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Recovering from COVID

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Appendix 1: Data Series

- Data Sources: Unless otherwise noted, the data are from FRED at the Federal Reserve Bank of St. Louis. Exceptions to this are:
 - The PCE data are from NIPA tables 2.8.4 and 2.8.5.
 - The quarterly TFP series `dtfp` and `dtfp_util` are from John Fernald's webpage at <https://www.johnferald.net/TFP>
- The data series are summarized in the tables on the following pages. The columns of the table are
 - Name: The FRED series names (as appropriate).
 - Series Description
 - Sample period available for analysis
 - Trans: Transformation Code with 2 denoting first difference, 4 denoting logarithm and 5 denoting the first difference of the logarithm.
 - Factor: "Y" means that the series was used to estimate the factors.
 - Outlier: 1 means that the series was adjusted for outliers in the pre-COVID sample period, and 0 otherwise.

Monthly Series

Name	Description	Smpl	Trans	Factor	Outlier
PCE Real Quantities					
Qpceall	PCE: Q Personal consumption expenditures (PCE)	1959:M1-2024:M11	5		0
Qpcegoods	PCE: Q Goods	1959:M1-2024:M11	5		0
Qpcegdsdur	PCE: Q Durable goods	1959:M1-2024:M11	5		0
Qpcegdsdurmotorveh	PCE: Q Motor vehicles and parts	1959:M1-2024:M11	5	Y	0
Qpcegdsdurfurn	PCE: Q Furnishings and durable household equipment	1959:M1-2024:M11	5	Y	0
Qpcegdsdurrecgoods	PCE: Q Recreational goods and vehicles	1959:M1-2024:M11	5	Y	0
Qpcegdsdurother	PCE: Q Other durable goods	1959:M1-2024:M11	5	Y	0
Qpcegdsnd	PCE: Q Nondurable goods	1959:M1-2024:M11	5		0
Qpcegdsndfood	PCE: Q Food and beverages purchased for offpremises consumption	1959:M1-2024:M11	5	Y	0
Qpcegdsndclothes	PCE: Q Clothing and footwear	1959:M1-2024:M11	5	Y	0
Qpcegdsndenergy	PCE: Q Gasoline and other energy goods	1959:M1-2024:M11	5	Y	0
Qpcegdsndother	PCE: Q Other nondurable goods	1959:M1-2024:M11	5	Y	0
Qpceservices	PCE: Q Services	1959:M1-2024:M11	5		0
Qpceserhealth	PCE: Q Health care	1959:M1-2024:M11	5	Y	0
Qpcesertrans	PCE: Q Transportation services	1959:M1-2024:M11	5	Y	0
Qpceserrec	PCE: Q Recreation services	1959:M1-2024:M11	5	Y	0
Qpceserfoodacc	PCE: Q Food services and accommodations	1959:M1-2024:M11	5	Y	0
Qpceserfin	PCE: Q Financial services and insurance	1959:M1-2024:M11	5	Y	0
Qpceserother	PCE: Q Other services	1959:M1-2024:M11	5	Y	0
Qpcenpish	PCE: Q Final cons exp of nonprofits (NPISHs)	1959:M1-2024:M11	5	Y	0
Qpceserhousxenergy	PCE: Q Housing and utilites (excl. energy)	1959:M1-2024:M11	5	Y	0
Qpceserhousenergy	PCE: Q Housing and utilites (energy)	1959:M1-2024:M11	5	Y	0
Employment CES					
PAYEMS	CES: Total Nonfarm	1959:M1-2024:M11	5		0
USPRIV	CES: Total Private	1959:M1-2024:M11	5		0
USGOOD	CES: Goods Producing	1959:M1-2024:M11	5		0
USMINE	CES: GD: Mining and Logging	1959:M1-2024:M11	5	Y	1
USCONS	CES: GD: Construction	1959:M1-2024:M11	5	Y	0
MANEMP	CES: GD: Manufacturing	1959:M1-2024:M11	5	Y	1
DMANEMP	CES: GD:Man:Durable goods	1959:M1-2024:M11	5	Y	1
NDMANEMP	CES: GD:Man:Nondurable goods	1959:M1-2024:M11	5	Y	0
CES0800000001	CES: Private Service Producing	1959:M1-2024:M11	5		1
USWTRADE	CES: SE:Wholesale Trade	1959:M1-2024:M11	5	Y	0
USTRADE	CES: SE: Retail Trade	1959:M1-2024:M11	5	Y	0
CES4300000001	CES: SE: Transportation and warehousing	1972:M1-2024:M11	5	Y	1
CES4422000001	CES: SE: Utilities	1964:M1-2024:M11	5	Y	1
USINFO	CES: SE: Information	1959:M1-2024:M11	5	Y	1
CES5552000001	CES: SE: Finance and Insurance	1990:M1-2024:M11	5	Y	0
CES5553000001	CES: SE: Real Estate	1990:M1-2024:M11	5	Y	0

