Improving Nowcasts of International Trade Data for the Index of Economic Activity (IDEA)

Seasonal Adjustment Practitioners Workshop

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What is the IDEA?

- U.S. Census Bureau Index of Economic Activity (IDEA) is an aggregation of 15 of Census Bureau's primary economic data series

- For each seasonally adjusted component series, we calculate the month-to-month growth rates and standardize them to have a mean 0, and variance 1.
  - Growth Rates: $X_t = \log Y_t - \log Y_{t-1}$

- We apply Principal Component Analysis (PCA) to the 15 rescaled series and use the first principal component as weights.

- Example: If we have variables X1 and X2 then we find weights w1 and w2 to calculate index, w1*X1 + w2*X2 (first principal component)

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Principal Component Analysis

- PCA computes the eigenvalues and eigenvectors of the correlation matrix for the 15 rescaled economic data series.

- The elements of the eigenvector corresponding to the largest eigenvalue define the weights for the index

- This weighted linear combination of the variables has maximum variance over all linear combinations whose squared weights sum to 1.
  - Since the weights don’t sum to 1, we standardize the index using the mean and standard deviation calculated over the time span August 2004 to May 2024, excluding March 2020 to August 2020, so that the final index has mean 0 and standard deviation 1

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Data series used in Economic Index

Series	Source	Sector	PCA Weight*
Exports of Goods and Services	International Trade: Goods & Services	International Trade	0.365
Manufacturing Value of New Orders	Manufacturers' Goods	Manufacturing	0.363
Imports of Goods and Services	International Trade: Goods & Services	International Trade	0.345
Manufacturing Inventories	Manufacturers' Goods	Manufacturing	0.330
Wholesale Trade Inventories	Advance Economic Indicator Report	Wholesale	0.305
Retail Inventories	Advance Economic Indicator Report	Retail	0.283
New Orders for Durable Goods	Advance Report Durable Goods	Manufacturing	0.265
Retail Trade and Food Services Sales	Advance Monthly Retail Trade	Retail	0.258
Total Construction Spending	Construction Spending	Construction	0.231
Housing Units Authorized in Permit-Issuing Places	New Residential Construction	Construction	0.225
Housing Units Started	New Residential Construction	Construction	0.216
New Single-Family Houses for Sale	New Residential Sales	Construction	0.197
Housing Units Completed	New Residential Construction	Construction	0.072
New Single-Family Houses Sold	New Residential Sales	Construction	0.046
Business Applications	Business Formation Statistics	Business Formations	0.019

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*Weights as of 08/14/2024

Source: Index of Economic Activity

CHALLENGES

1. Data revisions
   - historic data revisions
   - seasonal adjustment
   - benchmarking
   - advance vs. preliminary vs. revised estimates
2. The index is updated each business day as new values of any of its input data sources are released to the public, however;
   - Indicators are published at different dates during the month
   - These release dates can change from month to month, including the order in which these series are released

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Nowcasting Framework

For any given day in a month, between 1 and 15 indicators have been published. The missing indicators can be imputed via nowcasting:

- Projection based on past time series data and present cross-sectional data
- Use a fitted order 1 Vector AutoRegression (VAR) to nowcast the not yet released indicators for that month.
- Fitted over the model span, using the Yule-Walker equations
- PCA weights are applied to observed and nowcasted values through out the month.

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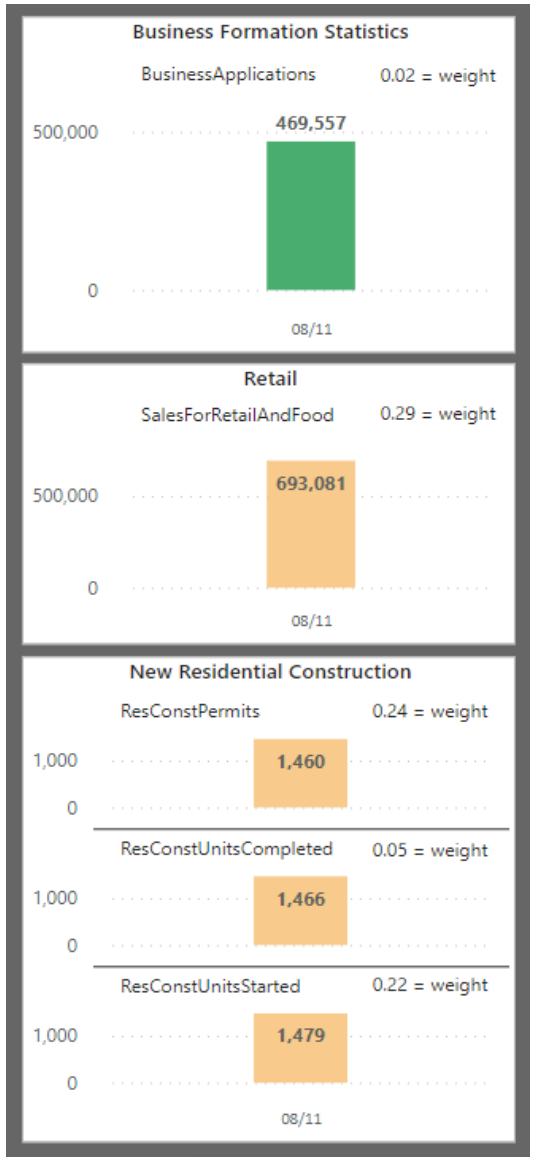
Nowcasts in Action

