

## **Introduction:**

PM has expressed their want to invest on the expectation that inflation will decline over the next year. PM believes that supply constraints driven by excess spending will ease as the latter falls and thus the lowered spending will reduce future inflation. It is questionable, however, whether the change in goods spending is temporary or permanent and therefore requires the analysis in this brief.

At the beginning of the Pandemic, the composition of spending certainly changed. In almost all recessions, goods spending drops substantially, and services stay relatively shielded from the business cycle. This time around however, it was clear that with a virus that spreads through social interaction, lockdowns and outbreaks would devastate service spending. In figure 1 of this FEDS notes article,<sup>1</sup> it is evident that demand for goods was sky-high, and that residential investment was trying to accompany the demand for space in a lockdown. This is supported by a later figure in the article which shows the change in square-footage in new homes. Extra space in a home also means extra space for stuff. People fill their homes with stuff and a houses space is synonymous to more capacity for goods consumption in the long run. Sticky effects from the initial demand jump like these should be considered in our theoretical conception of where the economy's heading.

This article by the Cleveland FED<sup>2</sup> distinguishes the increased spending between income growth (stimulus) and the context around the pandemic's shift in preference captured in their econometric model by a fixed effect variable 2020. A fixed effect essentially cross-sectionally across the data, captures the variation in a time series due to a "fixed" position such as the year. The results were consistent with a change in preferences. The article did a good job at looking specifically at cars, recreational goods, and furniture and appliances, the categories that align with the narrative of the preference shift. Around 55% of the whole durable goods basket's variation (all positive) was captured by 2020. 50% of the variation of cars was also captured by 2020, however it was equal to the effect of stimulus and thus 0% overall. Furniture and appliances were similar to the overall basket, reflecting the demand to fill one's own house. Recreational goods was a good look because almost all of the huge increase in spending landed into 2020 variable's lap. People don't have events or services, so they filled their time with

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<sup>1</sup> [The Fed - The Unusual Composition of Demand during the Pandemic \(federalreserve.gov\)](https://www.federalreserve.gov/econres/feds/20200901a.html)

<sup>2</sup> [Why Has Durable Goods Spending Been So Strong during the COVID-19 Pandemic? \(clevelandfed.org\)](https://www.clevelandfed.org/publications/economic-outlook/2020/09/why-has-durable-goods-spending-been-so-strong-during-the-covid-19-pandemic/)

things that reproduce entertainment instead. Overall, both the FEDS notes article and the Cleveland Fed article show the clear picture of 2020.

Getting into 2021 however, goods spending is off of the pre-pandemic anchor slightly, but may be trending back down towards the previous equilibrium point while services inch up closer to their own break even point. I would have to agree with the consensus that the demand for services is the same as pre-pandemic, and that is reflected by the pivot back to pre-pandemic trend level of service spending as reported by WSJ<sup>3</sup>. General demand for social interaction has probably not changed, the question is whether goods has latched onto a new anchor or if it is coming down. Looking at the article's own graph, you can see that there may be a trend in the difference between present and pre-pandemic, or it could be coming down from a hump. We must evaluate this in our forecasts to see if there has been a new anchor formed in goods spending.

### **Methodology:**

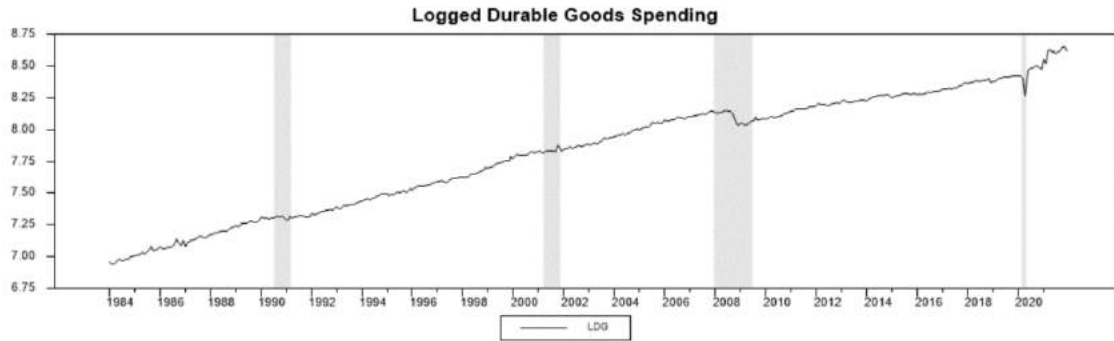
First, the data will be logged, and we will look to see if there are any unit roots and therefore evaluate if a shock to goods spending is persistent or temporary, infusing the literature and theory into that question. That will lead us to whether we forecast using an ARIMA model that takes out the unit root of sticky persistence, or a stationary around trend ARMA. After the model selection, we will model goods spending up until the great recession and the end of 2021 and forecast 5 years out from there. Our forecasts will convert the log back to levels and we will look at the error bands and how certain we could possibly be about the forecast itself. A critique on whether PM should make their investment decision based on the belief that the shock is temporary will conclude this briefing.

