*** | 0.795*** | 1.083*** | 1.051*** | 0.817*** |
| 3 | 0.649*** | 0.846*** | 1.110*** | 1.033 | 0.887*** |
| 4 | 0.770*** | 0.857*** | 1.154*** | 1.018** | 0.937*** |
| 5 | 0.794*** | 0.766*** | 1.172*** | 1.016*** | 0.909*** |
| 6 | 0.769*** | 0.676*** | 1.162*** | 1.038*** | 0.783*** |
| 7 | 0.631*** | 0.630*** | 0.973*** | 0.946*** | 0.633*** |
| 8 | 0.633** | 0.686** | 1.079*** | 1.086*** | 0.620*** |
| 9 | 0.598*** | 0.635*** | 1.076*** | 1.025 | 0.544*** |
| 10 | 0.567*** | 0.608*** | 1.074*** | 1.009*** | 0.519*** |
| 11 | 0.541*** | 0.570*** | 1.069*** | 1.059** | 0.523*** |
| 12 | 0.528*** | 0.542*** | 1.065*** | 1.067 | 0.591*** |
| 13 | 0.471*** | 0.488*** | 1.064*** | 1.084 | 0.835*** |

Table: RMSFE relative to the AR model over the evaluation sample 2011Q4-2019Q4. The RMSFE for the AR model is 3.05 for week 1 through 7, when the previous quarter figures for consumption have not been released yet, and equals 2.83 for weeks 8 through 13 after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. The differentials in the squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey West (1987). '*', '*** and '***' indicate significance levels for the DM test at the 10, 5 and 1 percent respectively.

# Results: Relative RMSE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 0.963 | 0.826*** | 0.938 |
| Retail Sales | 0.594*** | 0.406*** | 0.385*** |
| Financial News | 1.106*** | 1.047*** | 1.051*** |
| Unemployment | 0.636*** | 0.865*** | 1.004 |
| PMI | 1.117*** | 1.080*** | 1.042*** |
| Real Factor | 0.731*** | 0.904*** | 0.732*** |
| | **Week 5** | **Week 9** | **Week 13** |
| BA-Value | 0.794*** | 0.598*** | 0.471*** |
| BA-Volume | 0.766*** | 0.635*** | 0.488*** |

Table: RMSFE relative to AR model over the evaluation sample 2011Q4-2019Q4. RMSFE for AR model: 3.05 in column "One Month" and 2.83 in columns "Two Months" and "Full Quarter" after the release of previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '***' and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Note that Retail Sales is available about one month after the end of the reference month.

# Results: Relative RMSE Household Consumption

| Week | Value Goods | Value Services | Volume Goods | Volume Services |
|---|---|---|---|---|
| 1 | 0.498*** | 1.090*** | 0.886*** | 0.838*** |
| 2 | 0.608*** | 1.201*** | 1.019 | 0.818*** |
| 3 | 0.725*** | 1.224*** | 0.989 | 0.811*** |
| 4 | 0.792*** | 1.164*** | 0.991 | 0.857*** |
| 5 | 0.756*** | 1.085*** | 1.001 | 0.924*** |
| 6 | 0.740*** | 0.964*** | 0.911*** | 0.992 |
| 7 | 0.533*** | 0.864*** | 1.034 | 0.776*** |
| 8 | 0.567*** | 1.145*** | 0.969 | 0.902** |
| 9 | 0.529*** | 1.299*** | 0.887** | 0.974** |
| 10 | 0.498*** | 1.184** | 0.833*** | 1.008 |
| 11 | 0.434*** | 1.091 | 0.734*** | 0.962** |
| 12 | 0.343*** | 0.919* | 0.598*** | 0.898*** |
| 13 | 0.386*** | 1.000 | 0.794*** | 0.865*** |

Table: RMSE relative to the AR model for total consumption. Target variable: qoq growth rate of household consumption. RMSFE for the AR model: 3.98 for week 1 through 7 and 3.47 for weeks 8 through 13. Entries smaller than one indicate the alternative model is more accurate than the AR. The forecast errors are corrected for heteroskedasticity and autocorrelation using Newey West (1987). '*', '*** and '***' indicate significance levels for the DM test at the 10, 5 and 1 percent respectively ▸ subc

# Robustness Checks

- Results are robust to:
  - Evaluation release
    - latest release ▸ latest release
  - Estimation Scheme
    - expanding window
    - results unchanged ▸ expanding
  - Model Specification
    - number of lags ▸ nlags
    - no AR component ▸ no AR
  - Outliers
    - squared forecast errors for BankAxept smaller than ones by AR throughout whole evaluation sample ▸ cumRMSFE

# Nowcasting During the COVID-19 Pandemic

- First case of infection in Norway at end of February 2020
- Drastic restrictions implemented on March 12th (week 11)
- As a consequence:
  - Registered Unemployment up to 10.7% in March from 2.7% in February
  - Value of debit card payments fell by 14% wrt March 2019, by 10% wrt February 2020
  - Volume of transactions dropped by 25% wrt March 2019 and by 21% wrt to previous month
  - Stock prices plummeted by almost 25% from February to March
  - Uncertainty index almost doubled from February to March
  - Retail sales in March increased by 3.7% wrt February driven by increase in food, beverages and tobacco, vehicles and petroleum
  - consumption fell by 10.2% in qoq terms and by 6% in yoy terms
  - goods (services) consumption fell by 2% (16.2%) in qoq terms
  - qoq growth rate of mainland GDP was -1.5%

# BankAxept Data in 2020Q1

## Subcomponents

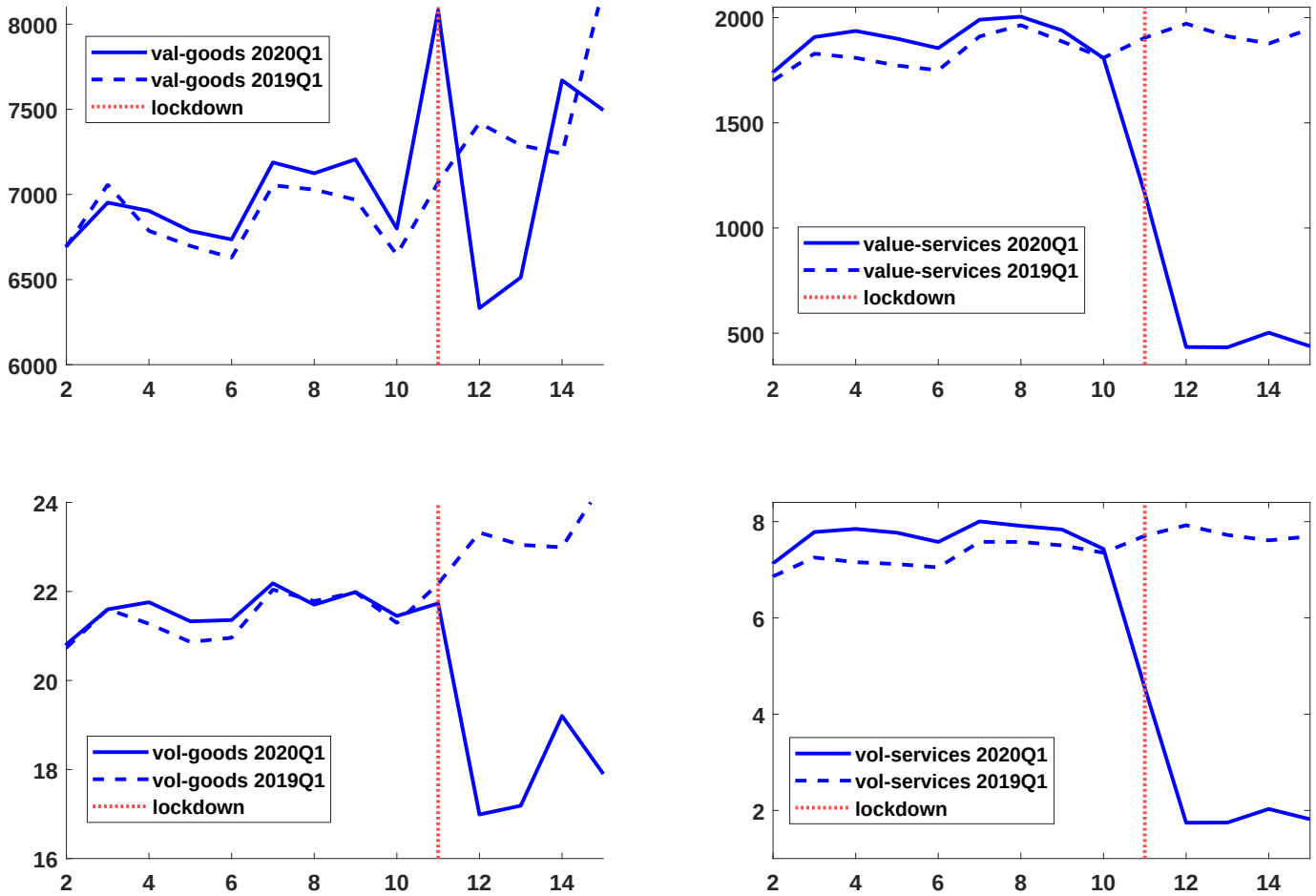



Figure: Weekly time series of debit card data over week 2 to 14 of 2020 compared to same weeks in 2019, level data. Lockdown measures implemented on March 12th (week 11).

# Density Nowcast for 2020Q1

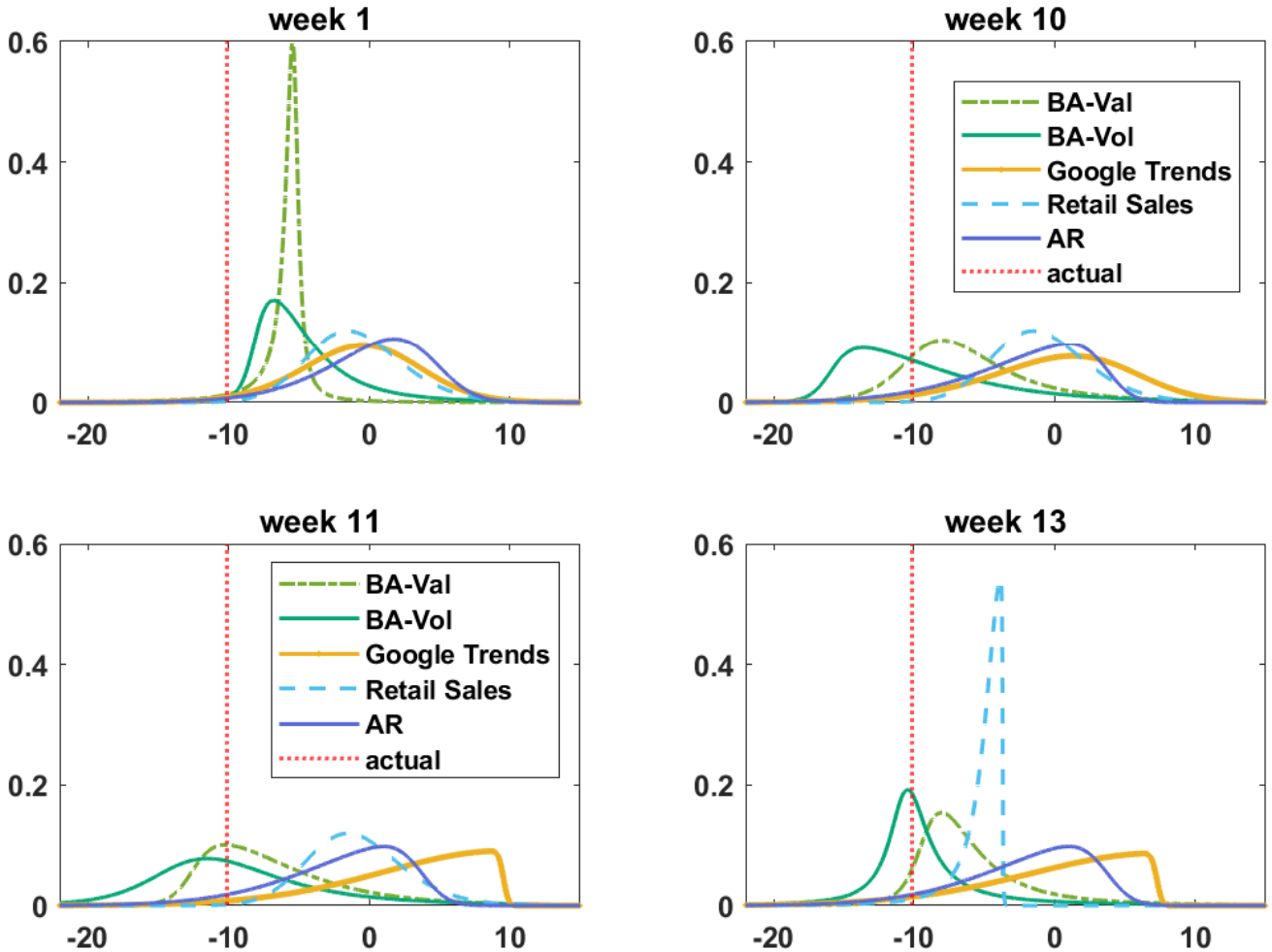



Figure: Density nowcasts from QARDL-MIDAS for percentiles 5, 25, 50, 75 and 95. In order to estimate the whole conditional density a parameter density function is fit by minimizing the distance between the regression quantiles and the density implied quantiles of a skewed t-distribution (Adrian et al. 2019, Azzalini and Capitanio (2003)