July 2023 Input Values as of 8/11



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Index = 0.11

Key

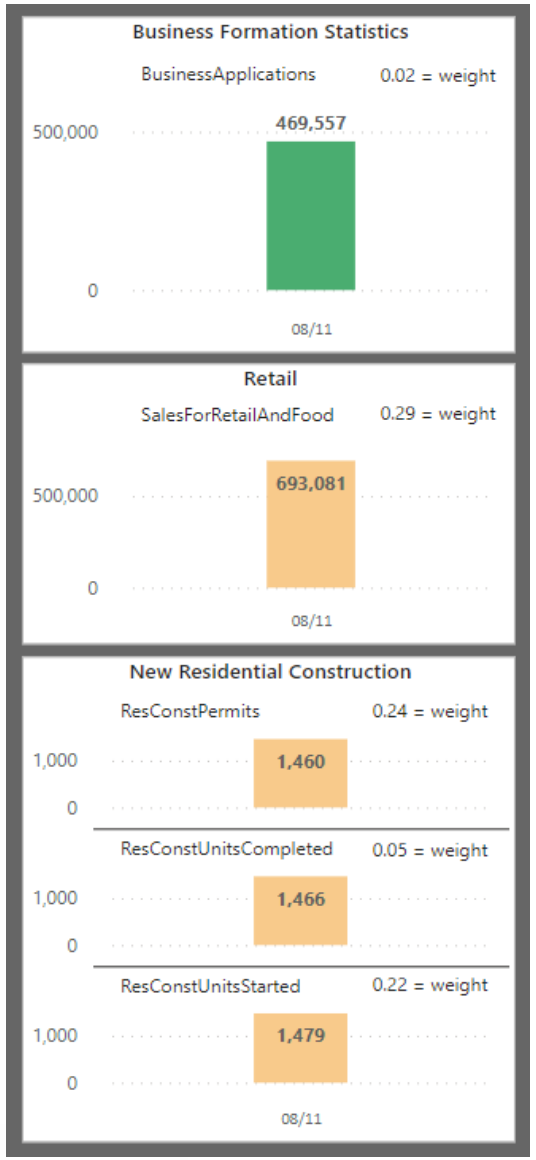
Green – Actual Values

Yellow – Nowcast Values

Source: Index of Economic Activity

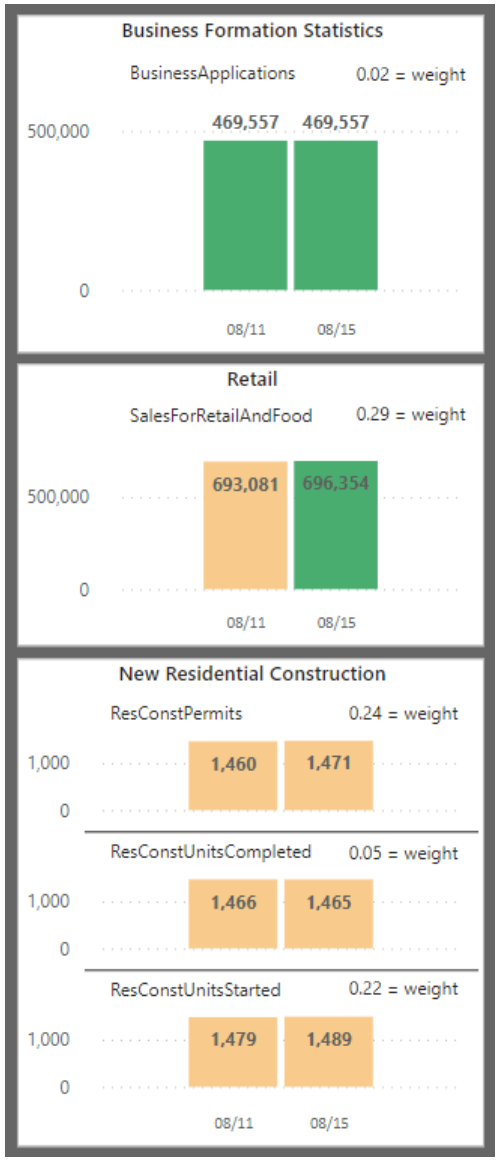
Nowcasts in Action

July Input Values as of 8/11



Index = 0.11

July Input Values as of 8/15



Index = 0.20

Key

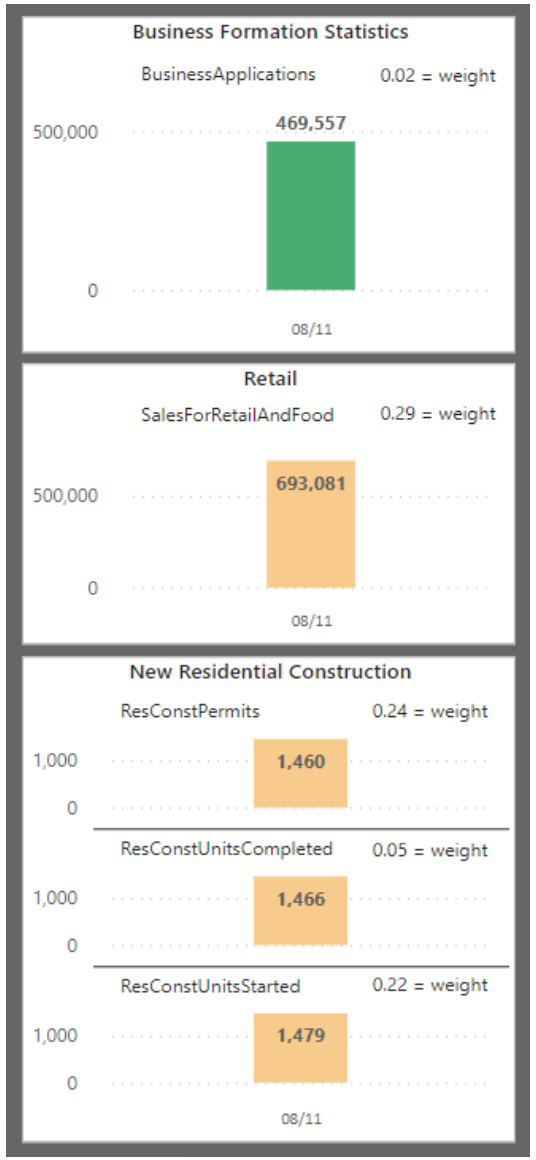