### **Econometric Analysis:**

After the Great Recession in 2008, notice durable goods spending clearly has a structural break, a stickiness in consumption pattern. How sticky this is forms our decision of how to model and whether we should make investments based on the narrative at hand. There is a clear upward trend in this series, and we can section off timeframes in the data to see if there is a unit root. If there is, the series has multiple trends it follows, representing the sticky behavior. As seen below, a unit root or "stickiness" can be seen by eye after 2008, however other sections of before/after recession are less clear. In the current context, our 5-year forecast from 2021 could face stickiness in its current deviation, or transitivity with a return to the previous trend.

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<sup>3</sup> <https://www.wsj.com/articles/consumers-are-pivoting-spending-to-services-like-dining-and-travel-11643797808>



Formally, a Dicky-Fully test can be applied to test for a unit root. The null hypothesis ( $H_0$ ) is that there is a unit root and is rejected in the left tail. Let's look at last cycle and this cycle.

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Dickey-Fuller Unit Root Test, Series LDG
Regression Run From 1984:04 to 2008:12
Observations      298
With intercept
With 2 lags chosen from 4 by AIC
Null is unit root. Reject in left tail.

Sig Level      Crit Value
1%(**)         -3.45396
5%(*)          -2.87138
10%            -2.57198
T-Statistic     -2.01897

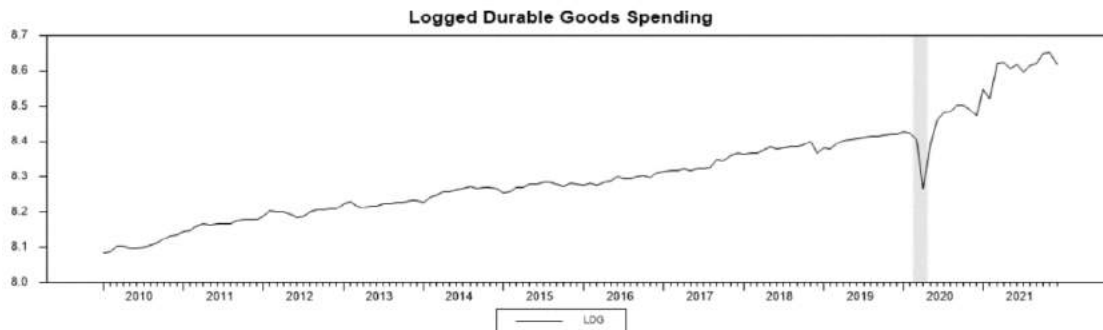
Dickey-Fuller Unit Root Test, Series LDG
Regression Run From 1984:06 to 2021:12
Observations      452
With intercept
With 4 lags chosen from 4 by AIC
Null is unit root. Reject in left tail.

Sig Level      Crit Value
1%(**)         -3.44692
5%(*)          -2.86820
10%            -2.57030
T-Statistic     -0.74156

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We can see that there is certainly a unit root in the data from the 1980's through 2008 and through 2021. Looking at a smaller example to see how sticky consumer spending is, the range from the 80's through the 90's and 2010 through 2021 also yield a unit root. Therefore there were sticky changes each recession. The evidence is strong that shocks lead to unit root deviations from trend. In the chart below, the pre-pandemic trend and post-pandemic data are plotted. Goods could either be on their way down, or part of a new trend. Our forecasting question is whether

