SUPPLEMENTARY RESULTS
Addressing COVID-19 Outliers in BVARs with Stochastic Volatility*

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Abstract

This online appendix provides additional results that complement the results shown in our paper.

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Table S.1: Relative RMSE in 2020

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Note: Comparison of “CONST” (baseline, in denominator of relative comparisons) against “SV” and “SVO.” Values below one indicate improvement over baseline. Evaluation window from 2020:M01 through 2020:M09. Due to the low number of observations in the evaluation window, significance tests have not been performed.
Table S.2: Relative Avg CRPS in 2020

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<td>0.62</td>
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<td>1.11</td>
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<td>0.88</td>
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<td>0.77</td>
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Note: Comparison of “CONST” (baseline, in denominator of relative comparisons) against “SV” and “SVO.” Values below one indicate improvement over baseline. Evaluation window from 2020:M01 through 2020:M09. Due to the low number of observations in the evaluation window, significance tests have not been performed.
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<td>1.03</td>
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Note: Comparison of “SVO” (baseline, in denominator of relative comparisons) against “SV-t(5)” and “SV-OutMiss.” Values below one indicate improvement over baseline. Evaluation window from 2020:M01 through 2020:M09. Due to the low number of observations in the evaluation window, significance tests have not been performed.
Table S.4: Relative Avg CRPS in 2020 (alternative models)

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<tr>
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</table>

Note: Comparison of “SVO” (baseline, in denominator of relative comparisons) against “SV-t(5)” and “SV-OutMiss.” Values below one indicate improvement over baseline. Evaluation window from 2020:M01 through 2020:M09. Due to the low number of observations in the evaluation window, significance tests have not been performed.
<table>
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<th>12</th>
<th>24</th>
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<th>3</th>
<th>12</th>
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<th>3</th>
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<td>11.04</td>
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<td>1.43</td>
<td>0.98</td>
<td>0.99</td>
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<td>1.01</td>
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<td>0.95</td>
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<tr>
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<td>0.97</td>
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<td>0.95</td>
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<td>1.00</td>
<td>1.06</td>
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<td>1.11</td>
<td>2.25</td>
<td>1.02</td>
<td>1.07</td>
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<td>0.94</td>
<td>1.02</td>
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<td>0.94</td>
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<td>2.67</td>
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<td>0.92</td>
<td>0.95</td>
<td>0.91</td>
<td>0.88</td>
<td>0.93</td>
<td>0.94</td>
<td>0.90</td>
</tr>
<tr>
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<td>0.24</td>
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<td>0.50</td>
<td>0.98</td>
<td>1.05</td>
<td>1.02</td>
<td>0.99</td>
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<td>1.03</td>
<td>0.89</td>
<td>0.85</td>
<td>0.95</td>
<td>1.02</td>
<td>0.88</td>
<td>0.76</td>
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<tr>
<td>PPI (fin. goods)</td>
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<td>10.63</td>
<td>11.77</td>
<td>11.01</td>
<td>1.00</td>
<td>0.98</td>
<td>0.94</td>
<td>0.88</td>
<td>1.00</td>
<td>0.98</td>
<td>0.93</td>
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<td>1.04</td>
<td>1.04</td>
<td>0.96</td>
<td>0.90</td>
<td>1.04</td>
<td>1.03</td>
<td>0.95</td>
<td>0.91</td>
</tr>
<tr>
<td>S&amp;P 500</td>
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<td>52.15</td>
<td>52.70</td>
<td>39.08</td>
<td>1.04</td>
<td>1.00</td>
<td>1.01</td>
<td>1.06</td>
<td>1.04</td>
<td>1.00</td>
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<td>29.89</td>
<td>27.40</td>
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<td>0.96</td>
<td>0.95</td>
<td>0.98</td>
<td>0.94</td>
<td>0.96</td>
<td>0.95</td>
<td>0.97</td>
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<tr>
<td>5-Year yield</td>
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<td>0.67</td>
<td>1.28</td>
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<td>0.87</td>
<td>1.09</td>
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<tr>
<td>10-Year yield</td>
<td>0.27</td>
<td>0.65</td>
<td>1.39</td>
<td>1.53</td>
<td>0.92</td>
<td>0.88</td>
<td>0.81</td>
<td>0.86</td>
<td>0.92</td>
<td>0.88</td>
<td>0.81</td>
<td>0.86</td>
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<td>2.09</td>
<td>1.78</td>
<td>0.81</td>
<td>0.74</td>
<td>0.86</td>
<td>0.80</td>
<td>0.79</td>
<td>0.71</td>
<td>0.82</td>
<td>0.78</td>
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Note: Comparison of “CONST” (baseline, in denominator of relative comparisons) against “SV” and “SVO.” Values below one indicate improvement over baseline. Evaluation window from 2007:M01 through 2014:M12. Significance assessed by Diebold-Mariano test using Newey-West standard errors with $h + 1$ lags.
Table S.6: Relative Avg CRPS around the GFC