Green – Actual Values

Yellow – Nowcast Values

Source: Index of Economic Activity

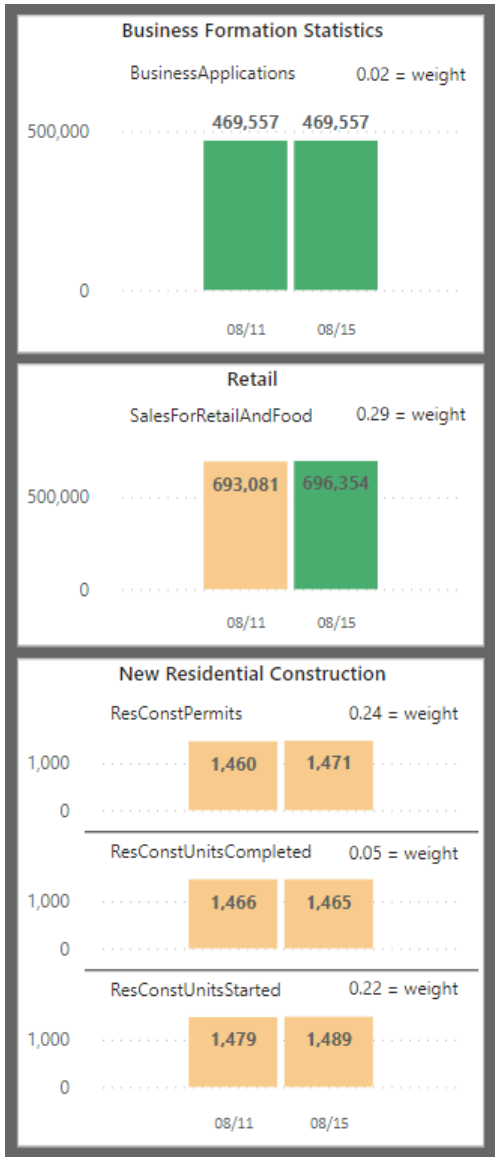
Nowcasts in Action

July Input Values as of 8/11



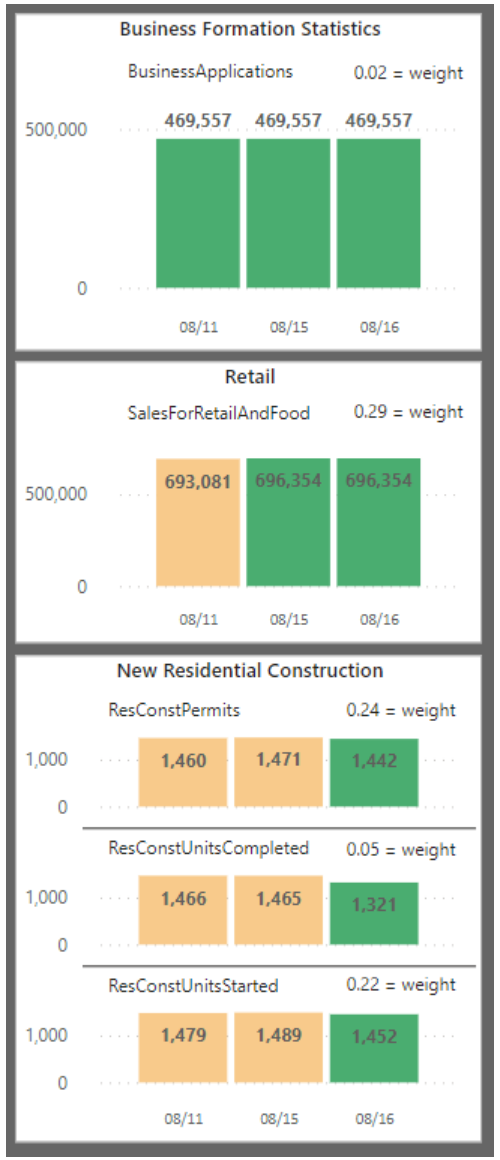
Index = 0.11

July Input Values as of 8/15



Index = 0.20

July Input Values as of 8/16



Index = 0.14

Key

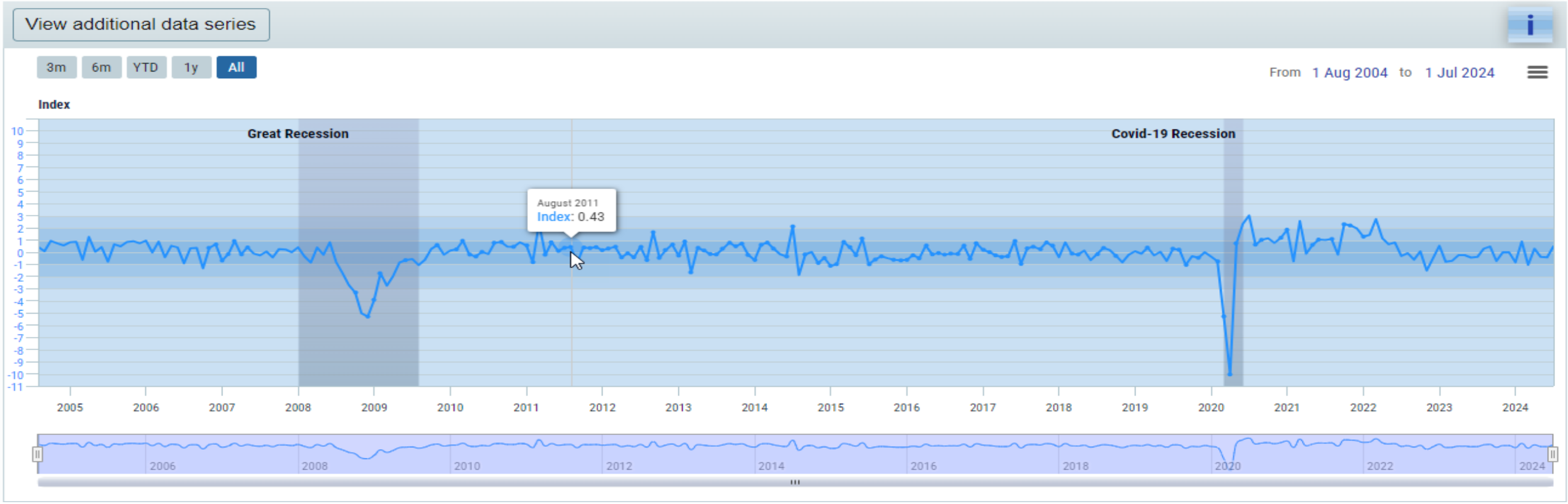
Green – Actual Values

Yellow – Nowcast Values

Source: Index of Economic Activity

Index Plot*

Last updated 11:30 AM August 29, 2024



- Process Control chart that characterizes whether economic activity is within a normal range, represented by the darker blue bands.
- We currently standardize the index using the mean and standard deviation of August 2004 through May 2024, excluding March 2020 – August 2020
- Great Recession and COVID-19 pandemic clearly reflected in index