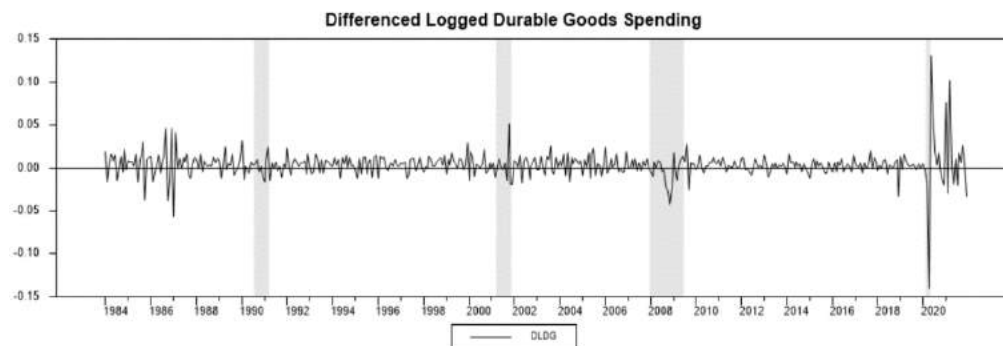
we use an ARMA model stationary around the post-2010 trend, or an ARIMA model that is first difference stationary.



The best conclusion based on the evidence of stickiness from the Dicky-Fuller tests, is that durable goods spending is very sticky to almost all shocks. The regression done in the Cleveland Fed article back this up, as the fixed effect for the year, "preferences," shifted spending more than or equal to the stimulus' effect. The Pandemic narrative is clear throughout the early pandemic and the change in trend since then will likely stand similar to the anchor

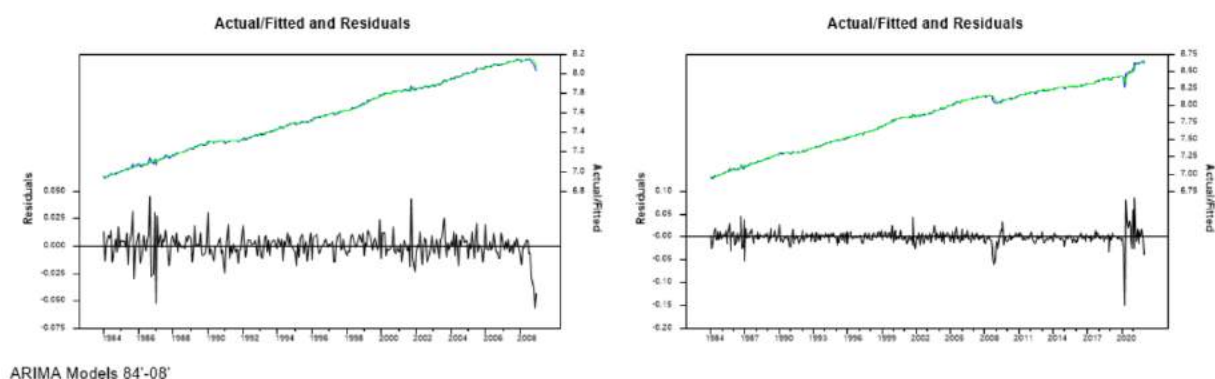
change after every other shock. Therefore, we should use an ARIMA model, mapping the first difference data to our model and forecasts.

Translate the theoretical reasoning into a test, as seen below, first differencing the data did take out the unit root in both time periods, with a stationarity around 0, however, with significant pandemic variation. We will therefore incorporate a difference = 1 component to add into a competing ARMA model to make a new ARIMA model.



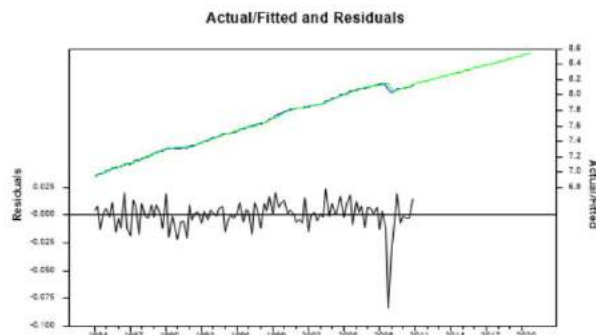
Using the bjauto fit computation as a starting point, I chose my ARIMA components as AR=2, MA=2 for the model up until the Great Recession and AR=3, MA=2 for until 2022. After inserting these coordinates for our models, we check for unit roots larger than 1 (we don't want any) and both models have all unit roots less than 1.