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<th>SVO</th>
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<td>3</td>
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<td>4.94</td>
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<tr>
<td>Real Consumption</td>
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<td>2.63</td>
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<tr>
<td>IP</td>
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<td>4.43</td>
<td>5.00</td>
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<tr>
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<td>0.57</td>
<td>1.91</td>
</tr>
<tr>
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<td>0.59</td>
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<td>0.28</td>
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<td>1.29</td>
<td>1.49</td>
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<td>6.64</td>
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<td>0.24</td>
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<td>0.82</td>
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<tr>
<td>Baa spread</td>
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<td>1.14</td>
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</table>

Note: Comparison of “CONST” (baseline, in denominator of relative comparisons) against “SV” and “SVO.” Values below one indicate improvement over baseline. Evaluation window from 2007:M01 through 2014:M12. Significance assessed by Diebold-Mariano test using Newey-West standard errors with $h + 1$ lags.
Table S.7: Relative RMSE around the GFC (alternative models)

<table>
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<th>SV-t(5)</th>
<th>SV-OutMiss</th>
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<td>11.03</td>
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<tr>
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<td>4.08</td>
<td>3.87</td>
<td>3.96</td>
</tr>
<tr>
<td>IP</td>
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<td>8.73</td>
<td>10.53</td>
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<td>1.10</td>
</tr>
<tr>
<td>Nonfarm payrolls</td>
<td>1.20</td>
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<td>2.20</td>
</tr>
<tr>
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<td>0.26</td>
<td>0.52</td>
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<td>10.95</td>
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<td>PCE prices</td>
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<td>3.36</td>
<td>3.79</td>
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<tr>
<td>Housing Starts</td>
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<td>0.15</td>
<td>0.38</td>
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<tr>
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<td>53.22</td>
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<td>1.11</td>
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<tr>
<td>10-Year yield</td>
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<tr>
<td>Baa spread</td>
<td>0.32</td>
<td>0.77</td>
<td>1.71</td>
</tr>
</tbody>
</table>

Note: Comparison of “SVO” (baseline, in denominator of relative comparisons) against “SV-t(5)” and “SV-OutMiss.” Values below one indicate improvement over baseline. Evaluation window from 2007:M01 through 2014:M12. Significance assessed by Diebold-Mariano test using Newey-West standard errors with \( h + 1 \) lags. Due to the close behavior of some of the models compared, and rounding of the report values, a few comparisons show a significant relative RMSE (alternative models) of 1.00. These cases arise from persistent differences in performance that are, however, too small to be relevant after rounding.
Table S.8: Relative Avg CRPS around the GFC (alternative models)