*Index graph as of 8/15/2024

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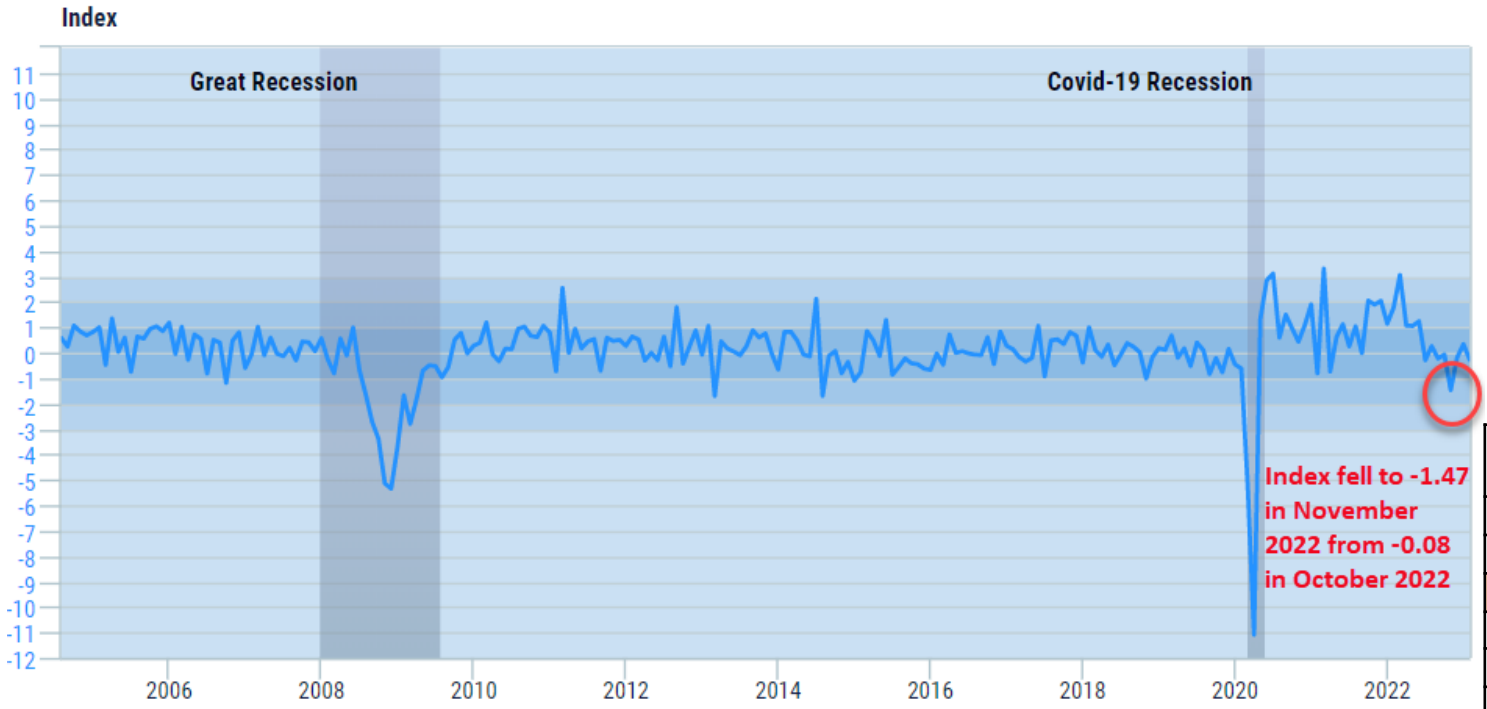
Source: Index of Economic Activity

What is causing movement in the index?



November 2022

Series	Month-to-Month % Change	PCA Weight
Manufacturing Value of New Orders	-1.93	0.37
Exports of Goods and Services	-1.82	0.36
Imports of Goods and Services	-6.34	0.34
Manufacturing Durable Goods Inventories	0.03	0.34
Retail Inventories	-0.04	0.30
Retail Trade and Food Services Sales	-1.07	0.28
New Orders for Durable Goods	-1.80	0.28
Wholesale Trade Inventories	0.82	0.28
Housing Units Authorized in Permit-Issuing Places	-10.65	0.24
Housing Units Started	-0.49	0.22
Total Construction Spending	1.77	0.19
New Single-Family Houses for Sale	-2.15	0.17
New Single-Family Houses Sold	-1.19	0.07
Housing Units Completed	13.41	0.05
Business Applications	-3.12	0.02

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Source: Index of Economic Activity

International Trade Imports and Exports

- Often at Census we produce advance estimates of our monthly economic indicators
  - Example: Advance Retail Sales and Retail Sales*
- For the Index calculation we use these advance estimates until the full estimates are produced.
- The International trade program produces advance estimates of imports and exports; however, they differ from the full trade numbers in a few ways (see next slide).