# Stringency Index for Norway

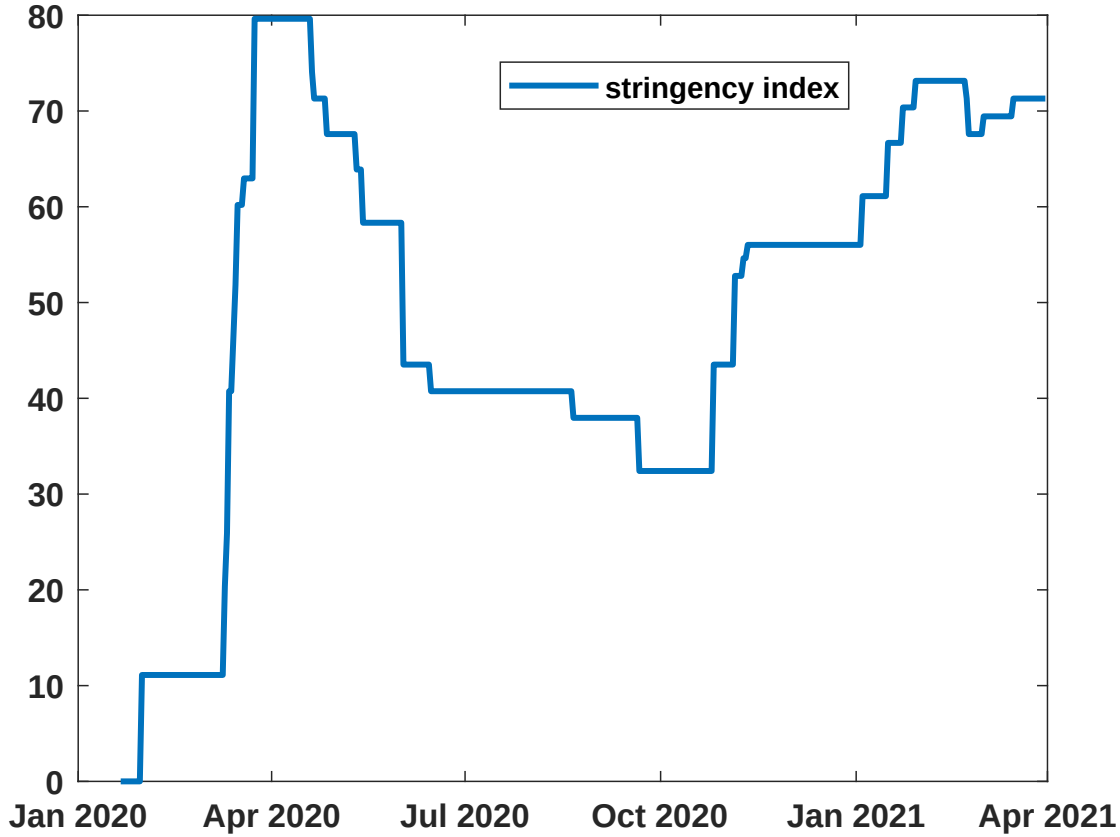
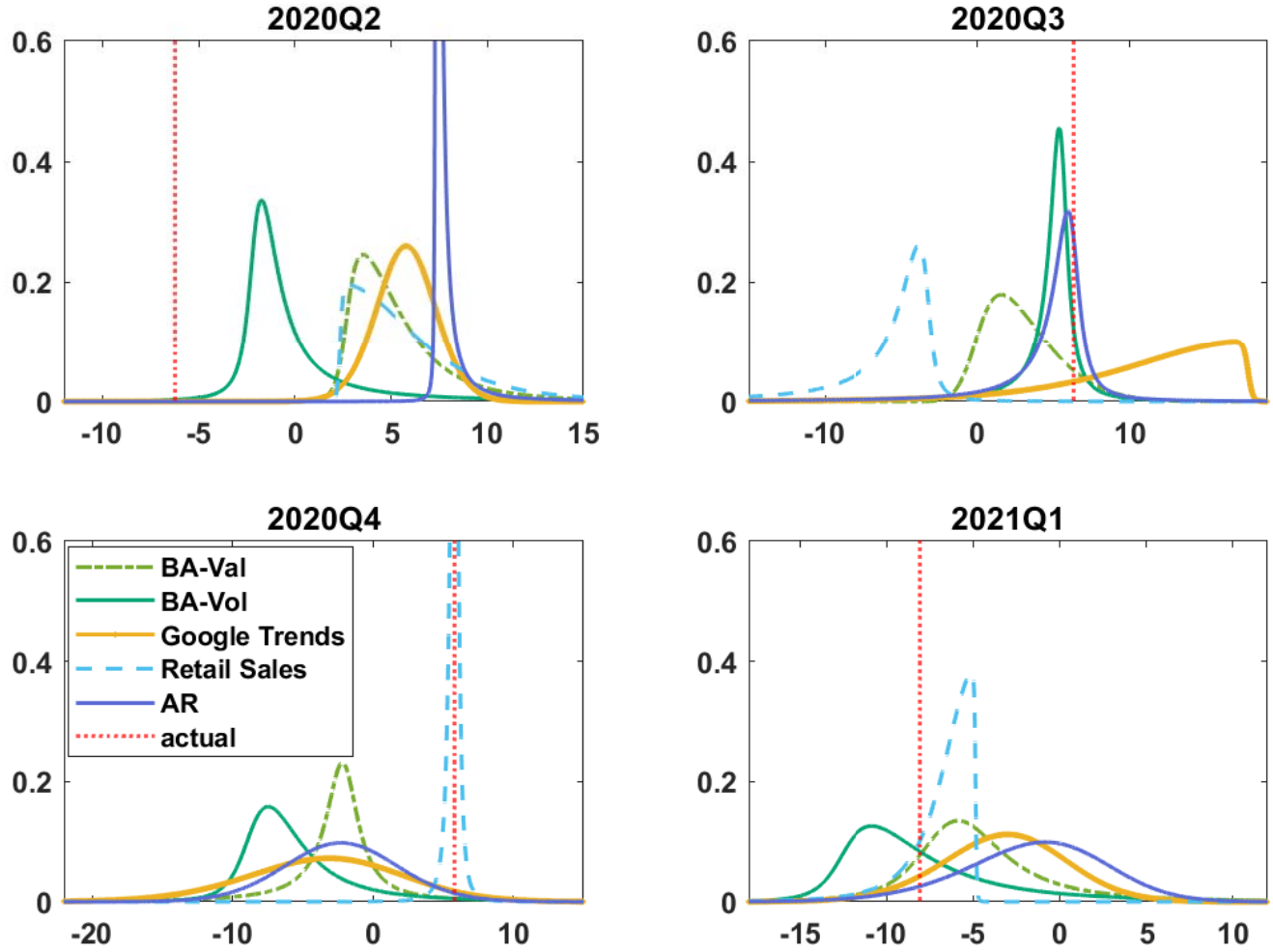



Figure: Covid-19 stringency measure for Norway from the database of Hale et al. 2021. This is a composite measure on nine response indicators including school closures, workplace closures, and travel bans, re-scaled to a value from 0 to 100 (100 is the strictest). If policies vary at the subnational level, the index is shown as the response level of the strictest sub-region. Source: Oxford COVID-19 Government Response Tracker.

# Nowcasting through 2021Q3

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# Probability of Outcome Lower than Actual

| Week | BAX-Val | BAX-Vol | Google Trends | Retail Sales | AR |
|---|---|---|---|---|---|
| | | | **2020Q1** | | |
| 1 | 0.063 | 0.006 | 0.019 | | |
| 10 | 0.173 | 0.528 | 0.042 | 0.002 | 0.065 |
| 11 | 0.277 | 0.499 | 0.031 | 0.002 | 0.065 |
| 13 | 0.069 | 0.468 | 0.065 | 0.037 | 0.065 |
| | | | **2020Q2** | | |
| 13 | 0.000 | 0.013 | 0.000 | 0.000 | 0.000 |
| | | | **2020Q3** | | |
| 13 | 0.899 | 0.879 | 0.185 | 0.997 | 0.761 |
| | | | **2020Q4** | | |
| 13 | 0.956 | 0.958 | 0.955 | 0.534 | 0.972 |
| | | | **2021Q1** | | |
| 13 | 0.165 | 0.596 | 0.098 | 0.192 | 0.069 |

Table: Probability of observing an outcome smaller than the actual consumption value for 2020Q1 through 2021Q1.