<table>
<thead>
<tr>
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<th>SV-t(5)</th>
<th>SV-OutMiss</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>4.32</td>
<td>5.70</td>
</tr>
<tr>
<td>Capacity Utilization</td>
<td>0.27</td>
<td>0.53</td>
<td>1.94</td>
</tr>
<tr>
<td>Unemployment</td>
<td>0.09</td>
<td>0.16</td>
<td>0.57</td>
</tr>
<tr>
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<td>1.28</td>
</tr>
<tr>
<td>Hours</td>
<td>0.11</td>
<td>0.14</td>
<td>0.28</td>
</tr>
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<td>1.17</td>
<td>1.24</td>
<td>1.41</td>
</tr>
<tr>
<td>PPI (fin. goods)</td>
<td>5.33</td>
<td>5.70</td>
<td>6.14</td>
</tr>
<tr>
<td>PCE prices</td>
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<td>1.70</td>
<td>2.05</td>
</tr>
<tr>
<td>Housing Starts</td>
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<td>0.08</td>
<td>0.21</td>
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<td>S&amp;P 500</td>
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<td>26.46</td>
<td>29.16</td>
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<td>USD / GBP FX rate</td>
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<td>15.61</td>
<td>16.09</td>
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<tr>
<td>5-Year yield</td>
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<td>0.61</td>
</tr>
<tr>
<td>10-Year yield</td>
<td>0.14</td>
<td>0.31</td>
<td>0.66</td>
</tr>
<tr>
<td>Baa spread</td>
<td>0.15</td>
<td>0.38</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Note: Comparison of “SVO” (baseline, in denominator of relative comparisons) against “SV-t(5)” and “SV-OutMiss.” Values below one indicate improvement over baseline. Evaluation window from 2007:M01 through 2014:M12. Significance assessed by Diebold-Mariano test using Newey-West standard errors with $h+1$ lags. Due to the close behavior of some of the models compared, and rounding of the report values, a few comparisons show a significant relative CRPS (alternative models) of 1.00. These cases arise from persistent differences in performance that are, however, too small to be relevant after rounding.
Figure S.1: Posteriors of Outlier States for Real Income

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $\sigma_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $\sigma_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.2: Posteriors of Outlier States for Real Consumption

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $\sigma_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $\sigma_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.3: Postiers of Outlier States for IP

(a) SV-t

(b) SVO

(c) SV-t (recent)

(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of \( o_{j,t} \) in SV-t and SVO models. Each panel shows posterior probabilities for \( o_{j,t} \) to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.4: Posterials of Outlier States for Capacity Utilization

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.5: Posteriors of Outlier States for Unemployment

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.6: Posteriors of Outlier States for Nonfarm Payrolls

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.7: Posterials of Outlier States for Hours

(a) SV-t

(b) SVO

(c) SV-t (recent)

(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $\sigma_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $\sigma_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.8: Posteriors of Outlier States for Hourly Earnings

(a) SV-t

(b) SVO

(c) SV-t (recent)

(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.9: Posteriors of Outlier States for PPI (fin. goods)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.10: Postiors of Outlier States for PCE prices

(a) SV-t

(b) SVO

(c) SV-t (recent)

(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.11: Postiors of Outlier States for Housing Starts

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.12: Posteriorities of Outlier States for SP500

(a) SV-t
(b) SVO
(c) SV-t (recent)
(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $\sigma_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $\sigma_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.13: Posteriors of Outlier States for U.S. / U.K. Forex

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.14: Posterior plots of Outlier States for 5-Year yield

(a) SV-t

(b) SVO

(c) SV-t (recent)

(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of \( o_{j,t} \) in SV-t and SVO models. Each panel shows posterior probabilities for \( o_{j,t} \) to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.15: Posterials of Outlier States for 10-Year yield

(a) SV-t

(b) SVO

(c) SV-t (recent)

(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $o_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $o_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.16: Postiers of Outlier States for Baa spread

(a) SV-t

(b) SVO

(c) SV-t (recent)

(d) SVO (recent)

Note: Full-sample estimates per September 2020 of posterior probabilities for realizations of $\alpha_{j,t}$ in SV-t and SVO models. Each panel shows posterior probabilities for $\alpha_{j,t}$ to fall into a range between two and five (blue bars) or to be larger than five (orange bars) in a given month of the sample. The lower row of panels zooms in on results for the last few years (numbers are identical to the corresponding results in the upper-row panels). The SV-t model is estimated with five degrees of freedom.
Figure S.17: SVO outlier probabilities

(a) Real Income

(b) Real Consumption

(c) IP

(d) Capacity Utilization

Note: Prior and posterior distribution of the outlier probability $p_j$ in the SVO model for selected variables, estimated from the full sample of data available from Match 1959 through September 2020.
Figure S.17: SVO outlier probabilities (ctd.)