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*Source: Advance Monthly Retail Trade Report and Monthly Retail Trade Report

International Trade Imports and Exports

Advance Imports and Exports*

- Includes only Goods
- Census Basis

Full Imports and Exports*

- Includes Goods and Services
- Balance of Payments Basis

Balance of Payments (BOP) vs. Census Basis: Goods on a Census basis are adjusted by the U.S. Bureau of Economic Analysis to goods on a BOP basis. Broadly, the adjustments include changes in ownership that occur without goods passing into or out of the customs territory of the United States.

Description of the International Trade Statistical Program (census.gov)

*Sources: Advance Economic Indicators Report and International Trade in Goods and Service Report

Typically we do not use the word "Full" to represent the preliminary estimates published after the advance estimates; however, for this presentation we use Full Imports and Exports for clarity.

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Are the advance trade growth rates predictive of full trade growth rates?

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Preliminary Research

Is error reduced when using advance trade growth rates to help predict full trade growth rates?

- Run initial regressions using advance estimates of seasonally adjusted growth rates to predict the full seasonally adjusted growth rates.

- Compare prediction error between models.

Preliminary Research (continued)

Some Model Options

1. Advance growth rates as a forecast of full growth rates
   - Calculate Root Mean Square Difference (RMSD) between advance and full estimates.
2. Autoregressive model of full export or import growth rates, with one advance growth rate as a regressor
3. Autoregressive model of full export or import growth rates, with advance growth rates for both imports and exports as regressors in each model
4. Normal Linear regression. Regress the full growth rates on the advance growth rates

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Preliminary Research (continued)

Including both advance and full trade numbers in the nowcast modeling should reduce regression prediction error variances

	σ For autoregressive time series model with no regressors	1. RMSD(x,y) for replacing full trade with advance trade	σ For autoregressive time series models with and without regressors		4. σ For regressing y on x
			2. With one advance estimate regressor	3. With both advance estimate regressors	
Exports	1.60	.76	.34	.33	.36
Imports	1.98	.46	.26	.25	.26

*Span of data used is 8/2004-9/2023, excluding the first 5 months of the pandemic, 3/2020-8/2020

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Source: Index of Economic Activity

Preliminary Research Conclusion

- Advance Trade growth rates are highly predictive of Full Trade growth rates
- Prediction error is reduced when including Advance Trade in the modeling of Full Trade

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How should we use these advance trade numbers to improve the IDEA?

Options Considered

1. Replace the Full Trade numbers with the Advance Trade numbers in the Index calculations. This would completely remove Full Trade from any calculations and the Index would still use 15 timeseries.
2. Add Advance Trade numbers to the Index calculations. The Index would then use 17 timeseries instead of 15.
3. Add the Advance Trade series to the nowcast model, but not the index calculations. The nowcast model would thus use 17 series, but the index definitions and the PCA calculations would still use the original 15 indicators. The Advance Trade series would contribute to the nowcasting of the Full Trade estimates and to the nowcasting of the other indicators.
4. Keep Index as it is

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Option 1: Replace the Full Trade with the Advance Trade numbers in the Index calculations

- Pros
  - Easy to do
  - Makes interpretable sense
  - Advance numbers are available earlier than the full trade numbers
- Cons
  - Doesn't include Services imports/exports which are in the full trade estimates

Option 2: Add Advance Trade numbers to the Index calculations

- Pros
  - Uses all available data
- Cons
  - Full Trade is imports/exports of goods and services. Advance trade includes Imports of Goods and Exports of Goods – no trade of services included. Cannot split the goods and services out of the imports and exports estimates.

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Option 3: Add the Advance Trade series to the fitting of the nowcast model

- Pros
  - Uses all available data
  - Advance trade is highly predictive of full trade
- Cons
  - Would divert from the conceptual consistency
  - Could affect the nowcasts of the other indicators in a negative way

Option 4: Keep Index as it is

- Pros
  - Less work
- Cons
  - Doesn't take advantage of the advance trade data

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Testing Option 1
Advance Trade replacing Full Trade

- Growth rates are not as similar as expected
- Noticeable effect on the index value and weights

Monthly Index Values				
Year	Month	Production	Option 1	Difference
2024	1	-0.83	-0.69	-0.14
2024	2	0.88	1.12	-0.24
2024	3	-1.04	-1.09	0.05
2024	4	0.32	0.52	-0.20
2024	5	-0.43	-0.48	0.05
2024	6	-0.33	0.05	-0.38
2024	7	-0.29	-0.46	0.17

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Source: Economic Indicator data available in the Census API