Now that our model produces a stable result (roots all  $<1$ ), we can evaluate whether our model has residuals without time dependence. The  $H_0$  is that there is no time dependence and therefore having a high p-value is the confirmation we need. As seen below, up until 2008, the residuals of this series are not time dependent, however, throughout the whole series, the Pandemic variation made this not so. This will make our forecast less reliable, however, the reasoning on why an ARIMA is still best stands. Below is a special graph of our ARIMA models and their residuals.

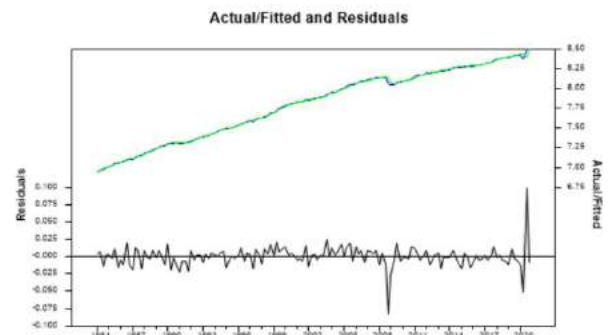


ARIMA Models 84'-08'

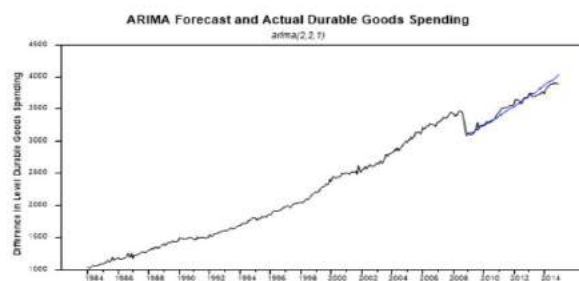
Let's compare that to our ARMA model with trend.



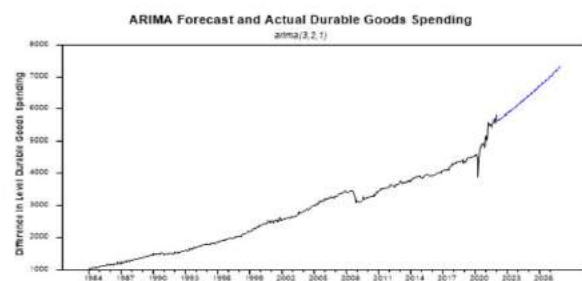
ARMA Models 84'-08, 84'-21'



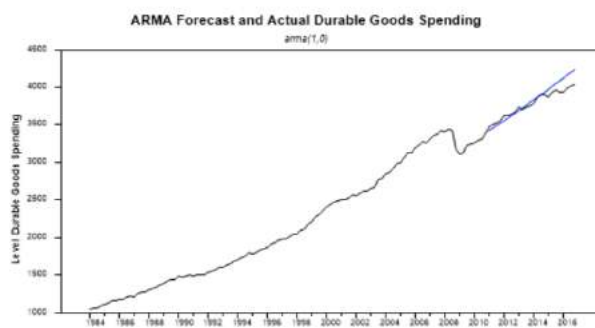
Now Our ARIMA forecasts.



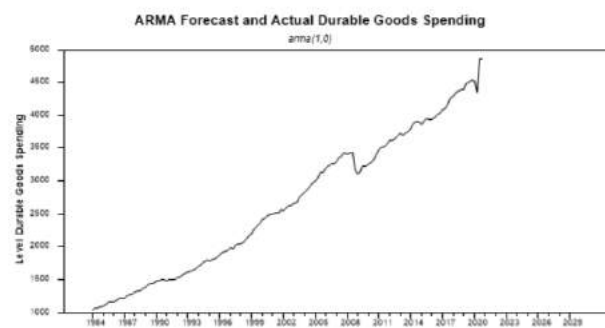
ARIMA Forecasts 84'-14', 84'-27'



Our ARMA forecasts.



ARMA Forecasts 84'-14', 84'-27'



Conclusion:

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Statistics on Series ARIMAERROR
Monthly Data From 2009:01 To 2014:12
Observations              72
Sample Mean                5.971929
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Statistics on Series ARMAERROR
Observations              24
Sample Mean              43.328365
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As seen above, the error from the ARIMA model confirms that it has a much lower error than that of the ARMA. Neither model has durable goods spending decreasing and by establishing that consumer spending is sticky, we can theoretically and empirically confirm that the ARIMA model is what we should go with to forecast our variable and that PM should not bet their money on the presumption that consumer spending will decrease.