USPBS	CES: SE: Prof and Bus Services	1959:M1-2024:M11	5	Y	0
CES6561000001	CES: SE: Education services	1990:M1-2024:M11	5	Y	0
CES6562000001	CES: SE: Health care and social assistance	1990:M1-2024:M11	5	Y	0
CES7071000001	CES: SE: Arts entertainment recreats	1990:M1-2024:M11	5	Y	0
CES7072000001	CES: SE: Accomodation and food services	1990:M1-2024:M11	5	Y	0
USSERV	CES: SE: Other Services	1959:M1-2024:M11	5	Y	0
USGOVT	CES: Government	1959:M1-2024:M11	5		1
CES9091000001	CES: GO: Federal	1959:M1-2024:M11	5	Y	1
CES9092000001	CES: GO: State	1959:M1-2024:M11	5		0
CES9092161101	CES: GO: ST: Education	1959:M1-2024:M11	5	Y	0
CES9092200001	CES: GO: ST: nonEducation	1959:M1-2024:M11	5	Y	0
CES9093000001	CES: GO: Local	1959:M1-2024:M11	5		0
CES9093161101	CES: GO: LO: Education	1959:M1-2024:M11	5	Y	0
CES9093200001	CES: GO: LO: nonEducation	1959:M1-2024:M11	5	Y	1
Employment CPS					
CLF16OV	CPS: Labor Force	1959:M1-2024:M11	5		0
CE16OV	CPS: Employed	1959:M1-2024:M11	5		0
UNEMPLOY	CPS: Unemployed	1959:M1-2024:M11	5		0
UNRATE	CPS: Unemployment Rate	1959:M1-2024:M11	2	Y	0
CIVPART	CPS: LFPR	1959:M1-2024:M11	2	Y	0
Jolts					
JTSJOL	Job Openings Total Nonfarm	2000:M12-2024:M10	5		0
JTS1000JOL	Job Openings Total Private	2000:M12-2024:M10	5		0
JTSHIL	Hires Total Nonfarm	2000:M12-2024:M10	5		0
JTS1000HIL	Hires Total Private	2000:M12-2024:M10	5		0
JTSQUL	Quits Total Nonfarm	2000:M12-2024:M10	5		0
JTS1000QUL	Quits Total Private	2000:M12-2024:M10	5		0
JTSTSL	Total Separations Total Nonfarm	2000:M12-2024:M10	5		0
JTS1000TSL	Total Separations Total Private	2000:M12-2024:M10	5		0
Industrial Production					
INDPRO	IP: Total index	1959:M1-2024:M11	5		0
IPFPNSS	IP:Mk: Final products and nonindustrial supplies	1959:M1-2024:M11	5		0
IPCONGD	IP:Mk: Consumer goods	1959:M1-2024:M11	5		0
IPDCONGD	IP:Mk: CG: Durable	1967:M1-2024:M11	5		1
IPB51110S	IP:Mk: CG:D:Automotive products	1967:M1-2024:M11	5	Y	1
IPB51121S	IP:Mk: CG:D: Home electronics	1987:M1-2024:M11	5	Y	0
IPB51122S	IP:Mk: CG:D: Appliances furniture carpeting	1987:M1-2024:M11	5	Y	0
IPB51123S	IP:Mk: CG:D: Miscellaneous goods	1967:M1-2024:M11	5	Y	0
IPNCONGD	IP:Mk: CG: Nondurable	1967:M1-2024:M11	5		0
IPB51210S	IP:Mk: CG:ND:Non-energy	1987:M1-2024:M11	5	Y	0
IPB51211S	IP:Mk: CG:ND:NE:Foods and tobacco	1967:M1-2024:M11	5	Y	0
IPB51212S	IP:Mk: CG:ND:NE:Clothing	1967:M1-2024:M11	5	Y	0
IPB51213S	IP:Mk: CG:ND:NE:Chemical Products	1974:M1-2024:M11	5	Y	0