# Nowcasting with Credit Cards through 2020Q1

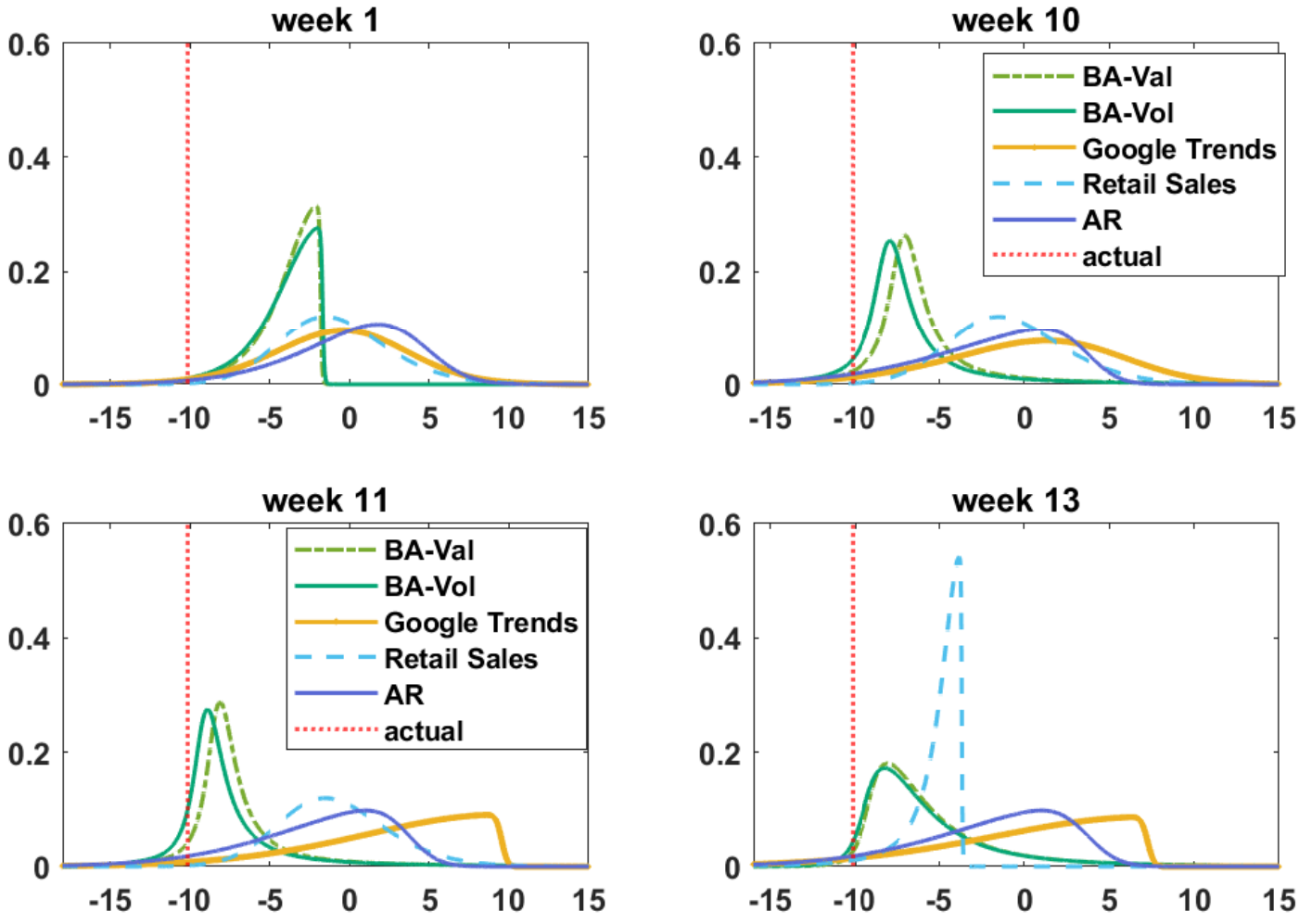


Figure: Density nowcast for selected models.

# Nowcasting with Credit Cards through 2021Q3

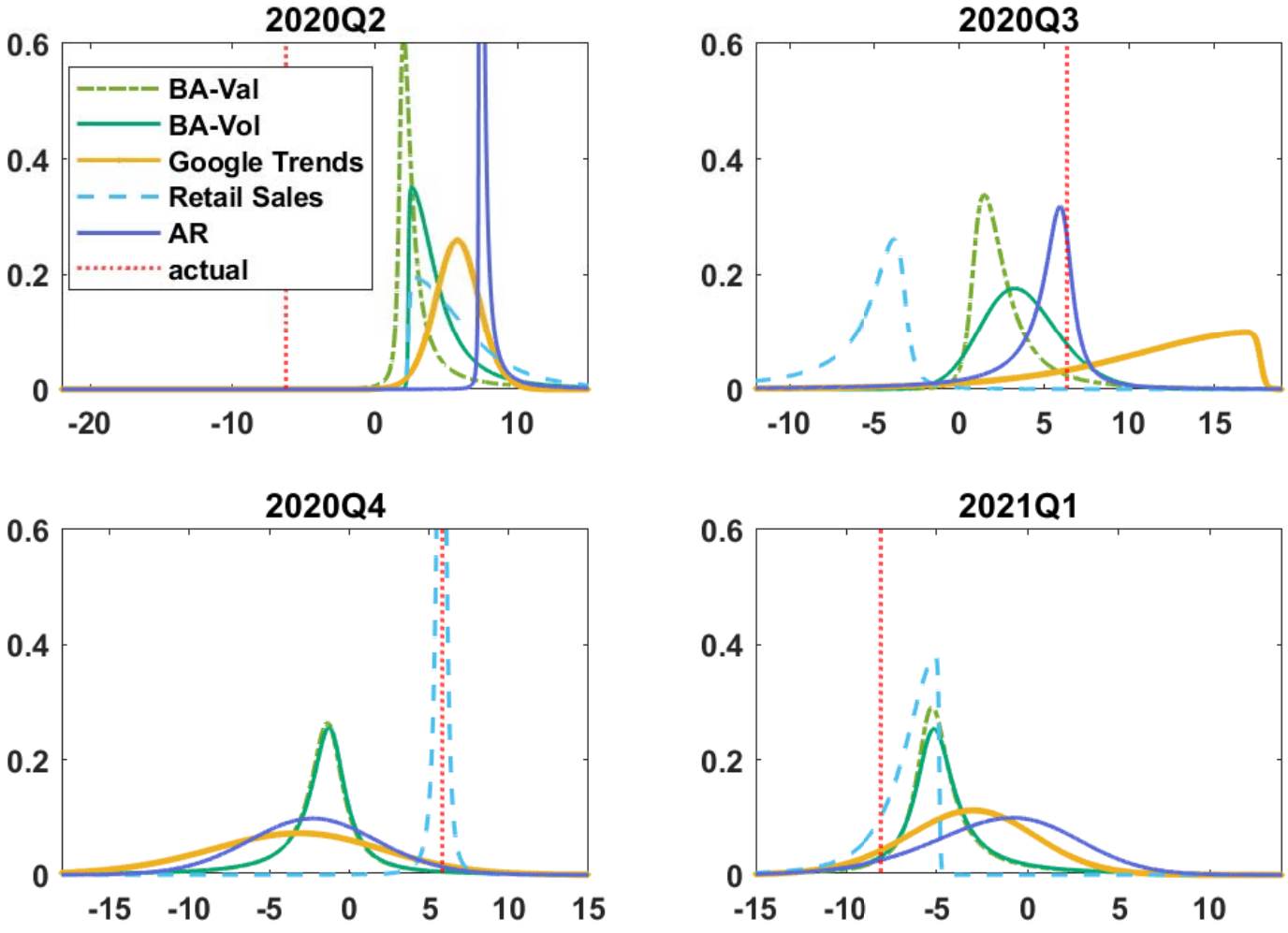


Figure: Density nowcast for selected models.

# Conclusions

- Debit card data accurate predictor of household consumption
  - on average over a longer evaluation sample
  - in periods of heightened uncertainty such as COVID pandemic
- Improvements for both point and density forecast
  - gains for point accuracy wrt benchmark up to 65%
  - improvements statistically significant throughout the quarter
- BanAxept data available at higher frequency, without delays or revisions
- Debit card transactions data should be useful for real time monitoring of consumption in other countries where card payments account for high share of consumption expenditures

# Google Trends Indicators

| Goods | Services |
|---|---|
| Vinmonopolet | SAS |
| Coop | Museum |
| Meny | Bar |
| XXL | Cinema |
| HM | Restaurant |
| Prada | Cafe' |
| House | Hotel |
| Furniture | Hairdresser |
| Ikea | |
| Pharmacy | |
| Car | |

Figure: Google Trend Indicators.

Back

# BankAxept Usage by Age Groups

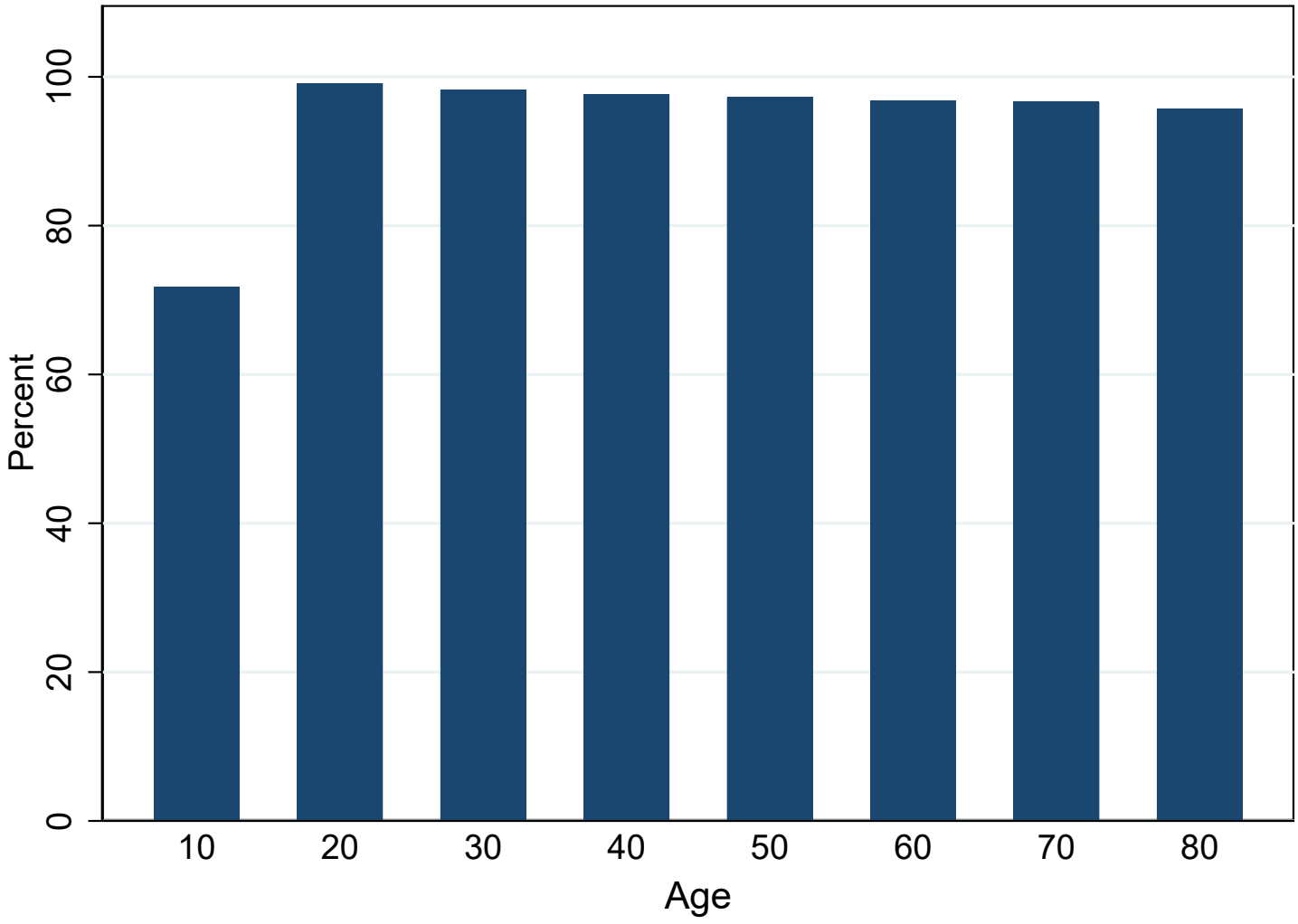


Figure: Percentage of population by age groups which has completed at least one transaction with the BankAxept system in 2018. The horizontal axis reports the first year included in the age bracket.

