

Project 3.

Introduction.

The effects of the COVID-19 pandemic are not those of a normal recession. We are in an unprecedented time and cannot expect a similar recovery path to say that after the Great Recession. For example, spending on goods has had a highly irregular journey through 2020 due to the unique circumstances introduced by social distancing. Even though consumer spending took a significant hit during the last year, the effects were extremely varied across the different categories, as social distancing limited the amount people could spend on services. “Social distancing has had a smaller impact on goods spending, as shopping may require less in-person interaction. Even as households have lost jobs precipitously, money that was no longer being spent on services freed up budgets to spend on goods. Indeed, we see . . . that the decline in spending on retail goods in March was mitigated by a shift toward online sales” (KC Fed). That being said, the future of goods spending is still uncertain; many variables will affect the growth of goods spending as we return to normal circumstances such as the disparity in spending between income levels, the recovery of spending on services as social distancing eases, and a decrease in the need for household goods. High- and low-income households have had very different experiences throughout the pandemic. As the financial relief that allowed lower-income households to greatly contribute to goods spending in 2020 wanes, we may see a drop off that might not be fully covered by higher-income households opening up their wallets. “[during the pandemic] 70 percent of respondents with household incomes of \$75,000 and higher have more savings than debt. This will power their spending in the coming months as Covid-19 vaccine distribution accelerates and activities such as travel and live events resume” (Martha White, NBC News). On the other hand, “An analysis of checking account balances by JPMorgan Chase & Co. found that lower-income families, although they derived a significant benefit from the April stimulus payments, also had the sharpest decline in their checking account balances at the median since then” (White). We must also take into consideration a shift in spending away from goods towards services. Working with a fixed income, many people will not be able to maintain their current level of goods spending and raise their level of service spending as the end of the pandemic nears. Additionally, “Even with spending on goods held up by a shift away from services, we may not expect elevated goods spending to persist, at least not in durables categories. Households derive enjoyment from the furniture, electronics, cars, and appliances they own rather than the act of purchasing these goods” (Aladangady & Garcia, FED). In other words, much of the spending on goods is on one-time purchases that won’t have a persistent effect on the level of goods spending over the next five years.

Methodology.

Why did the previous consultant create such a bad forecast?

There were multiple cases of misspecification within the old consultant’s model. Firstly, they were running their model and forecasting the levels of the data with a linear trend when the data should have been transformed. When graphing the levels of the series, an exponential trend seems to be the best fit for the data. Secondly, they failed to first difference the data and eliminate the unit root bias present in the levels. Thirdly, the lag length of their model seemed to

be wrong, when running @bjautofit on both the levels and first difference, neither gave me a (1,1) model as the optimal choice, but a (5,1) and (2,2) respectively.

How to improve the previous forecast?

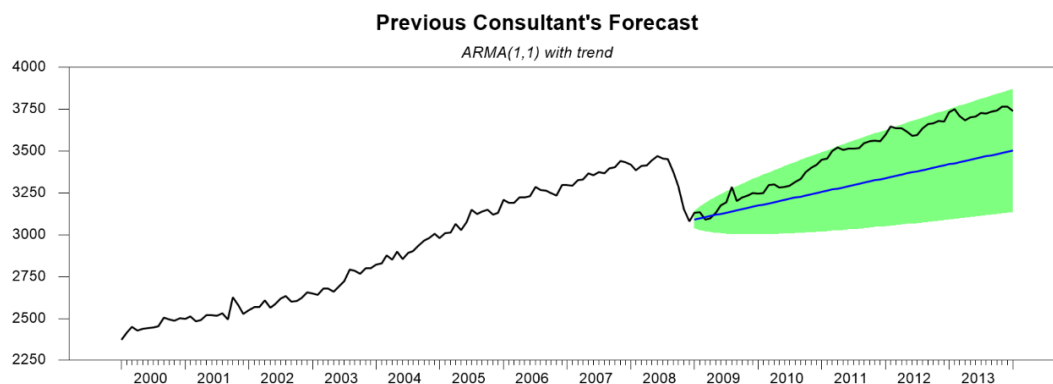
To improve the forecast, we simply have to fix the misspecifications discussed in the last section, For the data set, personal consumption expenditures for goods (DGDSRC1), I used the log of the data. A quick look at the chart of the series reveals what looks like an exponential trend, so logging the data will give us something that looks more linear. Secondly, I chose to use an ARIMA model to eliminate any possible unit roots in the data. After using the Dicky-Fuller test, we see that there is a unit root in levels, but no second unit root in the first-differenced data, so setting $\text{diffs} = 1$ in our model is sufficient. When doing the ARIMA model, I also chose to increase the lag length for both the AR and MA components to 2 which was the preferred model under both the AIC and SBC after differencing the data. Additionally, in the (2,2,1) model, a test for autocorrelation in the residuals found no significant evidence of time dependence.