(e) Unemployment

(f) Nonfarm Payrolls

(g) Hours

(h) Hourly Earnings

Note: Prior and posterior distribution of the outlier probability $p_j$ in the SVO model for selected variables, estimated from the full sample of data available from Match 1959 through September 2020.
Figure S.17: SVO outlier probabilities (ctd.)

(i) PPI (fin. goods)  
(j) PCE prices

(k) Housing Starts  
(l) S&P 500

Note: Prior and posterior distribution of the outlier probability $p_j$ in the SVO model for selected variables, estimated from the full sample of data available from Match 1959 through September 2020.
Figure S.17: SVO outlier probabilities (ctd.)

(m) USD / GBP FX rate

(n) 5-Year yield

(o) 10-Year yield

(p) Baa spread

Note: Prior and posterior distribution of the outlier probability $p_j$ in the SVO model for selected variables, estimated from the full sample of data available from Match 1959 through September 2020.
Figure S.18: Time-varying volatilities of Real Income in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.19: Time-varying volatilities of Real Consumption in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-$t$, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.20: Time-varying volatilities of IP in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.21: Time-varying volatilities of Capacity Utilization in 2020

(a) SV

(b) SVO

(c) SV-t

(d) SV-OUTMISS

(e) ex outlier

(f) ex outlier

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.22: Time-varying volatilities of Unemployment in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.23: Time-varying volatilities of Nonfarm Payrolls in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.24: Time-varying volatilities of Hours in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.25: Time-varying volatilities of Hourly Earnings in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of \( \Sigma_t \). Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from \( \Sigma_t = A^{-1} \Lambda_t A^{-T} \) (i.e. neglecting the \( O_t \) components in the computation of the uncertainty measures shown here, while including outliers in estimation of \( A^{-1} \), \( \Lambda_t \), etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.26: Time-varying volatilities of PPI (fin. goods) in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}, \Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.27: Time-varying volatilities of PCE prices in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.28: Time-varying volatilities of Housing Starts in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.29: Time-varying volatilities of S&P 500 in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.30: Time-varying volatilities of USD / GBP FX rate in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.31: Time-varying volatilities of 5-Year yield in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.32: Time-varying volatilities of 10-Year yield in 2020

(a) SV
(b) SVO
(c) SV-t
(d) SV-OutMiss
(e) ex outlier
(f) ex outlier

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.33: Time-varying volatilities of Baa spread in 2020

Note: Quasi-real-time trajectories of time-varying volatility in VAR residuals, measured by the diagonal elements of $\Sigma_t$. Medians of (smoothed) posterior obtained from different data samples ending at forecast origins as indicated in the figure legend. Panels (e) and (f) display estimates of stochastic volatility for SVO and SV-t, respectively, that ignore the contributions from outliers computed from $\Sigma_t = A^{-1} \Lambda_t A^{-T}$ (i.e. neglecting the $O_t$ components in the computation of the uncertainty measures shown here, while including outliers in estimation of $A^{-1}$, $\Lambda_t$, etc.). Reflecting the sizable differences in the size of estimates resulting with and without outlier treatment, different scales are used in upper- and lower-row panels.
Figure S.34: Predictive densities since March 2020 for Real Income

(a) March

CONST and SV alternatives

(b) April

(c) August

SV with outlier adjustments

(d) March

(e) April

(f) August

SV with and without Dummies

(g) March

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.35: Predictive densities since March 2020 for Real Consumption

CONST and SV alternatives

(a) March

(b) April

(c) August

SV with outlier adjustments

(d) March

(e) April

(f) August

SV with and without Dummies

(g) March

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.36: Predictive densities since March 2020 for IP

(a) March

(b) April

(c) August

(d) March

(e) April

(f) August

(g) March

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.37: Predictive densities since March 2020 for Capacity Utilization

(a) March

(b) April

(c) August

(d) March

(e) April

(f) August

(g) March

(h) April

(i) August

CONST and SV alternatives

SV with outlier adjustments

SV with and without Dummies

Note: Medians and 68% uncertainty bands of predictive densities, simluated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.38: Predictive densities since March 2020 for Unemployment

(a) March

(b) April

(c) August

(d) March

(e) April

(f) August

(g) March

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.39: Predictive densities since March 2020 for Nonfarm Payrolls

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.40: Predictive densities since March 2020 for Hours