# Timeline

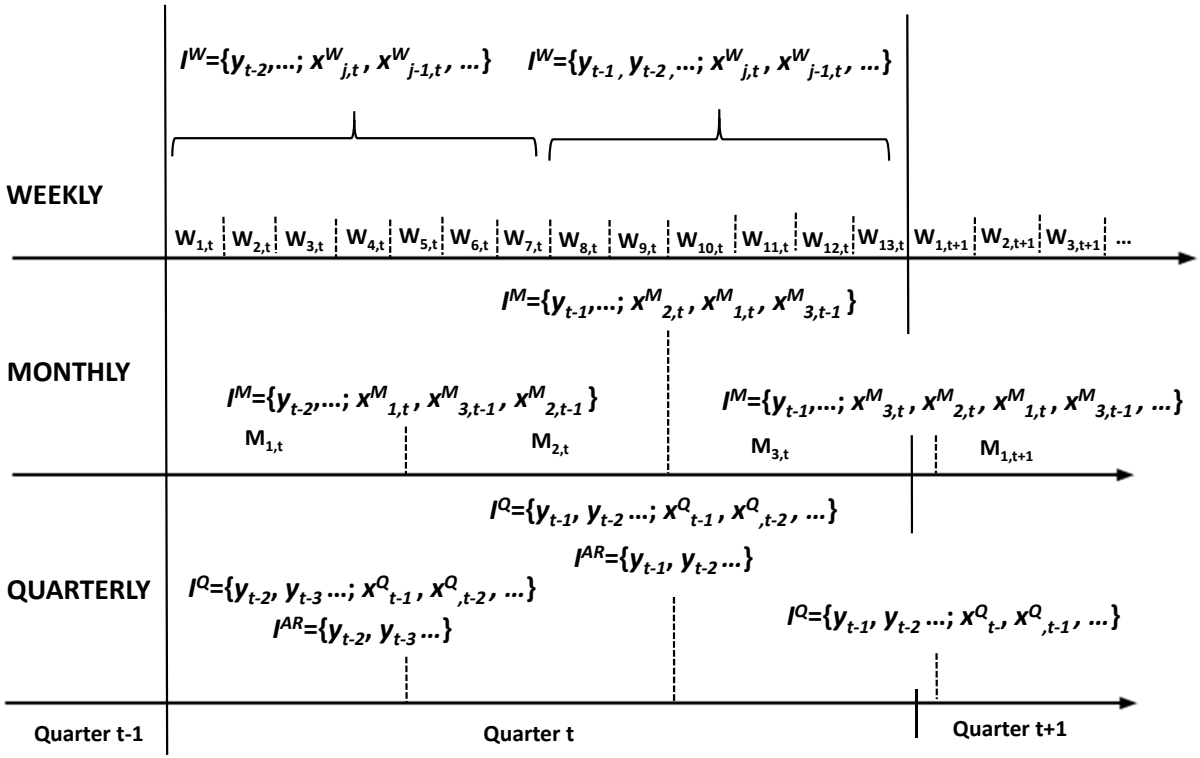


Figure: Timeline of the nowcasts.

# Relative RMSE by Subcomponents-Value

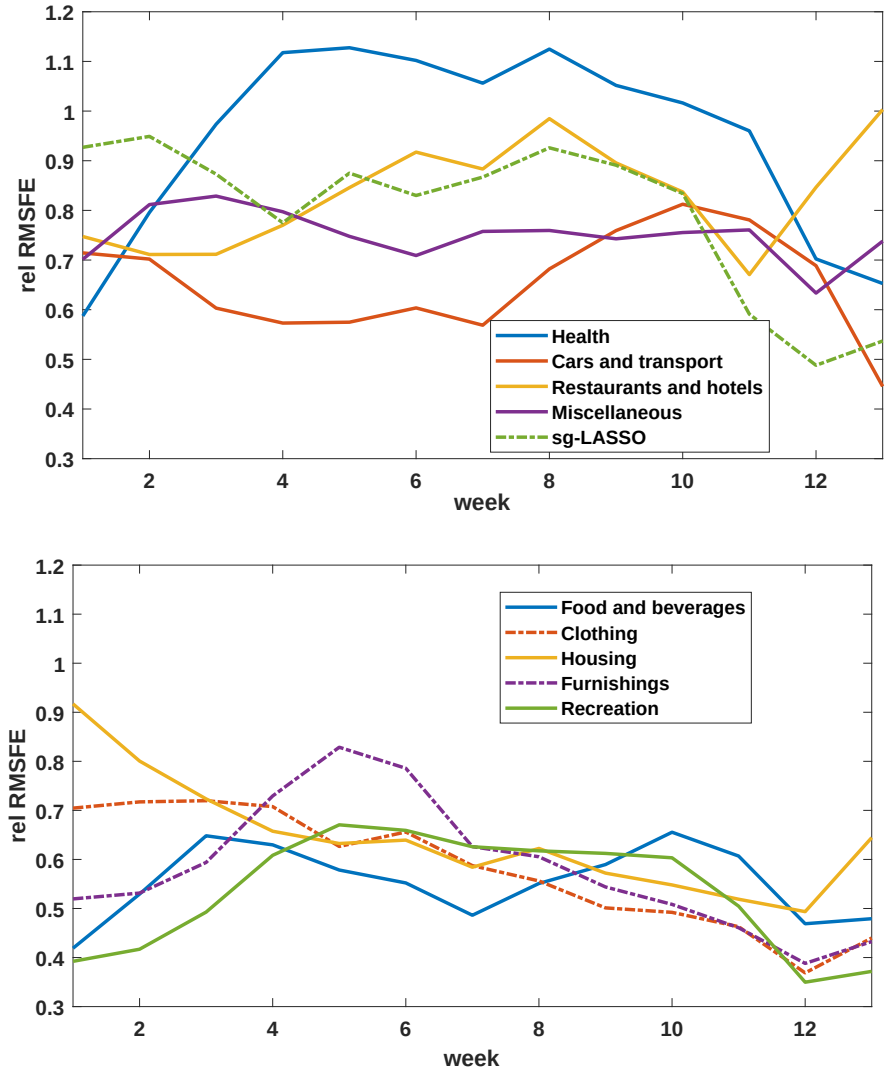


Figure: RMSFE by subcategory. Sparse group LASSO (with AR component), defined over the BankAxept subcomponents (over two groups, goods and services with 2 lags each), setting $\alpha = 0.95$. Back

# Robustness: Final Release

## Relative RMSFE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty | Google Trends |
|---|---|---|---|---|---|
| 1 | 0.581*** | 0.591*** | 1.062*** | 1.078*** | 0.765*** |
| 2 | 0.571*** | 0.840*** | 1.091*** | 1.027*** | 0.826*** |
| 3 | 0.664*** | 0.942*** | 1.126*** | 1.006 | 0.876*** |
| 4 | 0.782*** | 0.918*** | 1.168*** | 0.997 | 0.894*** |
| 5 | 0.844*** | 0.852*** | 1.182*** | 1.026*** | 0.856*** |
| 6 | 0.863*** | 0.767*** | 1.168*** | 1.036*** | 0.768*** |
| 7 | 0.761*** | 0.789*** | 0.956*** | 0.929*** | 0.645*** |
| 8 | 0.806*** | 0.902*** | 1.064*** | 1.069*** | 0.659*** |
| 9 | 0.774*** | 0.825*** | 1.067*** | 1.024*** | 0.628*** |
| 10 | 0.736*** | 0.762*** | 1.069*** | 1.039*** | 0.625*** |
| 11 | 0.703*** | 0.696*** | 1.068*** | 1.045*** | 0.630*** |
| 12 | 0.702*** | 0.691*** | 1.069*** | 1.054*** | 0.653*** |
| 13 | 0.726*** | 0.725*** | 1.072*** | 1.050*** | 0.862*** |

Table: RMSFE relative to AR model. The RMSFE for the AR model is 4.09 up to week 7 and 3.71 from week 8 onwards after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

# Robustness: Final Vintage

## Relative RMSFE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 0.957 | 0.750*** | 0.937 |
| Retail Sales | 0.697*** | 0.608*** | 0.538*** |
| Financial News | 1.080*** | 1.052*** | 1.053*** |
| Unemployment | 0.659*** | 0.841*** | 1.021 |
| PMI | 1.091*** | 1.048*** | 1.061*** |
| Real Factor | 0.752*** | 0.923*** | 0.822*** |
| | **Week 5** | **Week 9** | **Week 13** |
| BA-Value | 0.844*** | 0.774*** | 0.726*** |
| BA-Volume | 0.852*** | 0.825*** | 0.725*** |

Table: RMSFE relative to AR model. RMSFE for AR model: 4.09 in column "One Month" and 3.71 in columns "Two Months" and "Full Quarter" after the release of previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '***' and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Robustness: Expanding Window

## Relative RMSFE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty | Google Trends |
|---|---|---|---|---|---|
| 1 | 0.589*** | 0.585*** | 1.002 | 1.054*** | 0.918*** |
| 2 | 0.616*** | 0.917*** | 1.005 | 1.009*** | 0.952*** |
| 3 | 0.770*** | 0.913*** | 1.004 | 0.992*** | 0.931*** |
| 4 | 0.889*** | 0.870*** | 1.006* | 1.000 | 0.986 |
| 5 | 0.870*** | 0.776*** | 1.005* | 0.997 | 1.039*** |
| 6 | 0.819*** | 0.711*** | 1.004 | 1.005 | 1.060*** |
| 7 | 0.695*** | 0.677*** | 0.876*** | 0.869*** | 0.863*** |
| 8 | 0.808*** | 0.827*** | 1.011*** | 1.033*** | 1.022* |
| 9 | 0.805*** | 0.830*** | 1.006** | 1.023*** | 1.008 |
| 10 | 0.731*** | 0.783*** | 1.004* | 1.022* | 1.021 |
| 11 | 0.677*** | 0.745*** | 1.003* | 1.028* | 0.945*** |
| 12 | 0.667*** | 0.708*** | 1.006*** | 1.034*** | 0.925*** |
| 13 | 0.580*** | 0.629*** | 1.013*** | 1.016*** | 0.955*** |

Table: RMSFE relative to AR model. The RMSFE for the AR model is 3.95 up to week 7 and 3.41 from week 8 onwards after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

# Robustness: Expanding Window

## Relative RMSFE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 0.830*** | 0.818*** | 0.853*** |
| Retail Sales | 0.625*** | 0.529*** | 0.445*** |
| Financial News | 1.054*** | 1.062*** | 1.040*** |
| Unemployment | 0.638*** | 0.848*** | 1.012 |
| PMI | 1.056*** | 1.056*** | 1.009 |
| Real Factor | 0.673*** | 0.914*** | 0.775*** |
| | **Week 5** | **Week 9** | **Week 13** |
| BA-Value | 0.870*** | 0.805*** | 0.580*** |
| BA-Volume | 0.776*** | 0.830*** | 0.629*** |

Table: RMSFE relative to AR model, expanding window estimation scheme. RMSFE for AR model: 3.95 in column "One Month" and 3.41 in columns "Two Months" and "Full Quarter" after the release of previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Robustness: Two Lags

## Relative RMSFE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty | Google Trends |
|---|---|---|---|---|---|
| 1 | 0.506*** | 0.627*** | 1.063*** | 1.034*** | 0.564*** |
| 2 | 0.552*** | 0.732*** | 1.061*** | 1.008 | 0.527*** |
| 3 | 0.615*** | 0.852*** | 1.051*** | 1.010 | 0.509*** |
| 4 | 0.650*** | 0.874*** | 1.041*** | 0.970*** | 0.499*** |
| 5 | 0.692*** | 0.850*** | 1.035*** | 0.977** | 0.525*** |
| 6 | 0.810*** | 0.893*** | 1.038*** | 1.012 | 0.576*** |
| 7 | 0.638*** | 0.803*** | 0.953*** | 0.970** | 0.881*** |
| 8 | 0.659*** | 0.836*** | 1.041*** | 1.032*** | 1.015 |
| 9 | 0.614*** | 0.742*** | 1.057*** | 1.040*** | 1.016 |
| 10 | 0.583*** | 0.691*** | 1.069*** | 1.048*** | 0.969** |
| 11 | 0.519*** | 0.613*** | 1.076*** | 1.054*** | 0.901*** |
| 12 | 0.454*** | 0.540*** | 1.079*** | 1.076*** | 0.814*** |
| 13 | 0.436*** | 0.526*** | 1.079*** | 1.079*** | 0.744*** |