IPB51214S	IP:Mk: CG:ND:NE:Paper products	1974:M1-2024:M11	5	Y	1
IPB51220S	IP:Mk: CG:ND:Energy	1974:M1-2024:M11	5	Y	0
IPBUSEQ	IP:Mk: Business equipment	1967:M1-2024:M11	5		0
IPB52110S	IP:Mk: BE: Transit	1974:M1-2024:M11	5	Y	1
IPB52120S	IP:Mk: BE:Information processing	1987:M1-2024:M11	5	Y	1
IPB52130S	IP:Mk: BE:Industrial and other	1987:M1-2024:M11	5	Y	0
IPB52300S	IP:Mk: Defense and space equipment	1967:M1-2024:M11	5	Y	1
IPB54100S	IP:Mk: Construction supplies	1967:M1-2024:M11	5	Y	0
IPB54200S	IP:Mk: Business supplies	1967:M1-2024:M11	5	Y	0
IPMAT	IP:Mk: Materials	1959:M1-2024:M11	5		0
IPZ53010S	IP:Mk: MAT:Non-energy	1987:M1-2024:M11	5		0
IPDMAT	IP:Mk: MAT:NE:Durable	1967:M1-2024:M11	5	Y	0
IPNMAT	IP:Mk: MAT:NE:Nondurable	1974:M1-2024:M11	5	Y	1
IPB53300S	IP:Mk: MAT:Energy	1974:M1-2024:M11	5	Y	1
IPMANSICS	IP:Ind: Manufacturing SIC	1959:M1-2024:M11	5		0
IPMAN	IP:Ind: Manufacturing NAICS	1992:M1-2024:M11	5		0
IPDMAN	IP:Ind: MAN: Durable manufacturing	1992:M1-2024:M11	5		0
IPNMAN	IP:Ind: MAN: Nondurable manufacturing	1992:M1-2024:M11	5		0
IPMINE	IP:Ind: Mining	1959:M1-2024:M11	5		0
IPUTIL	IP:Ind: Utilities	1959:M1-2024:M11	5		0
Sales					
CMRMTSPLx	Real Manu. and Trade Industries Sales	1959:M1-2024:M9	5		0
Personal Income Real					
PI	Personal Income real	1959:M1-2024:M11	5		0
A576RC1	Wages and Salaries real	1959:M1-2024:M11	5		0
A132RC1	WS: Private real	1959:M1-2024:M11	5	Y	0
B202RC1	WS: Government real	1959:M1-2024:M11	5	Y	0
A038RC1	WS: Supplements real	1959:M1-2024:M11	5	Y	0
A041RC1	Proprietors Income real	1959:M1-2024:M11	5		0
A048RC1	Rental Income real	1959:M1-2024:M11	5	Y	0
PIROA	Personal Income Receipts on Assets real	1959:M1-2024:M11	5	Y	0
PCTR	Personal Current Transfer Receipts real	1959:M1-2024:M11	5		0
A063RC1	Gov Transfers to Persons real	1959:M1-2024:M11	5	Y	0
DSPI	Disposal Personal Income real	1959:M1-2024:M11	5		0
PSAVERT	Personal Savings Rate	1959:M1-2024:M11	5		0
W875RX1	Real Personal Income Excluding Transfers	1959:M1-2024:M11	5		0
Orders and Inventories					
ACOGNO	New Orders for Consumer Goods	1992:M2-2024:M9	5	Y	0
AMDMNOx	New Orders for Durable Goods	1959:M1-2024:M10	5	Y	0
AMDMUOx	New Orders for Nondefense Capital Goods	1959:M1-2024:M10	5	Y	0
BUSINVx	Total Business Inventories	1959:M1-2024:M9	5	Y	0
ISRATIOx	Total Business: Inventories to Sales Ratio	1959:M1-2024:M9	4	Y	0
Housing Permits and Starts					