(a) March
(b) April
(c) August
(d) March
(e) April
(f) August
(g) March
(h) April
(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.41: Predictive densities since March 2020 for Hourly Earnings

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.42: Predictive densities since March 2020 for PPI (fin. goods)

(a) March  
CONST and SV alternatives

(b) April

(c) August

(d) March  
SV with outlier adjustments

(e) April

(f) August

(g) March  
SV with and without Dummies

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.43: Predictive densities since March 2020 for PCE prices

(a) March  

(b) April  

(c) August

(d) March  

(e) April  

(f) August

(g) March  

(h) April  

(i) August

SV with outlier adjustments

SV with and without Dummies

Note: Medians and 68\% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.44: Predictive densities since March 2020 for Housing Starts

(a) March  
CONST and SV alternatives

(b) April

(c) August

(d) March
SV with outlier adjustments

(e) April

(f) August

(g) March
SV with and without Dummies

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.45: Predictive densities since March 2020 for S&P 500

(a) March  
(b) April  
(c) August

CONST and SV alternatives

(d) March  
(e) April  
(f) August

SV with outlier adjustments

(g) March  
(h) April  
(i) August

SV with and without Dummies

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) - (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.46: Predictive densities since March 2020 for USD / GBP FX rate

CONST and SV alternatives

(a) March

(b) April

(c) August

SV with outlier adjustments

(d) March

(e) April

(f) August

SV with and without Dummies

(g) March

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.47: Predictive densities since March 2020 for 5-Year yield

(a) March
(b) April
(c) August
(d) March
(e) April
(f) August
(g) March
(h) April
(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.48: Predictive densities since March 2020 for 10-Year yield

(a) March

(b) April

(c) August

(d) March

(e) April

(f) August

(g) March

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.49: Predictive densities since March 2020 for Baa spread

(CONST and SV alternatives)

(a) March

(b) April

(c) August

(SV with outlier adjustments)

(d) March

(e) April

(f) August

(SV with and without Dummies)

(g) March

(h) April

(i) August

Note: Medians and 68% uncertainty bands of predictive densities, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. In panels (d) – (f), observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.50: Comparison SVO vs SV-OutMiss in 2020 for Real Income

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.52: Comparison SVO vs SV-OutMiss in 2020 for IP

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.53: Comparison SVO vs SV-OutMiss in 2020 for Capacity Utilization

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.54: Comparison SVO vs SV-OutMiss in 2020 for Unemployment

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.55: Comparison SVO vs SV-OutMiss in 2020 for Nonfarm Payrolls

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.56: Comparison SVO vs SV-OutMiss in 2020 for Hours

(a) January          (b) February          (c) March

(d) April           (e) May              (f) Jun

(g) April           (h) May              (i) Jun

Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.57: Comparison SVO vs SV-OutMiss in 2020 for Hourly Earnings

Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.58: Comparison SVO vs SV-OutMiss in 2020 for PPI (fin. goods)

Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.59: Comparison SVO vs SV-OutMiss in 2020 for PCE prices

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.60: Comparison SVO vs SV-OutMiss in 2020 for Housing Starts

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.61: Comparison SVO vs SV-OutMiss in 2020 for S&P 500

Note: Medians of predictive densities for models SVO and SV-Outmiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.62: Comparison SVO vs SV-OutMiss in 2020 for USD / GBP FX rate

Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.63: Comparison SVO vs SV-OutMiss in 2020 for 5-Year yield

(a) January

(b) February

(c) March

(d) April

(e) May

(f) Jun

(g) April

(h) May

(i) Jun

Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.64: Comparison SVO vs SV-OutMiss in 2020 for 10-Year yield

Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.
Figure S.65: Comparison SVO vs SV-OutMiss in 2020 for Baa spread

Note: Medians of predictive densities for models SVO and SV-OutMiss as well as 68% and 50% uncertainty bands for SV-OutMiss, simulated out-of-sample at various forecast origins as indicated in each panel. The solid green line denotes realized data prior to the forecast origin. Observations identified ex-ante as outliers, based on being more than 5 times the inter-quartile range away from the median, are indicated with a circle, and the corresponding backcast densities from the SV-OutMiss model are superimposed.