Table: RMSFE relative to the AR model, all models estimated with 2 lags of the dependent variable and of the high frequency regressors, over the sample 2011Q4-2019Q4. The RMSFE for the AR model is 2.70 for week 1 through 7, when the previous quarter figures for consumption have not been released yet, and equals 2.61 for weeks 8 through 13 after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent

# Robustness: Two Lags

## Relative RMSFE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 1.111 | 1.079 | 1.102*** |
| Retail Sales | 0.413*** | 1.002 | 0.393*** |
| Financial News | 1.064* | 1.084*** | 1.057*** |
| Unemployment | 1.137*** | 0.799*** | 0.725*** |
| PMI | 1.033** | 1.096*** | 1.109*** |
| Real Factor | 0.844*** | 0.540*** | 0.501*** |
| | **Week 5** | **Week 9** | **Week 13** |
| BA-Value | 0.870*** | 0.805*** | 0.580*** |
| BA-Volume | 0.776*** | 0.830*** | 0.629*** |

Table: RMSFE relative to AR model. RMSFE for AR model: 2.70 in column "One Month" and 2.61 in columns "Two Months" and "Full Quarter" after the release of previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '***' and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Robustness: no AR component

## Relative RMSFE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty | Google Trends |
|---|---|---|---|---|---|
| 1 | 0.654*** | 0.809*** | 1.194*** | 1.148*** | 1.047*** |
| 2 | 0.815*** | 0.979*** | 1.170*** | 1.114*** | 1.105*** |
| 3 | 0.965*** | 0.939*** | 1.147*** | 1.118*** | 1.071*** |
| 4 | 0.981*** | 0.887*** | 1.156*** | 1.122*** | 1.020** |
| 5 | 0.940*** | 0.817*** | 1.173*** | 1.128*** | 0.942*** |
| 6 | 0.864*** | 0.767*** | 1.180*** | 1.146*** | 0.832*** |
| 7 | 0.826*** | 0.763*** | 1.209*** | 1.221*** | 0.761*** |
| 8 | 0.853*** | 0.840*** | 1.350*** | 1.346*** | 0.808*** |
| 9 | 0.788*** | 0.785*** | 1.360*** | 1.290*** | 0.848*** |
| 10 | 0.676*** | 0.673*** | 1.375*** | 1.292*** | 0.928*** |
| 11 | 0.595*** | 0.598*** | 1.394*** | 1.338*** | 1.047*** |
| 12 | 0.536*** | 0.552*** | 1.409*** | 1.355*** | 1.178*** |
| 13 | 0.461*** | 0.485*** | 1.410*** | 1.329*** | 1.259*** |

Table: RMSFE relative to the AR model, MIDAS models excluding the AR component, over the sample 2011Q4-2019Q4. The RMSFE for the AR model is 2.70 for week 1 through 7, when the previous quarter figures for consumption have not been released yet, and equals 2.61 for weeks 8 through 13 after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

# Robustness: no AR component

## Relative RMSFE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 1.013 | 0.895*** | 0.971 |
| Retail Sales | 0.816*** | 0.400*** | 0.423*** |
| Financial News | 1.189*** | 1.350*** | 1.311*** |
| Unemployment | 0.851*** | 0.935** | 1.238*** |
| PMI | 1.164*** | 1.353*** | 1.345*** |
| Real Factor | 0.770*** | 1.015 | 0.849*** |
| | **Week 5** | **Week 9** | **Week 13** |
| BA-Value | 0.940*** | 0.788*** | 0.461*** |
| BA-Volume | 0.817*** | 0.785*** | 0.485*** |

Table: RMSFE relative to AR model, MIDAS models excluding the AR component. RMSFE for AR model: 2.70 in column "One Month" and 2.61 in columns "Two Months" and "Full Quarter" after the release of previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '***' and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Difference in Cumulative RMSFE

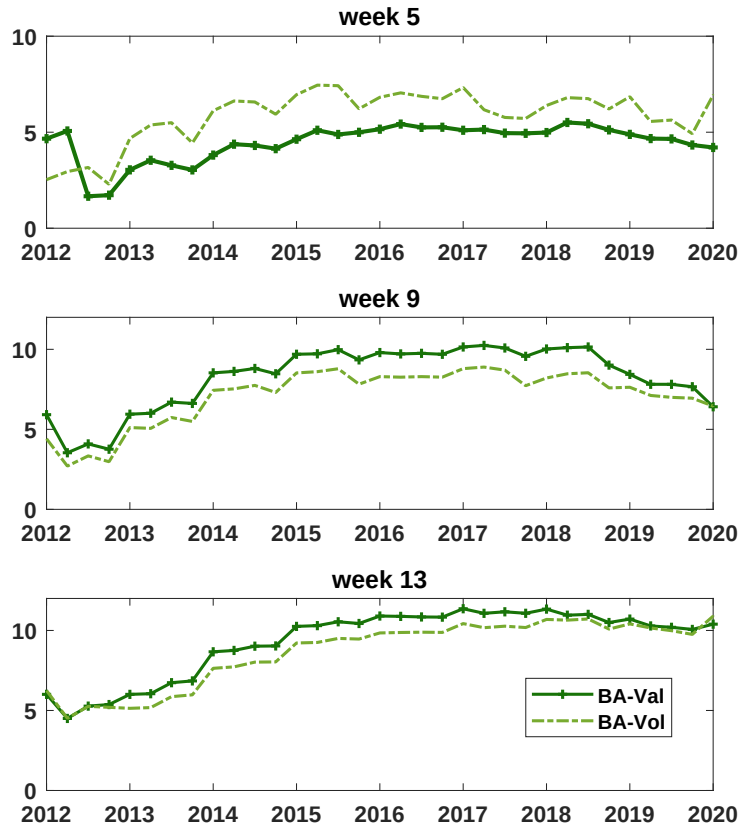


Figure: Time series of difference in cumulative Root Mean Squared Forecast Errors for selected weeks. At each point in time "t" the difference is defined as the cumulative RMSFE of the AR model minus the cumulative RMSFE for the BankAxept model up to time "t". Target variable is quarter over quarter growth of consumption.

Back

# Value of Debt Card over Consumption

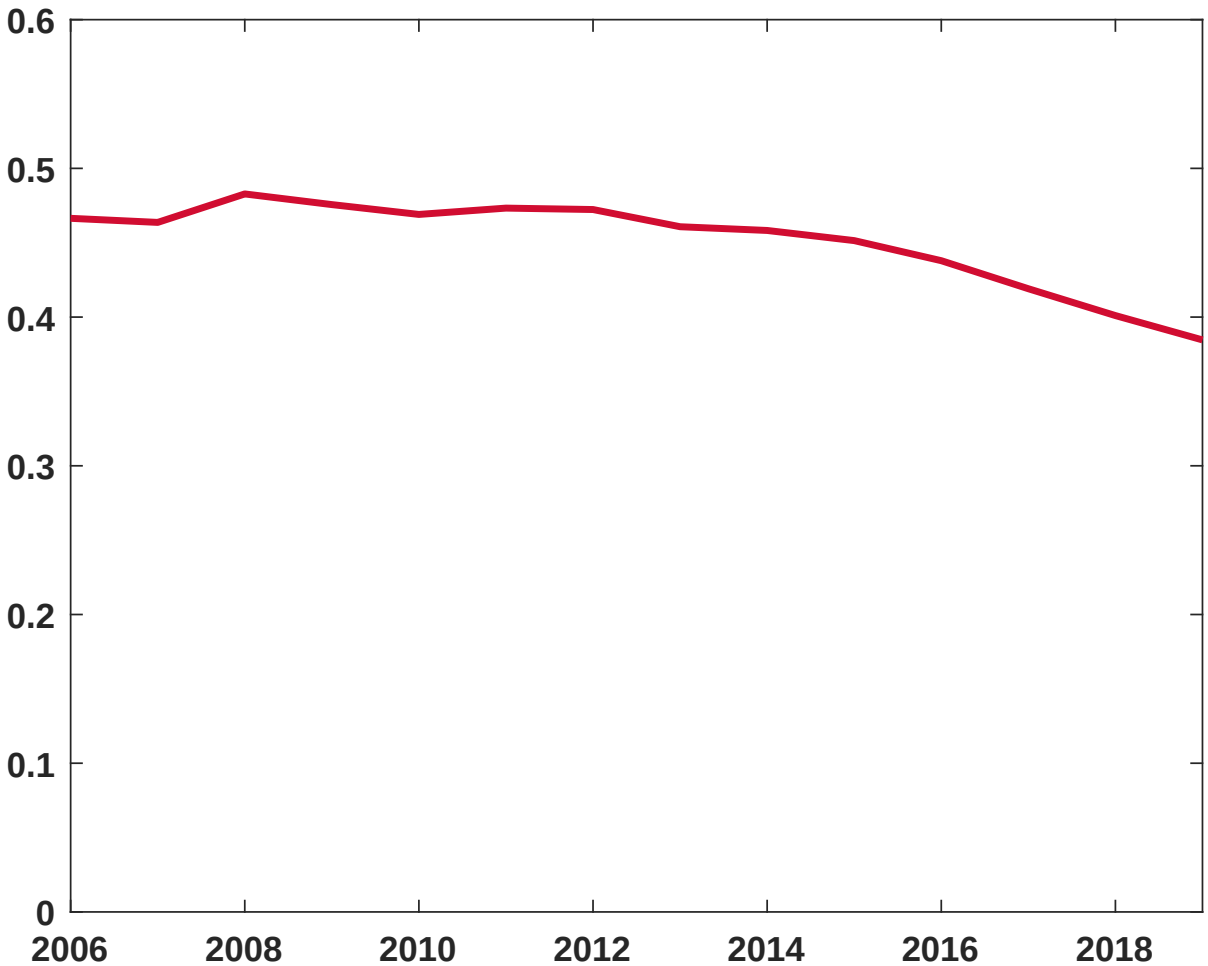


Figure: Value of Debit Card Transactions over Household Consumption, Annual.