Testing Option 2
Add Advance Trade to the Index calculations

- Results in the 4 trade series weighted too heavily
- These 4 trade numbers are representing too much of the same thing
- Noticeable effect on the index

	Weights		
Series	**Production**	**Option 2**	**Difference**
Full Trade_Exports	**0.365**	**0.373**	**-0.008**
Advance Trade_Exports		**0.358**	**-0.358**
Advance Trade_Imports		**0.358**	**-0.358**
Full Trade_Imports	**0.345**	**0.358**	**-0.013**
ManuNewOrders	0.363	0.302	0.061
ManuInventories	0.330	0.284	0.046
SalesForRetailAndFood	0.258	0.238	0.020
RetailInventories	0.283	0.229	0.054
WholesaleInventories	0.305	0.227	0.078
DurableGoodsNewOrders	0.265	0.211	0.054
ResConstPermits	0.225	0.193	0.032
ResConstUnitsStarted	0.216	0.175	0.041
ConstructionSpending	0.231	0.128	0.104
NewHomesForSale	0.197	0.107	0.090
NewHomesSold	0.046	0.049	-0.003
ResConstUnitsCompleted	0.072	0.013	0.059
BusinessApplications	0.019	0.003	0.016

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Source: Economic Indicator data available in the Census API

Testing Option 3
Add Advance Trade for modeling and nowcasting

- Gives us a better nowcast of trade earlier, which gives us a better estimate of the index earlier
- Less volatility of the index value throughout the month
- Does not affect final index value

Source: Economic Indicator data available in the Census API

Comparing the Nowcasting Variance

Variances are times 10^{-5}

	Production (No Advance Trade)	Add Advance Trade for nowcasting (Option 3)
Index Nowcasting Variance	9.17	1.79
Nowcasting Variance for 5 input series that were missing		
ConstructionSpending	7.42	7.32
ManuNewOrders	4.04	3.69
InternationalTrade_Imports	26.26	0.50
InternationalTrade_Exports	14.11	0.98
ManuInventories	1.27	1.20

Data as of 6.28.2024

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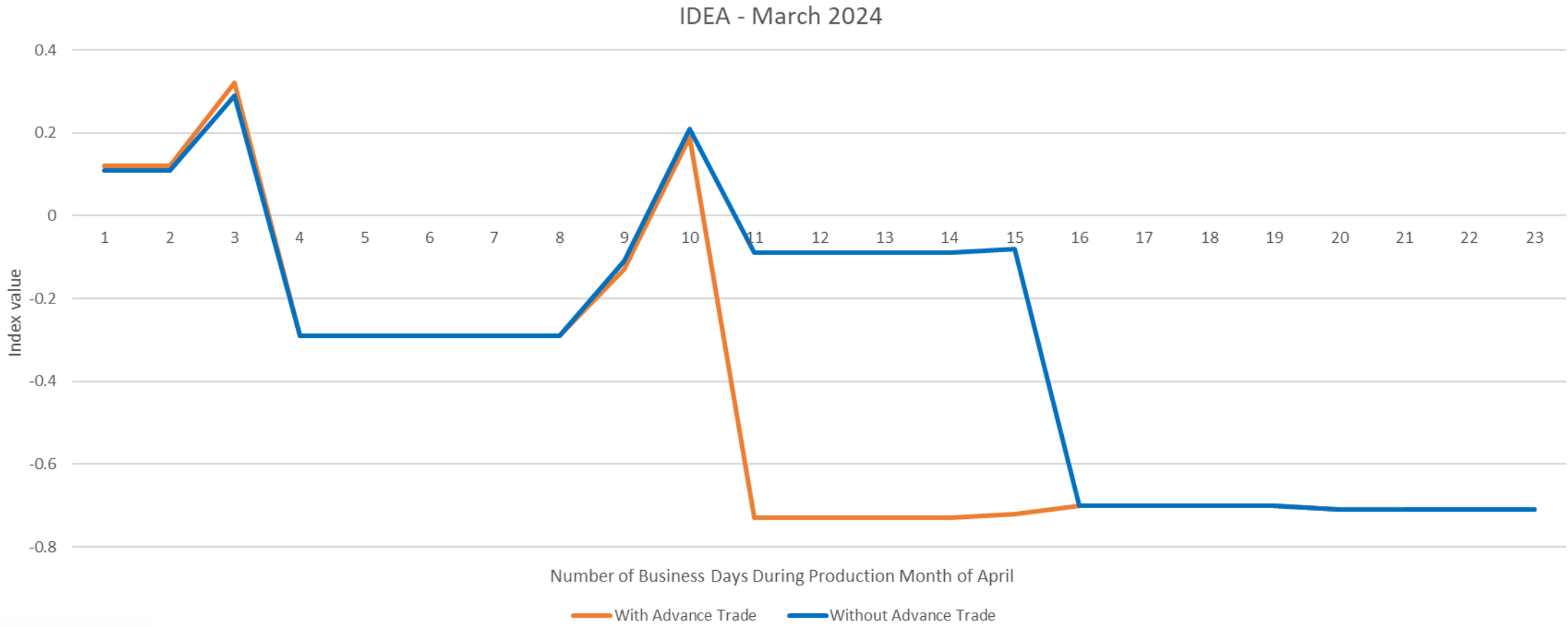
Source: Economic Indicator data available in the Census API

