

Online Appendix

for

“Are Business Applications Early Economic Indicators?”

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In this appendix, we repeat the cross-correlation analysis from the main text, except that we now include the pandemic period. Panels A and B of Figure A1 are similar to those of Figure 2, except that we use growth rates for all years (growth rates for July 2005–September 2022). The inclusion of the pandemic years leads to some non-trivial changes. HBA and Retail Sales now exhibit a negative correlation with nonfarm employment for all $k > 0$. Moreover, for HBA the correlations are no longer monotonic in k . Nevertheless, HBA retains its lead of Nonfarm Employment at $k = -9$ and Retail Sales does the same for $k = -1$.

These changes are driven by the unusually sharp contraction in economic activity in the early stages of the pandemic. Figure A2 is similar to Figure A1, except that we exclude growth rates for March–June 2020 and March–June 2021 in the analysis. We eliminate the growth rates for March–June 2021 because, as the growth rates are calculated on a year-over-year basis, they use data from 2020 in their computation. We find that HBA and Retail Sales lead times are closer to those when we focus on the pre-pandemic period in panels A and B of Figure 2.

Figure A3 takes a closer look at the monthly year-over-year growth rates of HBA, Retail Sales, and Nonfarm Employment during the Great Recession and the COVID-19 recession. Panel A shows clearly how HBA and retail sales lead nonfarm employment during the Great Recession. Panel B shows a sharp decline in all three series in April 2020 followed by a swift recovery in HBA and slower recoveries for Retail Sales and Nonfarm Employment, which alter the correlations among these series.

The growth rates during March–June 2020 are dramatic outliers given the unprecedented sharp contraction of the economy during the lockdown phases of the pandemic. In April 2020, Nonfarm Employment declined by 14.3% (on a year-over-year basis), Retail Sales declined by 22.6%, and HBA by 34.7%. For the analysis in this paper seeking to explore the general relationship between the BFS series and key PFEIs, it is unclear that inferences should be based on data that include those outlier months. Nevertheless, we include the analysis with those months for completeness. The results

including all years but excluding March–June 2020 are broadly similar to those pre-pandemic (i.e., a comparison of Figure 2 and Figure A2). In other words, these unusual months provide less guidance about the typical relationship between the BFS series and the key PFEIs.

Table A1 reports the lead/lag of all the PFEI’s and nonfarm employment and the correlations. Columns 2–7 reports these results for three cases: 1) excluding growth rates for 2020–2022 (our baseline case in the main text), 2) including all years (2005–2022), and 3) including all years (2005–2022) except for the growth rates for March–June of 2020 and 2021. We find that in all three cases, HBA exhibits similar patterns. For the case of BA, the series has a higher lead with a positive correlation when we exclude the growth rates for March–June of 2020 and 2021. Table A2 reports whether HBA leads/lags the PFEI’s listed in Table A1 for the same three cases. We find similar patterns in that across the three cases HBA tends to lead the other PFEI’s. While HBA’s lead times generally increase when we exclude growth rates for March–June of 2020 and 2021, the correlations get weaker in many cases.

Figure A1. Cross-correlograms of monthly year-over-year growth rates (all years, 2005–2022)