# Consumption and Debit Card Data

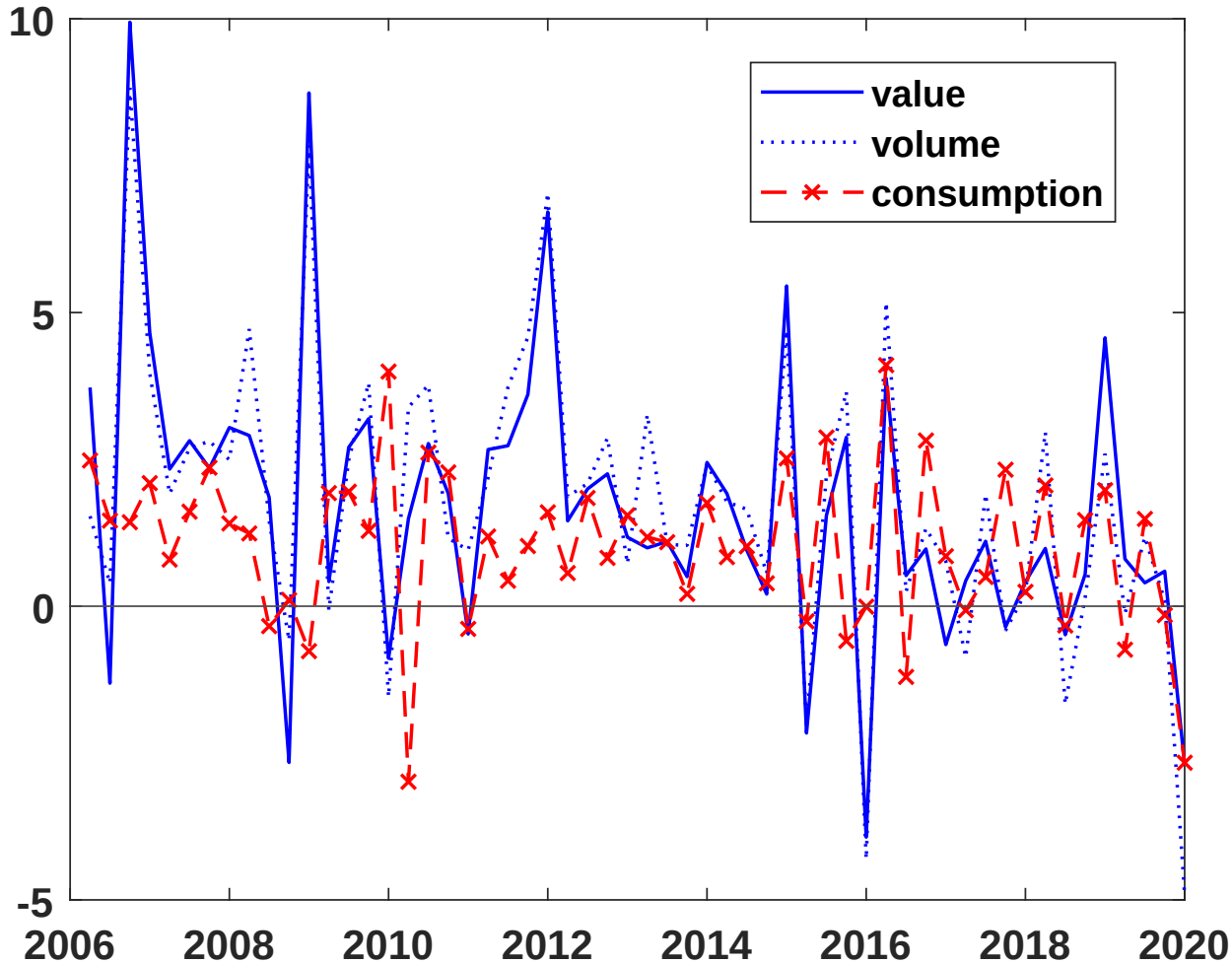


Figure: Quarter over quarter growth rate.

# Difference in Cumulative RMSFE 2021Q1

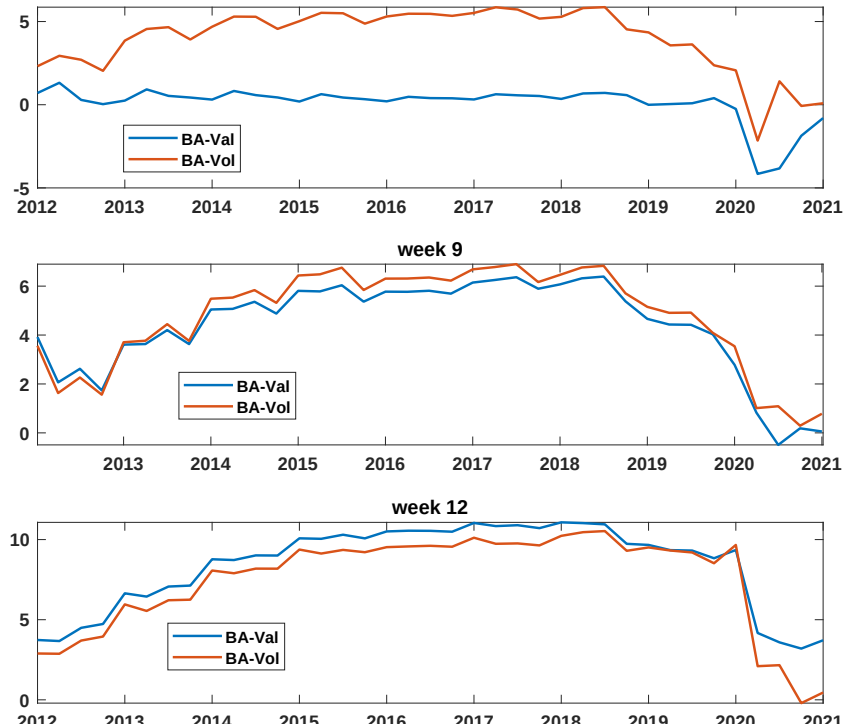


Figure: Time series of difference in cumulative Root Mean Squared Forecast Errors for selected weeks. At each point in time "t" the difference is defined as the cumulative RMSFE of the AR model minus the cumulative RMSFE for the BankAxept model up to time "t". Target variable is quarter over quarter growth of consumption.

Back

# Difference in Cumulative RMSFE 2021Q1 V2

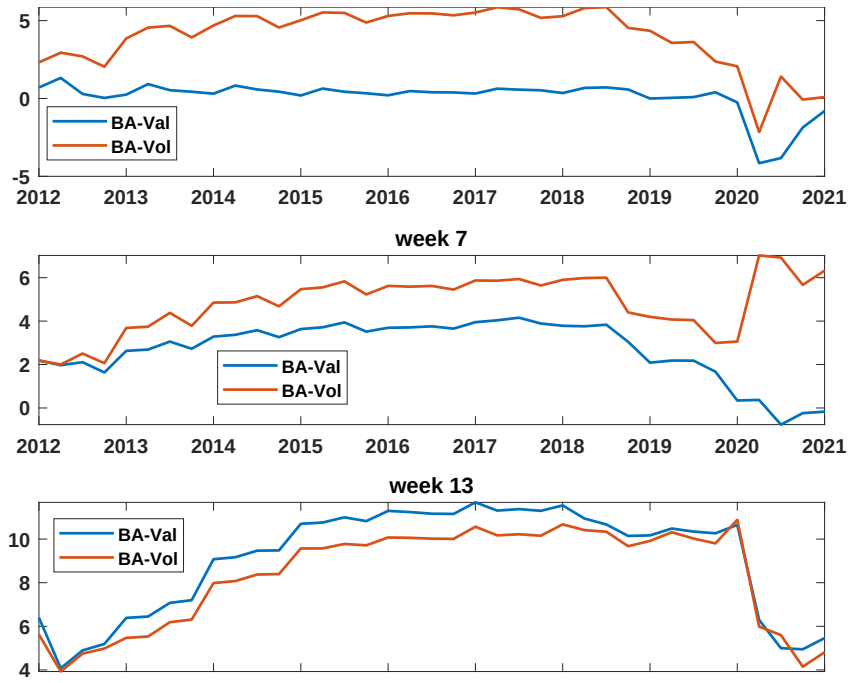


Figure: Time series of difference in cumulative Root Mean Squared Forecast Errors for selected weeks. At each point in time "t" the difference is defined as the cumulative RMSFE of the AR model minus the cumulative RMSFE for the BankAxept model up to time "t". Target variable is quarter over quarter growth of consumption.

Back

# BankAxept Data in 2020Q1

## Aggregate Data

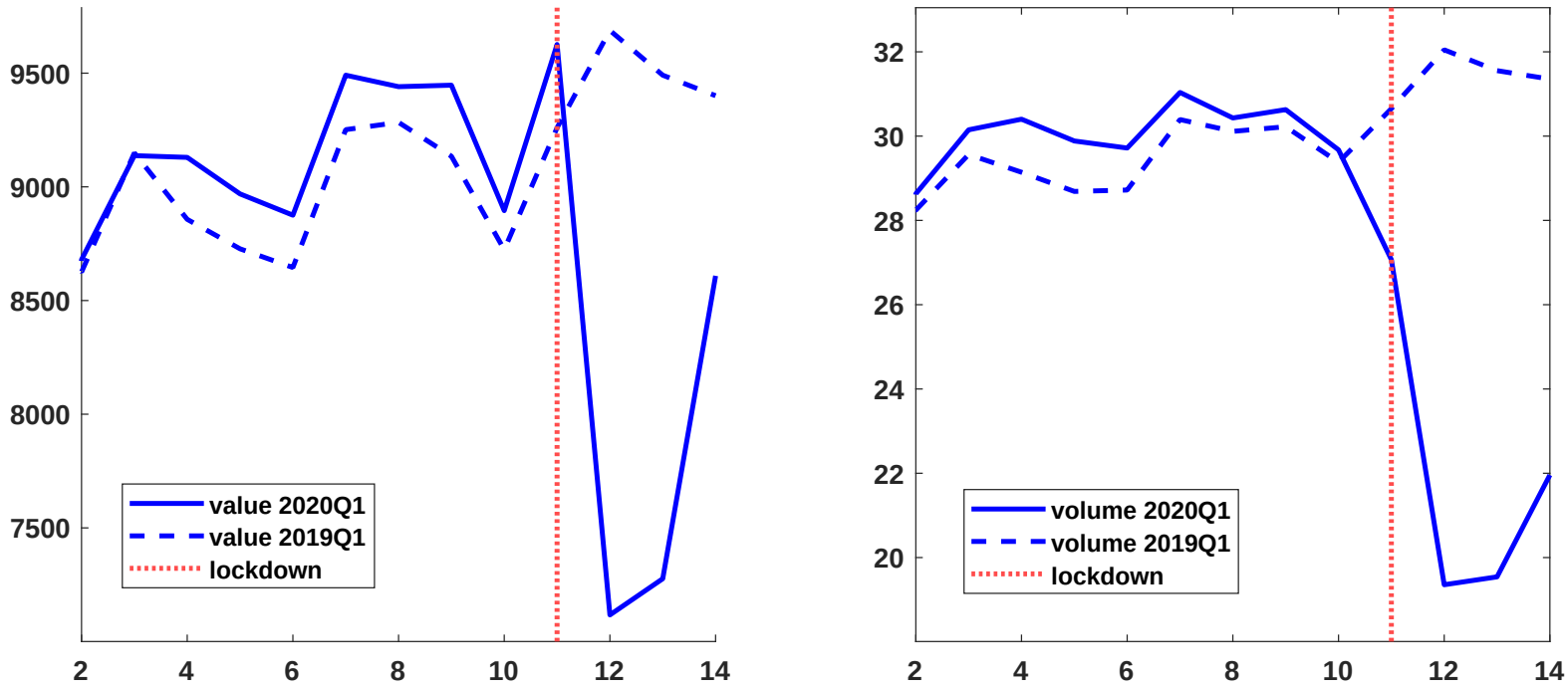


Figure: Weekly time series of debit card data over week 2 to 14 of 2020 compared to same weeks in 2019, level data. Lockdown measures implemented on March 12th (week 11).