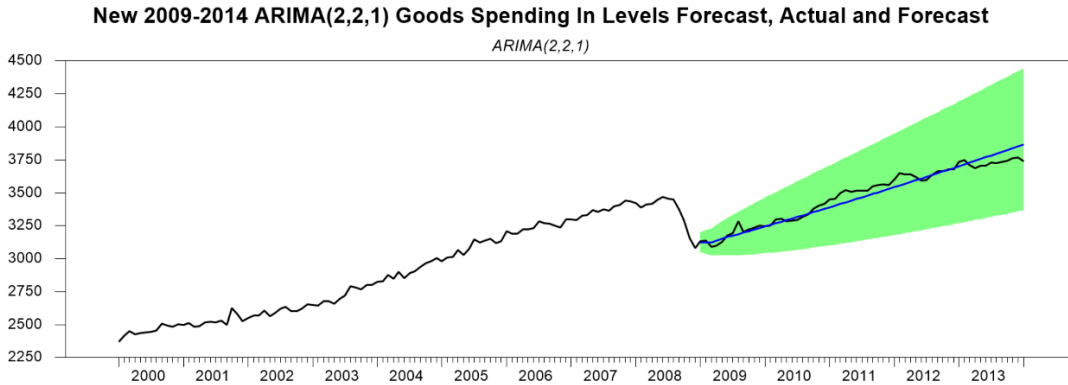
The forecast of goods spending using the ARMA (1,1) with a linear trend runs for 5 years from Jan 2009 through Jan 2014 using a 95% confidence interval. There are two different forecasts of goods spending using my improved ARIMA model; one running and forecasting over the same period as the ARMA model and another that forecasts the recovery following the more recent COVID-19 pandemic for 5 years from Feb 2021 through Feb 2026. Both forecasts use a 95% confidence interval.

To evaluate all the forecasts in this project, I used both the THEIL procedure and the g-Newbold and dmario tests. The THEIL procedure will allow us to compare the forecasts from the Great Recession against a random walk to grade their accuracy. The Newbold and dmario tests will allow me to statistically grade the previous consultant's forecast against my model. For the Newbold test, I will need to analyze the autocorrelation in the residuals of the forecasts, as an assumption of the test is that the forecasts are serially uncorrelated.

Results.

How accurate was the forecast produced by the last consultant?





When we reproduce the forecast done by the previous consultant, we can indeed see that it consistently underperformed. But, running the THEIL procedure against this forecast, beats a random walk in all but 2 months out of the possible 60, those two being March and April of 2009. So, while the forecast wasn't great, it was better than nothing. That being said, I can confirm that my improved model is statistically superior using THEIL and the dmario test. When comparing the relative THEIL U values, the coefficient on the ARIMA model forecast is almost twice as small as that on the ARMA forecast.