PERMIT	HO: Permits Total	1960:M1-2024:M11	4		0
PERMITMW	HO: PE: Midwest	1960:M1-2024:M11	4		0
PERMITNE	HO: PE: Northeast	1960:M1-2024:M11	4		0
PERMITS	HO: PE: South	1960:M1-2024:M11	4		0
PERMITW	HO: PE: West	1960:M1-2024:M11	4		0
HOUST	HO: Starts Total	1959:M1-2024:M11	4		0
HOUSTMW	HO: ST: Midwest	1959:M1-2024:M11	4	Y	0
HOUSTNE	HO: ST: Northeast	1959:M1-2024:M11	4	Y	0
HOUSTS	HO: ST: South	1959:M1-2024:M11	4	Y	0
HOUSTW	HO: ST: West	1959:M1-2024:M11	4	Y	0
Misc					
UMCSENTx	Consumer Sentiment Index	1959:M5-2024:M10	1	Y	0

Additional Quarterly Series

Name	Description	Smpl	Trans	Factor	Outlier
NIPA Real					
A191RA3Q086SBEA	Gross domestic product	1959:Q1-2024:Q3	5		0
A006RA3Q086SBEA	Gross private domestic investment	1959:Q1-2024:Q3	5		0
A007RA3Q086SBEA	GPDI Fixed investment	1959:Q1-2024:Q3	5		0
A008RA3Q086SBEA	GPDI Nonresidential	1959:Q1-2024:Q3	5		0
B009RA3Q086SBEA	GPDI Nonresidential Structures	1959:Q1-2024:Q3	5	Y	0
Y033RA3Q086SBEA	GPDI Nonresidential Equipment	1959:Q1-2024:Q3	5	Y	0
Y001RA3Q086SBEA	GPDI Nonresidential Intellectual property products	1959:Q1-2024:Q3	5	Y	0
A011RA3Q086SBEA	GPDI Residential	1959:Q1-2024:Q3	5	Y	0
B020RA3Q086SBEA	Exports	1959:Q1-2024:Q3	5		0
B253RA3Q086SBEA	Exports Goods	1959:Q1-2024:Q3	5	Y	0
B646RA3Q086SBEA	Exports Services	1959:Q1-2024:Q3	5	Y	0
B021RA3Q086SBEA	Imports	1959:Q1-2024:Q3	5		0
B255RA3Q086SBEA	Imports Goods	1959:Q1-2024:Q3	5	Y	0
B656RA3Q086SBEA	Imports Services	1959:Q1-2024:Q3	5	Y	0
B822RA3Q086SBEA	Government consumption expenditures and gross investment	1959:Q1-2024:Q3	5		0
B823RA3Q086SBEA	Gov Federal	1959:Q1-2024:Q3	5		0
B824RA3Q086SBEA	Gov Federal National defense	1959:Q1-2024:Q3	5	Y	0
B825RA3Q086SBEA	Gov Federal Nondefense	1959:Q1-2024:Q3	5	Y	0
B829RA3Q086SBEA	Gov State and local	1959:Q1-2024:Q3	5	Y	0
Productivity					
OPHNFB	Nonfarm Business Sector: Labor Productivity (Output per Hour) for All Workers	1959:Q1-2024:Q3	5	Y	0
OPHPBS	Business Sector: Labor Productivity (Output per Hour) for All Workers	1959:Q1-2024:Q3	5		0
dtfp	TFP growth rate (Fernald)	1959:Q1-2024:Q3	1	Y	0
dtfp_util	Utilization-Adjusted TFP growth rate (Fernald)	1959:Q1-2024:Q3	1		0

Appendix 3: Estimation Details

The estimation approach aims to keep the number of parameters estimated over the short COVID period to a minimum. We proceed as follows:

- $\Lambda, \Gamma, C_t, F_t$ are estimated as described in Section III.A.
- The decomposition in equation (3) uses

$$Y_t = \Lambda F_t^F + \Lambda F_t^C + \Gamma C_t^F + \Gamma C_t^C + u_t \quad (1)$$

where

$$F_t^F = \Theta_{FF}(L)\varepsilon_t^F$$

$$F_t^C = \Theta_{FC}(L)\varepsilon_t^C$$

$$C_t^F = \Theta_{CF}(L)\varepsilon_t^F$$

and

$$C_t^C = \Theta_{CC}(L)\varepsilon_t^C$$

- With the normalization $\Theta_{CC}(0) = 1$, assumptions (iia) and (iv) imply that ε_t^C can be obtained as the residual from the regression of C_t onto lags of (C_t, F_t) . We use one lag in this regression, so that

$$\varepsilon_t^C = C_t - (\rho_{CC}C_{t-1} + \rho_{CF}F_{t-1}) \quad (2)$$

where ρ_{CC} and ρ_{CF} are estimated by OLS over the sample period 2020m7-2023m2, and ε_t^C is then constructed from (2) over 2020m3-2023m2 and $\varepsilon_t^C = 0$ for other dates.