# Nowcasting Mainland GDP

## Relative RMSFE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty |
|---|---|---|---|---|
| 1 | 0.509*** | 0.991 | 1.169*** | 1.137* |
| 2 | 0.639*** | 1.039 | 1.144** | 1.135* |
| 3 | 0.818** | 1.064 | 1.127** | 1.168*** |
| 4 | 0.894* | 1.053 | 1.116* | 1.165*** |
| 5 | 0.905* | 1.032 | 1.093 | 1.175** |
| 6 | 0.879** | 1.027 | 1.084 | 1.199*** |
| 7 | 0.865*** | 1.011 | 1.118* | 1.224*** |
| 8 | 1.077 | 1.198*** | 1.416*** | 1.529*** |
| 9 | 1.082* | 1.142*** | 1.427*** | 1.556*** |
| 10 | 1.038 | 1.056 | 1.446*** | 1.570*** |
| 11 | 0.823*** | 0.768*** | 1.467*** | 1.593*** |
| 12 | 0.495*** | 0.537*** | 1.484*** | 1.548*** |
| 13 | 0.754*** | 1.109** | 1.509*** | 1.569*** |

Table: RMSFE relative to AR model. The RMSFE for the AR model is 3.040 up to week 7 and 2.422 from week 8 onwards after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Nowcasting Mainland GDP

## Relative RMSFE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 1.090 | 1.425*** | 1.258*** |
| Retail Sales | 0.836*** | 0.949 | 0.528*** |
| Financial News | 1.125*** | 1.515*** | 1.457*** |
| Unemployment | 0.644*** | 1.247*** | 1.395*** |
| PMI | 1.107*** | 1.480*** | 1.438*** |
| R-Factor | 0.382*** | 0.666*** | 0.639*** |
| | **Week 5** | **Week 9** | **Week 13** |
| BA-Value | 0.905* | 1.082* | 0.754*** |
| BA-Volume | 1.032 | 1.142*** | 1.109** |

Table: RMSFE relative to AR model. The RMSFE for the AR model is 3.040 up to week 7 and 2.422 from week 8 onwards after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Additional Forecasting Models

- ARDL-MIDAS:

$$y_t = \delta + \sum_{j=1}^{p} y_{t-j} + \gamma B\left(L^{1/m};\theta\right) x_{n,t}^{(m)} + \eta_t, \qquad \eta_t \sim N\left(0,\sigma_\eta^2\right)$$

  - with $x_{n,t}^{(m)}$ the single $n-th$ high frequency indicator or a factor
  - $B\left(L^{1/m};\theta\right) = \sum_{k=0}^{K} B\left(k;\theta\right) L^{k/m}$
  - $L^{1/m}$: lag operator such that $L^{k/m} x_{n,t}^{(m)} = x_{n,t-k/m}^{(m)}$
  - $B\left(k;\theta\right)$: lag coefficient associated to the lag operator $L^{k/m}$
- Sparse Group LASSO-MIDAS (Babii, Ghysels, Striaukas, 2021):
  - $\hat{\beta}$ solves the penalizes least squares problem:

$$\min_{b} \quad \|\mathbf{y} - \mathbf{X}b\|_T^2 + 2\lambda\omega\left(b\right) \tag{1}$$

  - where $\omega\left(b\right) = \alpha|b|_1 + \left(1-\alpha\right)\|b\|_{2,1}$
  - where $\|b\|_{2,1} = \sum_{g\in G} |b_G|_2$ is the group LASSO norm and $G$ is a group structure

Back

# Nowcasting Exercise

## MIDAS Models

- General MIDAS Model:

$$y_t = \delta + \gamma B\left(L^{1/m};\theta\right) x_{n,t}^{(m)} + \eta_t, \quad \eta_t \sim N\left(0, \sigma_\eta^2\right)$$

  - where $y_t$ is the low frequency target variable
  - with $x_{n,t}^{(m)}$ the $n-th$ high frequency indicator, $m = 3$ for monthly, $m = 13$ for weekly data
  - $B\left(L^{1/m};\theta\right) = \sum_{k=0}^{K} B\left(k;\theta\right) L^{k/m}$
  - $L^{1/m}$: lag operator such that $L^{k/m} x_{n,t}^{(m)} = x_{n,t-k/m}^{(m)}$
  - $B\left(k;\theta\right)$: lag coefficient associated to the lag operator $L^{k/m}$, parameterized as function of low-dimensional vector of parameters $\theta$

Back

# Nowcasting Exercise

- Simple MIDAS Model with Legendre Polynomials:

$$y_t = \delta + \beta' \tilde{X}_{n,t}^{(m)} + \eta_t, \quad \eta_t \sim N\left(0, \sigma_\eta^2\right)$$

- with $\tilde{X}_{n,t}^{(m)} = Q X_{n,t}^{(m)}$ a $(p+1) \times 1$ vector
- with $X_{n,t}^{(m)}$ a $K \times 1$ vector of lags of the $n-th$ high frequency indicator:

$$X_{n,t}^{(m)} = \left[x_{n,t}^{(m)}, x_{n,(t-1)/m}^{(m)}, ....., x_{n,(t-K+1)/m}^{(m)}\right]$$

- $Q$ is a $(p+1) \times K$ matrix of coefficients:

$$Q = \begin{bmatrix} L_0(x_1) & L_0(x_2) & L_0(x_2) & \dots & L_0(x_K) \\ L_1(x_1) & L_1(x_2) & L_1(x_3) & \dots & L_1(x_K) \\ L_2(x_1) & L_2(x_2) & L_2(x_3) & \dots & L_2(x_K) \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ L_p(x_1) & L_p(x_2) & L_p(x_3) & \dots & L_p(x_K) \end{bmatrix}$$

- with $L_0(x) = 1$, $L_1(x) = x$, $L_2(x) = (3/2)x^2 - 1/2$, $L_3(x) = (3/2)x^3 - 3/2x, \dots$ and $x_1, x_2, \dots, x_K$ is uniform in the interval $[-1, 1]$
- the model is linear in the transformed data $\tilde{X}_{n,t}^{(m)}$ and the coefficient $\beta$ can be estimated via OLS

# Nowcasting Exercise

- MIDAS Models with Legendre Polynomial: Implementation Details

$$y_t = \delta + \boldsymbol{\beta}' \tilde{X}_{n,t}^{(m)} + \eta_t, \quad \eta_t \sim N\left(0, \sigma_\eta^2\right)$$

  - where $y_t$ is the qoq growth of seasonally unadjusted consumption
  - where $K = 3$ and $p = 1$ for monthly predictors, $K = 13$ and $p = 1$ for weekly predictors so $\boldsymbol{\beta}$ is a $2 \times 1$ vector
  - $X_{n,t}^{(m)} = \left[x_{n,t}^{(m)}, x_{n,(t-1)/m}^{(m)}, x_{n,(t-2)/m}^{(m)}\right]$
  - $x_{n,t}^{(m)}$ the quarter over quarter growth of the predictor (e.g. growth from M1 of 2020Q1 to M1 of 2020Q2; growth from week 1 of 2020Q1 to week 1 of 2020Q2)
  - For monthly and weekly data respectively $Q$ is:

$$Q = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \end{bmatrix}$$

$$Q = \begin{bmatrix} 1 & 1 & \dots & 1 \\ 1 & 2 & \dots & 13 \end{bmatrix}$$

# Results: Relative Log Scores Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty | Google Trends |
|---|---|---|---|---|---|
| 1 | 0.759*** | 0.844*** | 1.030 | 1.021 | 0.917** |
| 2 | 0.731*** | 0.906*** | 1.043 | 1.012 | 0.958 |
| 3 | 0.797*** | 0.958 | 1.058 | 1.008 | 0.996 |
| 4 | 0.884** | 1.018 | 1.077 | 1.002 | 1.017 |
| 5 | 0.920 | 0.994 | 1.077 | 1.003 | 0.993 |
| 6 | 0.902** | 0.919 | 1.066 | 1.006 | 0.931 |
| 7 | 0.914 | 0.875** | 0.979 | 0.967 | 0.857* |
| 8 | 0.864*** | 0.886** | 1.026 | 1.038 | 0.881* |
| 9 | 0.814*** | 0.894 | 1.024 | 1.006 | 0.855** |
| 10 | 0.803*** | 0.870** | 1.022 | 0.992 | 0.818*** |
| 11 | 0.762*** | 0.763*** | 1.020 | 1.014 | 0.786*** |
| 12 | 0.830*** | 0.789*** | 1.019 | 1.026 | 0.814*** |
| 13 | 0.792*** | 0.778*** | 1.021 | 1.030 | 0.924*** |

Table: Log Scores: averages over the evaluation sample, relative to the AR. '*', '*** and '***' indicate significance levels for the Amisano and Giacomini (2007) test at the 10, 5 and 1 percent respectively. The average log score for the AR model is -2.741 for week 1 through 7 and equals -2.621 for weeks 8 through 13 after the NA release.

# Results: Relative Log Scores Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| AR | -2.741 | -2.621 | -2.621 |
| | | | |
| Car Sales | 1.062 | 0.968*** | 1.048** |
| Retail Sales | 0.795*** | 0.652*** | 0.664*** |
| Financial News | 1.026 | 1.008 | 1.015 |
| Unemployment | 0.848** | 0.945 | 1.003 |
| PMI | 1.031 | 1.024 | 1.015 |
| Real Factor | 0.939 | 0.952 | 0.885** |
| | | | |
| | Week 5 | Week 9 | Week 13 |
| | | | |
| BA-Value | 0.920 | 0.814*** | 0.792*** |
| BA-Volume | 0.994 | 0.894 | 0.778*** |

Table: Log Scores, averages over the evaluation sample. '*', '*** and '***' indicate significance levels for the Amisano and Giacomini (2007) test at the 10, 5 and 1 percent respectively.

# BankAxept vs Retail Sales

| Relative RMSFE | | | |
|---|---|---|---|
| Model | One Month | Two Months | Full Quarter |
| | | **Relative to AR** | |
| BA-Val, RS | 0.468*** | 0.343*** | 0.381*** |
| BA-Vol, RS | 0.555*** | 0.410*** | 0.375*** |
| | | **Relative to Retail Sales** | |
| BA-Val, RS | 0.937* | 0.967* | 0.997 |
| BA-Vol, RS | 0.816*** | 0.948* | 0.988 |
| | | **Relative to BankAxept** | |
| BA-Val, RS | 0.674*** | 0.867*** | 0.926** |
| BA-Vol, RS | 0.511*** | 0.803*** | 0.740*** |

Table: Relative RMSFE from MIDAS models with monthly predictors. "BA-Val, RS" ("BA-Vol, RS") refers to a MIDAS model with both BAX-Value (BAX-Volume) and Retail Sales as regressors. Behnchmark models are (i) AR; (ii) MIDAs monthly model with retail sales (iii) MIDAS monthly model with BankAxept; '*', '*** and '***' indicate significance levels for the DM test at the 10, 5 and 1 percent respectively.

# Outline

- BankAxept Data Description
- Nowcasting Exercise
  - Model Specification
  - Predictors
  - Implementation Details
- Results
  - Point
  - Density
  - Nowcasting Consumption Subcomponents
  - Robustness Checks
- Nowcasting during COVID-19 pandemic

# Results: Rel RMSE Goods Consumption

| Week | BA-Val-G | BA-Val-S | BA-Vol-G | BA-Vol-S |
|---|---|---|---|---|
| 1 | 0.576*** | 0.735*** | 0.976 | 1.075* |
| 2 | 0.799*** | 0.816*** | 0.976 | 1.038 |
| 3 | 0.916** | 0.859** | 0.905*** | 1.029 |
| 4 | 0.896*** | 0.921* | 0.842*** | 1.024 |
| 5 | 0.832*** | 0.976 | 0.780*** | 1.032 |
| 6 | 0.810*** | 0.977 | 0.827*** | 1.061** |
| 7 | 0.793*** | 0.918*** | 0.816*** | 1.122*** |
| 8 | 0.777** | 0.891*** | 0.784*** | 1.170*** |
| 9 | 0.696*** | 0.806*** | 0.675*** | 1.129** |
| 10 | 0.585*** | 0.759*** | 0.571*** | 1.115** |
| 11 | 0.392*** | 0.566*** | 0.373*** | 0.874 |
| 12 | 0.197*** | 0.846 | 0.210*** | 1.158 |
| 13 | 0.366*** | 0.959 | 0.516*** | 1.122** |

Table: RMSFE relative to the AR model for goods consumption. Target variable: qoq growth rate of goods consumption. RMSFE for the AR model: 8.904 for week 1 through 7 and 8.294 for weeks 8 through 13. Entries smaller than one indicate the alternative model is more accurate than the AR. The forecast errors are corrected for heteroskedasticity and autocorrelation using Newey West (1987). '*', '*** and '***' indicate significance levels for the DM test at the 10, 5 and 1 percent respectively

# Results: Rel RMSE Services Consumption

| Week | BA-Val-G | BA-Val-S | BA-Vol-G | BA-Vol-S |
|---|---|---|---|---|
| 1 | 1.309*** | 1.436*** | 1.344* | 1.289*** |
| 2 | 1.274** | 1.392*** | 1.179 | 1.135* |
| 3 | 1.105 | 1.353*** | 1.035 | 1.098 |
| 4 | 0.964 | 1.296*** | 0.962 | 1.094 |
| 5 | 0.908 | 1.207** | 0.955 | 1.128 |
| 6 | 0.898 | 1.112 | 0.937 | 1.200 |
| 7 | 0.862 | 1.022 | 0.943 | 1.239 |
| 8 | 0.635*** | 0.694*** | 0.695*** | 0.862 |
| 9 | 0.678*** | 0.733*** | 0.736*** | 0.915 |
| 10 | 0.745*** | 0.781** | 0.785** | 0.927 |
| 11 | 0.844*** | 0.819* | 0.876* | 0.884 |
| 12 | 0.716*** | 0.696*** | 0.754*** | 0.735*** |
| 13 | 0.671*** | 0.652*** | 0.721*** | 0.803* |