Comparing Index with and without Advance Trade in the nowcast modeling



Source: Economic Indicator data available in the Census API

Final Decision

Option 3: Add Advance Trade series to the nowcast model.

Thank you!

Questions about this presentation?

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Questions about the IDEA in general?

IDEA team: EID.Economic.Index@census.gov

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Extra Slides

Option 5: Calculate the Index with the Advance Trade numbers until the Full Trade numbers become available

- Pros
  - Uses all available data
  - Growth rates of the advance and full trade are similar.
- Cons
  - Not straightforward to explain to data users
  - Would divert from the conceptual consistency that underlies the index and that is realized in the historical numbers

We rejected this option and did not program for testing because advance trade and full trade are not comparable

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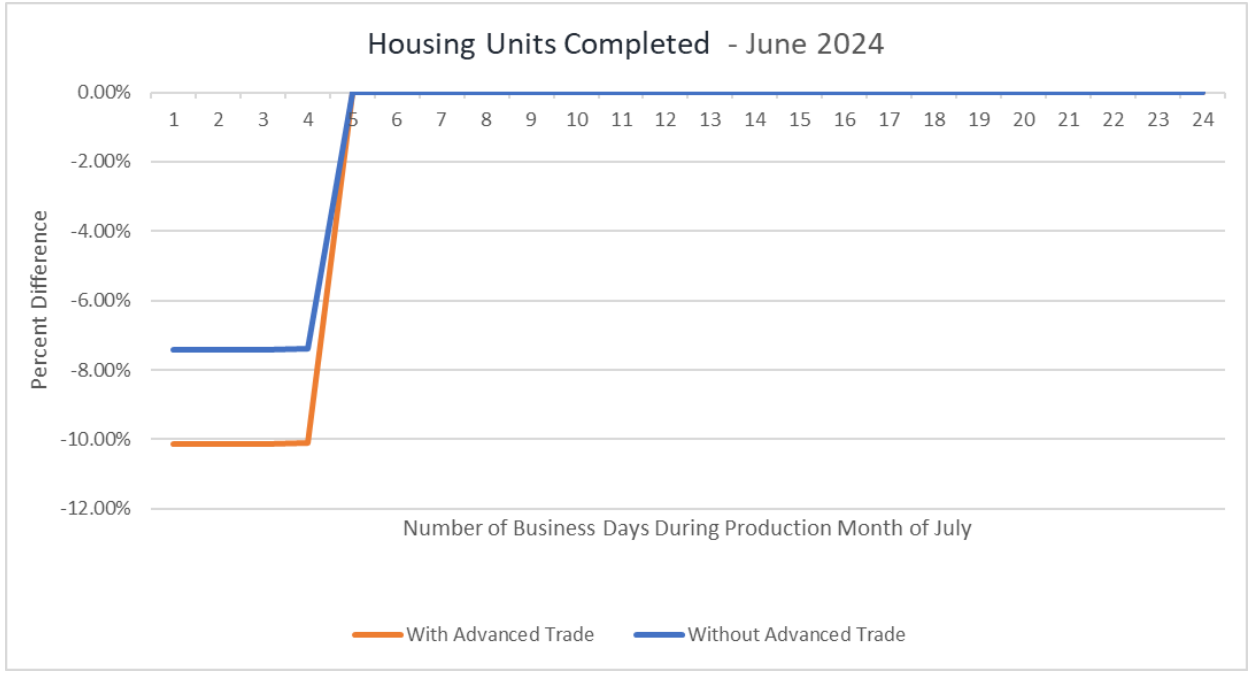
Example of a negative impact on nowcasting for Option 3

- There are months where some series nowcast worse with advance trade
- We accept this difference because the series is published early in the month and/or the series is weighted low
- For example, Housing Units Completed is the 3rd lowest weighted series and the series is published on Day 5
- We continue to monitor the effects of advance trade on the nowcasting for the other series



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Preliminary Research

Root Mean Square Difference (RMSD)

$$RMSD = \sqrt{MSD}$$

$$MSD = \frac{1}{n}\sum_{t}\sqrt{(y_t - x_t)^2}$$

t = all timepoints used in the model fitting

y_t = full trade growth rates

x_t = advance trade growth rates

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