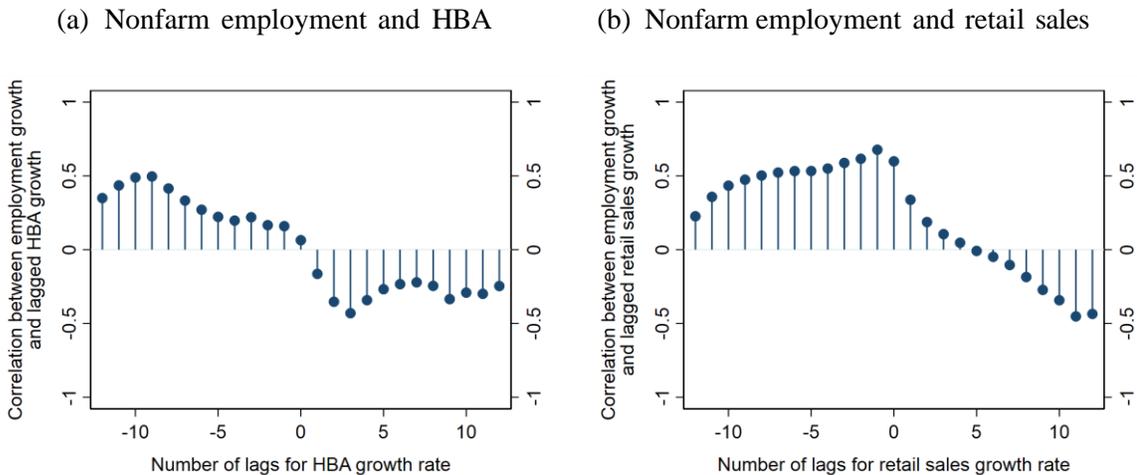


Figure A2. Cross-correlograms of monthly year-over-year growth rates
(excluding growth rates for March–June of 2020 and 2021)

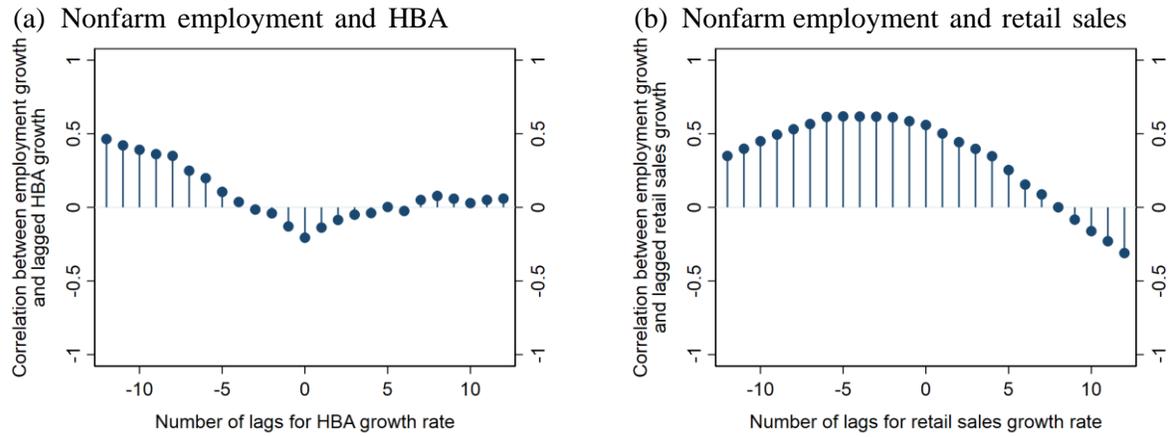


Figure A3. Growth rates of HBA, retail sales, and nonfarm employment (year-over-year growth rates)