Table: RMSFE relative to the AR model for services consumption. Target variable: qoq growth rate of services consumption. RMSFE for the AR model: 1.606 for week 1 through 7 and 2.309 for weeks 8 through 13. Entries smaller than one indicate the alternative model is more accurate than the AR. The forecast errors are corrected for heteroskedasticity and autocorrelation using Newey West (1987). '*', '*** and '***' indicate significance levels for the DM test at the 10, 5 and 1 percent respectively

# Robustness: Final Release

## Relative RMSFE Weekly Frequency

| | BA-Value | BA-Volume | Stock Prices | Uncertainty |
|---|---|---|---|---|
| Week 1 | 0.902* | 1.111* | 1.114** | 1.121*** |
| Week 2 | 1.019 | 0.997 | 1.123*** | 1.098*** |
| Week 3 | 1.028 | 0.876* | 1.119*** | 1.099*** |
| Week 4 | 0.962 | 0.834** | 1.129*** | 1.107** |
| Week 5 | 0.877** | 0.782*** | 1.131*** | 1.138*** |
| Week 6 | 0.857** | 0.852** | 1.143*** | 1.139*** |
| Week 7 | 0.834** | 0.854** | 1.162*** | 1.176*** |
| Week 8 | 0.857** | 0.865* | 1.344*** | 1.296*** |
| Week 9 | 0.775*** | 0.753*** | 1.350*** | 1.323*** |
| Week 10 | 0.688*** | 0.664*** | 1.356*** | 1.369*** |
| Week 11 | 0.579*** | 0.528*** | 1.362*** | 1.405*** |
| Week 12 | 0.558*** | 0.557*** | 1.388*** | 1.358*** |
| Week 13 | 0.622*** | 0.685*** | 1.428*** | 1.395** |

Table: RMSFE relative to AR model. The RMSFE for the AR model is 4.25 up to week 7 and 3.77 from week 8 onwards after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Results: RMSE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty |
|---|---|---|---|---|
| 1 | 0.951 | 1.137* | 1.175** | 1.133*** |
| 2 | 1.066 | 0.998 | 1.146** | 1.127*** |
| 3 | 1.057 | 0.862** | 1.139*** | 1.113*** |
| 4 | 0.964 | 0.801** | 1.147*** | 1.128*** |
| 5 | 0.858** | 0.738*** | 1.151*** | 1.165*** |
| 6 | 0.829*** | 0.806*** | 1.163*** | 1.156*** |
| 7 | 0.788*** | 0.794*** | 1.192*** | 1.189*** |
| 8 | 0.795** | 0.799** | 1.389*** | 1.338*** |
| 9 | 0.700*** | 0.690*** | 1.394*** | 1.346*** |
| 10 | 0.619*** | 0.618*** | 1.400*** | 1.412*** |
| 11 | 0.507*** | 0.474*** | 1.405*** | 1.466*** |
| 12 | 0.356*** | 0.368*** | 1.432*** | 1.439*** |
| 13 | 0.456*** | 0.558*** | 1.471*** | 1.476*** |

Table: RMSFE relative to AR model. The RMSFE for the AR model is 3.98 up to week 7 and 3.47 from week 8 onwards after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

# Results: Rel RMSE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 1.046 | 1.020 | 1.047 |
| Retail Sales | 0.843*** | 0.494*** | 0.438*** |
| Financial News | 1.153*** | 1.404*** | 1.353*** |
| Unemployment | 0.839*** | 1.021 | 1.186 |
| PMI | 1.168*** | 1.400*** | 1.385*** |
| Real Factor | 0.747*** | 1.074** | 0.907 |
| | **Week 5** | **Week 9** | **Week 13** |
| BA-Value | 0.858** | 0.700*** | 0.456*** |
| BA-Volume | 0.738*** | 0.690*** | 0.558*** |

Table: RMSFE relative to AR model. RMSFE for AR model: 3.98 in column "One Month" and 3.47 in columns "Two Months" and "Full Quarter" after the release of previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq. Note that Retail Sales is available about one month after the end of the reference month.

# Results: Log Scores Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty |
|---|---|---|---|---|
| 1 | -2.815 | -2.939* | -2.977** | -2.942*** |
| 2 | -2.892 | -2.791 | -2.956*** | -2.937*** |
| 3 | -2.863 | -2.626*** | -2.961*** | -2.926*** |
| 4 | -2.756 | -2.539*** | -2.980*** | -2.943*** |
| 5 | -2.626*** | -2.445*** | -2.990*** | -2.973*** |
| 6 | -2.596*** | -2.569*** | -3.007*** | -2.963*** |
| 7 | -2.565** | -2.599* | -3.586*** | -3.476*** |
| 8 | -2.410** | -2.418** | -3.591*** | -3.362*** |
| 9 | -2.262*** | -2.245*** | -3.575*** | -3.477*** |
| 10 | -2.215** | -2.235** | -3.569*** | -3.588*** |
| 11 | -2.530 | -2.228** | -3.584*** | -3.740*** |
| 12 | -2.087* | -1.991*** | -3.729*** | -3.673*** |
| 13 | -1.966*** | -2.089*** | -3.933*** | -3.779** |

Table: Log Scores: averages over the evaluation sample. '*', '*** and '***' indicate significance levels for the Amisano and Giacomini (2007) test at the 10, 5 and 1 percent respectively. The average log score for the AR model is -2.822 for week 1 through 7 and equals -2.688 for weeks 8 through 13 after the NA release.

# Results: Log Scores Monthly-Quarterly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| AR | -2.822 | -2.688 | -2.688 |
| | | | |
| Car Sales | -2.930** | -2.934 | -3.031 |
| Retail Sales | -2.605** | -1.932*** | -2.162*** |
| Financial News | -2.959*** | -3.789*** | -4.168*** |
| Unemployment | -2.684 | -2.761 | -2.844* |
| PMI | -2.951 | -3.721*** | -3.749*** |
| Real Factor | -2.625** | -2.863* | -2.644 |
| BT Survey | -2.513* | -2.808 | -3.372 |
| | | | |
| | Week 5 | Week 9 | Week 13 |
| | | | |
| BA-Value | -2.626*** | -2.262*** | -1.966*** |
| BA-Volume | -2.445*** | -2.245*** | -2.089*** |

Table: Log Scores, averages over the evaluation sample. '*', '*** and '***' indicate significance levels for the Amisano and Giacomini (2007) test at the 10, 5 and 1 percent respectively. The average log score for the AR model is -2.822 for week 1 through 7 and equals -2.688 for weeks 8 through 13 after the NA release.

# Robustness: YoY Growth Rates

## Relative RMSFE Weekly Frequency

| Week | BA-Value | BA-Volume | Stock Prices | Uncertainty |
|---|---|---|---|---|
| 1 | 1.160*** | 1.285** | 1.095* | 1.020 |
| 2 | 1.189 | 1.351 | 1.126* | 0.996 |
| 3 | 1.029 | 1.058 | 1.141* | 0.984 |
| 4 | 0.921 | 0.911 | 1.150* | 1.000 |
| 5 | 0.849 | 0.814 | 1.151** | 0.980 |
| 6 | 1.115*** | 1.072 | 1.132** | 1.011 |
| 7 | 1.198* | 1.095 | 1.080* | 1.067 |
| 8 | 0.937 | 0.865 | 1.031 | 1.018 |
| 9 | 0.970 | 0.863 | 0.999 | 1.004 |
| 10 | 0.860 | 0.816 | 0.955 | 1.097 |
| 11 | 0.881 | 0.792 | 0.909 | 1.243* |
| 12 | 0.873 | 0.667 | 0.897 | 1.190* |
| 13 | 0.770 | 0.646 | 0.938 | 1.355* |

Table: RMSFE relative to AR model. The RMSFE for the AR model is 4.25 up to week 7 and 3.77 from week 8 onwards after the release of the previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# Robustness: YoY Growth Rates

## Relative RMSFE Monthly Frequency

| | One Month | Two Months | Full Quarter |
|---|---|---|---|
| Car Sales | 1.181*** | 1.109 | 1.172*** |
| Retail Sales | 1.018 | 1.024 | 0.927 |
| Financial News | 1.115*** | 1.034 | 1.041 |
| Unemployment | 1.063* | 1.027 | 1.150* |
| PMI | 1.042* | 0.985 | 0.934 |
| Real Factor | 1.082* | 1.024 | 1.010 |
| BT Survey | 1.428*** | 1.133*** | 1.210*** |
| | Week 5 | Week 9 | Week 13 |
| BA-Value | 0.849 | 0.970 | 0.770 |
| BA-Volume | 0.814 | 0.863 | 0.646 |

Table: RMSFE relative to AR model. RMSFE for AR model: 4.25 in column "One Month" and 3.77 in columns "Two Months" and "Full Quarter" after the release of previous quarter value. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

Back

# BankAxept Data and MPR: Today

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- The coronavirus outbreak forced us to produce more disaggregated forecasts of household consumption
- Subgroups of services consumption directly affected by containment measures are not well represented in BankAxept:
  - child and health care services
  - education
  - parts of recreational and cultural services
  - purchases abroad by resident households
- Use BankAxept mainly to nowcast goods consumption (excluding car purchases and electricity consumption) and hotel and restaurant purchases (14% of services consumption)
- Look at alternative indicators and apply judgement to the other services subgroups (e.g. for consumption abroad look at percentage change in number of international flights)

# BankAxept Data and MPR: Going Forward

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# BankAxept Data and MPR: Going Forward

- Normally, the variation in household consumption is due to goods consumption and not services consumption
- When the containment measures that affect services consumption are lifted, we expect to be able to rely on BankAxept to nowcast a bigger share of household consumption
- Recently started to receive credit card data which cover services better than BankAxept and should help to further improve our nowcasts
  - A preliminary evaluation exercise shows credit card data improve nowcasts of services consumption compared to BAX, because of bills and online purchases.
  - It also improves our nowcasts of goods consumption, but only in months were online purchases are high (e.g. in November due to Black Friday offers). Note that this data series starts in January 2019.

# BankAxept Data (Week 10) and MPR

| | BA-Value | BA-Volume | MPR |
|---|---|---|---|
| | **Against First Release** | | |
| QoQ | 0.619*** | 0.618*** | 0.701 |
| YoY | 0.860 | 0.816 | 0.776 |
| | **Against Latest Release** | | |
| QoQ | 0.688*** | 0.664*** | 0.724 |
| YoY | 0.877 | 0.807 | 0.819 |

Table: RMSFE relative to AR model. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.

# BankAxept Data (Week 13) and MPR

| | BA-Value | BA-Volume | MPR |
|---|---|---|---|
| | **Against First Release** | | |
| QoQ | 0.456*** | 0.558*** | 0.701 |
| YoY | 0.770 | 0.646 | 0.776 |
| | **Against Latest Release** | | |
| QoQ | 0.622*** | 0.685*** | 0.724 |
| YoY | 0.837 | 0.744 | 0.819 |

Table: RMSFE relative to AR model. Entries smaller than one indicate the alternative model is more accurate than the AR. Differential in squared forecast errors are corrected for heteroskedasticity and autocorrelation using Newey and West (1987). '*', '*** and '***' indicate significance levels for the Diebold and Mariano (1995) test at the 10, 5 and 1 percent respectively. Predictors in growth rates are computed as qoq.