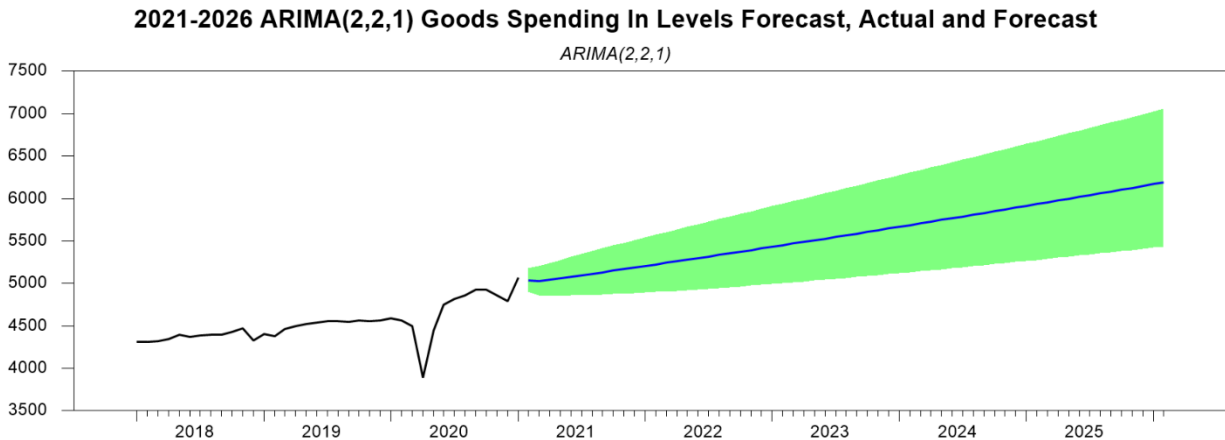
Theil's Relative U 10.359975

Theil's Relative U 5.933543

Unfortunately, running a test for autocorrelation in the residuals of both series found significant results, so the Newbold test cannot be applied here. When looking at the results of the dmario test, we again easily reject the simple forecast(fore1) in favor of the new ARIMA model(levelsfore2).

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Diebold-Mariano Forecast Comparison Test
Forecasts of LGOODS over 2009:01 to 2014:01
Test Statistics Corrected for Serial Correlation of 7 lags
Forecast      MSE      Test Stat P(DM>x)
FORE1         11490668.7   -4.0220 0.99997
LEVELSFORE2   12059084.2     4.0220 0.00003
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The second iteration of the ARIMA model from 2021-2026 paints a moderate picture, with a similar growth rate to before the pandemic.



The forecast had an average monthly change of \$8 million and a sample mean of \$5,579 million over the forecasting period. I am fairly confident in the results of this forecast. The p-value associated with it is 0.00000 and I would argue that the path of the forecast matches with what was discussed in the introduction. Due to the nature of spending during the pandemic, it is unlikely that the shock to spending on goods is very sticky. I predict people will shift their spending back away from goods once they have completed their necessary large-good purchases and services begin to reopen and it will revert to its long-run rate of growth. Unlike the forecast from the previous consultant, I feel as though the biggest risk of this forecast is over-performing. Due to the reasons just discussed and the uncertainty in the ability of lower-income households to spend, there is a chance goods will make up a much smaller portion of personal consumption for a time; possibly even to the point where there is a drop compared to pre-pandemic times, and this forecast will overshoot the level of goods spending.

Conclusion.

In conclusion, the previous consultant fell victim to misspecification in their model, failing to transform the data before performing analysis. While not a great forecast, theirs was better than a random walk in all but two months out of five years. That being said, my ARIMA model outperformed their ARMA model quite handily whether looking at the THEIL and dmario tests or just a simple side-by-side plot. The same ARIMA model forecasting the recovery coming out of the pandemic presents a moderate image, maintaining a relatively similar growth path to that before the pandemic.

What are the implications of the retail apocalypse?

Exiting the pandemic, there is a chance that the effects of the retail apocalypse have been fast-tracked. Much of the rise in goods spending throughout the pandemic was through online shopping.; as was discussed in Aladangady and Garcia's analysis of pandemic spending, "Goods spending itself has shifted toward online sales. . . From the perspective of firms, good producers—particularly those able to sell online. . . may be able to maintain revenue streams, particularly if fiscal stimulus can mitigate the decline in demand from income losses. But certain service sector firms and retailers with only brick-and-mortar presence may be less fortunate". Ultimately, it is the stubbornness of consumers that will decide how much further the pendulum shifts towards online shopping moving forward. If people have become comfortable with doing the majority of their shopping online over the past year, I would imagine there is a large chance

that many stick with it. I believe the implication, and recommendation is “it can’t hurt to be more flexible”. A more robust online shopping system will not only widen the possible consumer base but also provide a safety net if similar situations to the pandemic that require distancing were to occur.