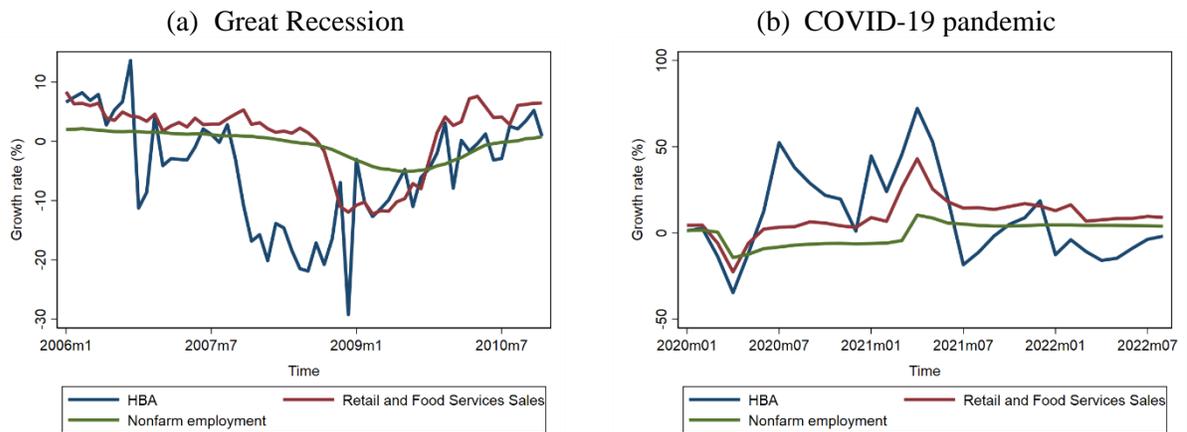


Table A1. Cross-correlations: PFEI growth rate and growth rate in nonfarm employment

Series name	2005–2019		All years (2005–2022)		Excluding growth rates for March–June of 2020 and 2021	
	Lead/Lag	Correlation	Lead/Lag	Correlation	Lead/Lag	Correlation
Advance Monthly Sales Retail and Food Services	–4	0.845*** (0.041)	–1	0.677*** (0.052)	–5	0.618*** (0.056)
Construction Spending	1	0.841*** (0.041)	1	0.458*** (0.062)	0	0.589*** (0.058)
New Single-family Homes for Sale	1	0.798*** (0.046)	2	0.595*** (0.056)	0	0.697*** (0.051)
Manufacturing and Trade Inventories	1	0.796*** (0.046)	1	0.710*** (0.049)	0	0.778*** (0.045)
New Residential Construction Permits	–8	0.784*** (0.047)	–10	0.416*** (0.064)	–8	0.517*** (0.061)
Industrial Production	–4	0.783*** (0.047)	0	0.756*** (0.046)	0	0.678*** (0.052)
New Residential Construction Units Started	–7	0.774*** (0.048)	–1	0.402*** (0.064)	–4	0.486*** (0.062)
New Single-family Homes Sold	–12	0.739*** (0.051)	–11	0.348*** (0.066)	–12	0.413*** (0.065)
Wholesale Inventories	2	0.703*** (0.054)	1	0.652*** (0.053)	0	0.704*** (0.051)
New Residential Construction Units Completed	–6	0.680*** (0.056)	–2	0.360*** (0.065)	–6	0.451*** (0.064)
Durable Goods New Orders	–4	0.675*** (0.056)	–1	0.540*** (0.059)	–4	0.502*** (0.062)
HBA	–11	0.643*** (0.058)	–9	0.496*** (0.061)	–12	0.464*** (0.063)
Manufacturing and Trade Sales	–3	0.641*** (0.059)	–1	0.638*** (0.054)	–2	0.556*** (0.059)
Manufacturing Shipments	–3	0.603*** (0.061)	–1	0.624*** (0.055)	–2	0.547*** (0.06)
Manufacturing New Orders	–3	0.590*** (0.062)	–1	0.566*** (0.058)	–3	0.498*** (0.062)
Wholesale Sales	–3	0.551*** (0.064)	–1	0.625*** (0.055)	–2	0.533*** (0.06)
Real Hourly Earnings Production and Nonsupervisory Employees	–2	–0.463*** (0.068)	0	–0.714*** (0.049)	0	–0.619*** (0.056)
BA	–5	0.446*** (0.068)	3	–0.538*** (0.059)	–12	0.355*** (0.067)
NHBA	–1	0.233** (0.074)	3	–0.563*** (0.058)	0	–0.410*** (0.065)

Notes: Standard errors in parenthesis. Table is sorted by the absolute value of the correlations reported in column 3 (correlations calculated excluding growth rates for 2020–2022). Columns 6 and 7 report results when we exclude growth rates for March–June of 2020 and for the same months of 2021. We do so to avoid large outliers that took place during March–June of 2020; we removed the growth rates of March–June of 2021 because, as the growth rates are calculated on a year-over-year basis, they use data from 2020 in their computation. Note that if the Lead/Lag is negative, then the indicator is leading; if the Lead/Lag is zero then the indicator is coincident; if the Lead/Lag is positive then the indicator is lagging. ***, **, * indicate significance at the 0.1, 1, and 5 percent levels, respectively.