- The coefficients of the lag polynomial $\Theta_{FC}(L)$ are estimated by regressing F_t onto current and four lags of ε_t^C . This allows calculation of

$$F_t^C = \Theta_{FC}(L)\varepsilon_t^C$$

and

$$F_t^F = F_t - F_t^C.$$

- The decomposition of C_t into $C_t^C + C_t^F$ then follows from

$$(1 - \rho_{CC}L)C_t = \varepsilon_t^C + \rho_{CF}F_{t-1} = \varepsilon_t^C + \rho_{CF}(F_{t-1}^C + F_{t-1}^F).$$

Which yields

$$C_t^C = (1 - \rho_{CC}L)^{-1}(\varepsilon_t^C + \rho_{CF}F_{t-1}^C)$$

and

$$C_t^F = (1 - \rho_{CC}L)^{-1}\rho_{CF}F_{t-1}^F. \quad (3)$$

- Equation (1) can then be used to decompose Y_t into components associated with ε_t^C (that is $\Lambda F_t^C + \Gamma C_t^C$) and with ε_t^F (that is $\Lambda F_t^F + \Gamma C_t^F$). These decompositions are used in Figures 11-13 in the text.

The counterfactuals were computed by changing the values of ε_t^F , leading the changes in $\{F_t^F, C_t^F\}$. This is done as follows:

- The lag polynomial $\Theta_{FF}(L)$ is estimated using the pre-COVID (1985-2020m2) observations on F_t^F (where $F_t^F = F_t$ during the pre-COVID period). Specifically, we estimate a VAR(6) model $\Phi(L)F_t^F = \varepsilon_t^F$ and set $\Theta_{FF}(L) = \Phi(L)^{-1}$.
 - The value of ε_t^F is then computed as $\varepsilon_t^F = \Phi(L)F_t^F$ over the entire sample period.
 - Counterfactuals of ε_t^F , say $\varepsilon_t^{F,Counterfactual}$ are then computed as described in Section VI.A.
- $F_t^{F,Counterfactual}$ was computed as $F_t^{F,Counterfactual} = \Phi(L)^{-1}\varepsilon_t^{F,Counterfactual}$.
- The value of $C_t^{F,Counterfactual}$ is computed from (3) using $F_t^{F,Counterfactual}$.
- The counterfactual values of Y_t are then computed from (1) replacing (F_t^F, C_t^F) with $(F_t^{F,Counterfactual}, C_t^{F,Counterfactual})$. These are the values plotted in Figure 16.

Appendix 4: Andrews End-Of-Sample Stability Tests for Λ

As described in Section V, we carried out Andrews (1993) end-of-sample stability tests for Λ , using an in-sample period of 1985m1-2020m2 (pre-COVID) and an out-of-sample period of 2023m3-2024m9 (post-COVID), and where the post-COVID period was suggested by the R^2 plot in Figure 6.

There was little evidence of instability. Of the 128 series, five series had p-values less than 0.05. These were

Series	p-value
CES: SE: Information	0.04
CES: GO: ST: nonEducation	<0.01
CPS: Unemployed	0.05
HO: PE: Northeast	0.01
PCE: Q Health care	0.04

Across the 128 series, the selected percentiles of the p-values are shown in the following table

Percentile	Value
0.05	0.07
0.25	0.33
0.50	0.62
0.75	0.79
0.95	0.96

Appendix 2: Data Plots and Factor Shock Decomposition

Each page shows a four panel figure for each series. The panels are

- Panel (1,1): The raw data series
- Panel (1,2): The transformation data series (in Pre-COVID standard deviation units)
- Panels (2,1) and (2,2): The factor-shock decomposition of the series over the COVID period as shown in Figure 12 in the text.





























































































































































































































