Table A2. Cross-correlations: HBA growth rate and growth rate of other PFEI's

Series name	2005–2019		All years (2005–2022)		Excluding growth rates for March through June of 2020 and 2021	
	Lead/Lag	Correlation	Lead/Lag	Correlation	Lead/Lag	Correlation
Total Nonfarm Employees	-11	0.643*** (0.058)	-9	0.496*** (0.061)	-12	0.464*** (0.062)
Total Private Sector Employees	-10	0.637*** (0.059)	-9	0.503*** (0.061)	-12	0.473*** (0.062)
Unemployment Rate	-7	-0.599*** (0.061)	-9	-0.502*** (0.061)	-12	-0.513*** (0.062)
Manufacturing and Trade Inventories	-12	0.553*** (0.064)	-12	0.499*** (0.061)	-12	0.406*** (0.062)
Advance Monthly Sales Retail and Food Services	-6	0.552*** (0.064)	-8	0.611*** (0.055)	-12	0.521*** (0.057)
New Single-family Homes for Sale	-8	0.534*** (0.064)	-12	0.502*** (0.061)	-12	0.481*** (0.062)
Industrial Production	-8	0.507*** (0.066)	-9	0.451*** (0.062)	-8	0.378*** (0.064)
New Single-family Homes Sold	5	0.488*** (0.067)	1	0.492*** (0.061)	0	0.502*** (0.062)
Construction Spending	-12	0.476*** (0.067)	-11	0.381*** (0.065)	-12	0.413*** (0.066)
New Residential Construction Units Started	0	0.467*** (0.067)	0	0.439*** (0.063)	0	0.377*** (0.064)
Wholesale Inventories	-12	0.464*** (0.068)	-12	0.492*** (0.061)	-12	0.382*** (0.062)
New Residential Construction Units Completed	-1	0.459*** (0.068)	1	0.356*** (0.065)	4	0.370*** (0.067)
New Residential Construction Permits	3	0.459*** (0.068)	0	0.432*** (0.063)	0	0.389*** (0.064)
Durable Goods New Orders	-5	0.437*** (0.069)	-9	0.407*** (0.064)	-11	0.341*** (0.065)
Manufacturing and Trade Sales	-10	0.424*** (0.069)	-9	0.497*** (0.061)	-12	0.417*** (0.062)
Manufacturing Shipments	-10	0.409*** (0.07)	-10	0.402*** (0.064)	-12	0.346*** (0.065)
Manufacturing New Orders	-5	0.391*** (0.07)	-9	0.400*** (0.064)	-11	0.325*** (0.065)
Wholesale Sales	-9	0.377*** (0.071)	-9	0.492*** (0.061)	-12	0.417*** (0.062)
Real Hourly Earnings Production and Nonsupervisory Employees	-12	-0.272*** (0.073)	3	0.374*** (0.065)	0	0.228*** (0.066)

Notes: Standard errors in parenthesis. Table is sorted by the absolute value of the correlations reported in column 3 (correlations calculated excluding growth rates for 2020–2022). Columns 6 and 7 report results when we exclude growth rates for March–June of 2020 and for the same months of 2021. We do so to avoid large outliers that took place during March–June of 2020; we removed the growth rates of March–June of 2021 because, as the growth rates are calculated on a year-over-year basis, they use data from 2020 in their computation. Note that if the Lead/Lag is negative, then the indicator is leading; if the Lead/Lag is zero then the indicator is coincident; if the Lead/Lag is positive then the indicator is lagging. ***, **, * indicate significance at the 0.1, 1, and 5 percent levels, respectively.