

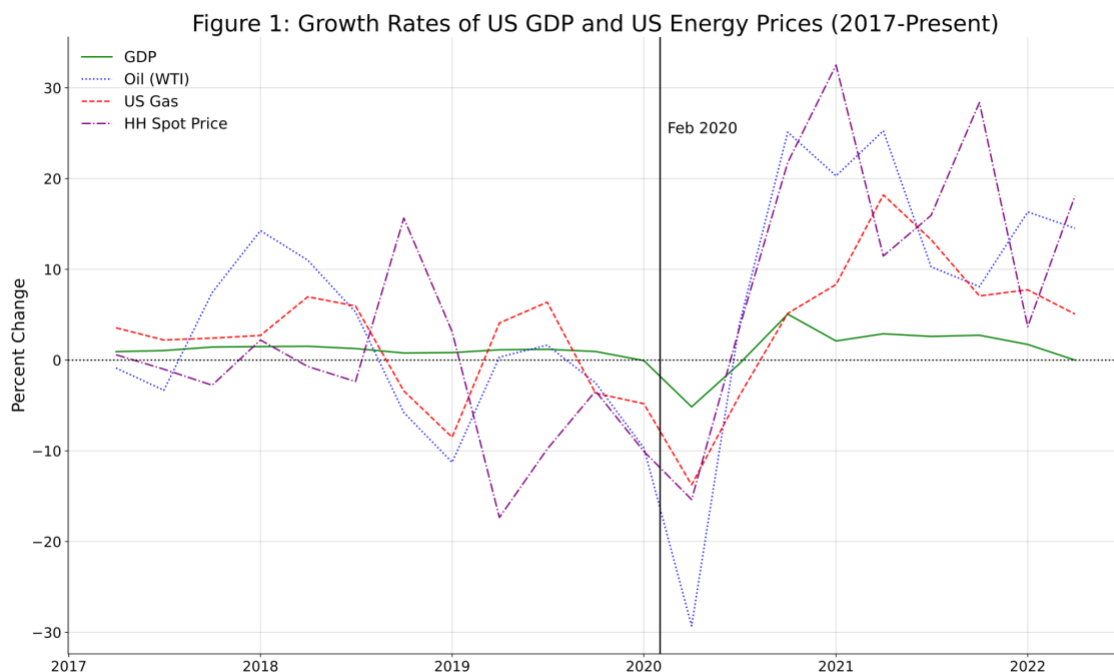
# Energy Prices and US GDP

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**Executive Summary:** In recent months, we have seen extreme volatility in energy prices. Since December 2021, US gas prices have increased 27%, crude oil prices have increased 63%, and the Henry Hub Natural Gas Spot Price has increased 73%. US GDP has been moving in tandem with these measures, suggesting that it is positively correlated with energy prices to some degree. I aim to determine if these shifts in energy prices can act as indicators of US GDP movement. I will also tie movements to recent events in order to qualify these claims. Additionally, I will try to forecast future movement of US GDP using energy prices as a proxy.

## US Energy Price Volatility

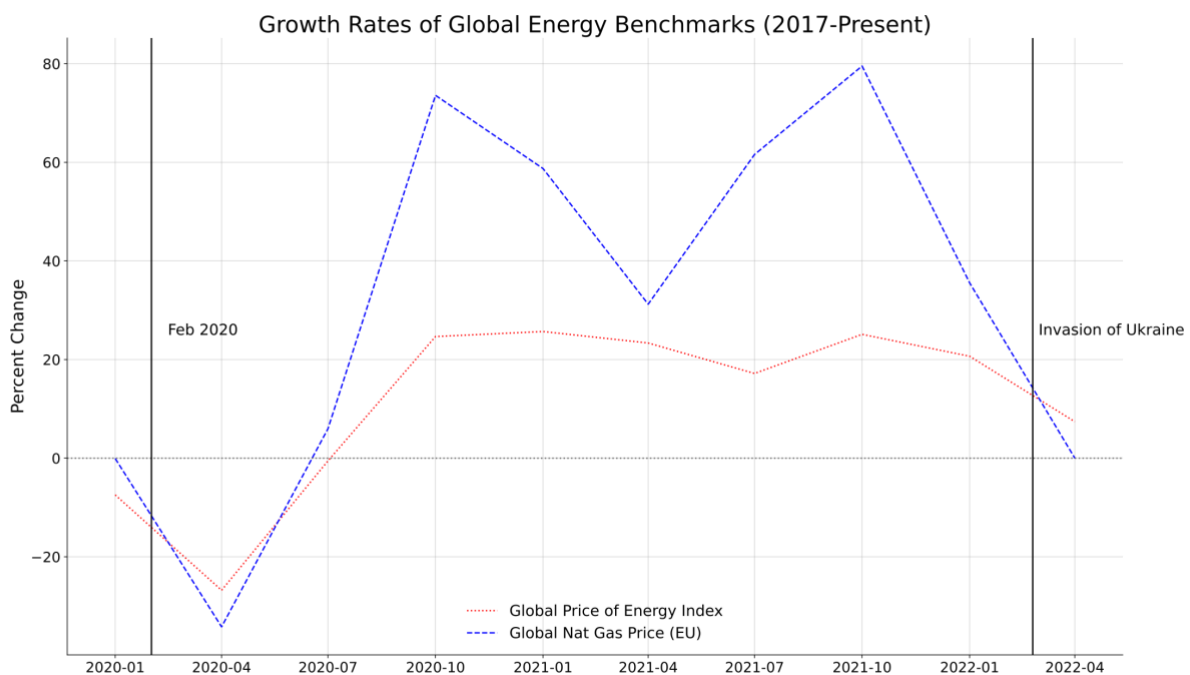
As the world economy recovers from the Covid-19 pandemic, prices around the world have yet to stabilize. Energy prices in particular have suffered extreme volatility. During the 2010's, US gas prices saw an average percent change of only 1.39% quarter to quarter, indicating slow, gradual growth over time. Since January 2020, US gas prices saw an average percent change of 2.80% quarter to quarter. Both crude oil (WTI) prices and the Henry Hub Natural Gas Spot Price have seen increased volatility since Jan 2020 as well. Figure 1 below shows the growth rates of these US energy prices. Shortly after Feb 2020, all measures saw recent peaks and troughs in growth, signaling high volatility.



## Volatility and Current Events

The economy has been on a tumultuous recovery path since early 2020. Covid-19 restrictions disrupted supply chains both foreign and domestic, causing prices of products to fluctuate. Because energy is a necessary commodity in the production of all goods and services, those prices too saw instability. In recent months, a couple of key events have led to additional volatility.

The war in Ukraine has led many NATO nations to put sanctions on Russian energy. Since Russia's main energy market is Europe, these sanctions likely didn't affect US energy prices too much (the US has had sanctions on Russian energy since 2014). Increasing tensions over the past several months have led to increased volatility, as suppliers of oil became uncertain about their ability to provide. As a result, growth has slowed, signaling yet another potential change in trajectory (see figure 2).



Although these aren't US benchmarks, these prices are positively correlated with US GDP, so it is still relevant to consider overseas benchmarks when evaluating the movement of US prices (both measures were at least 86% correlated).

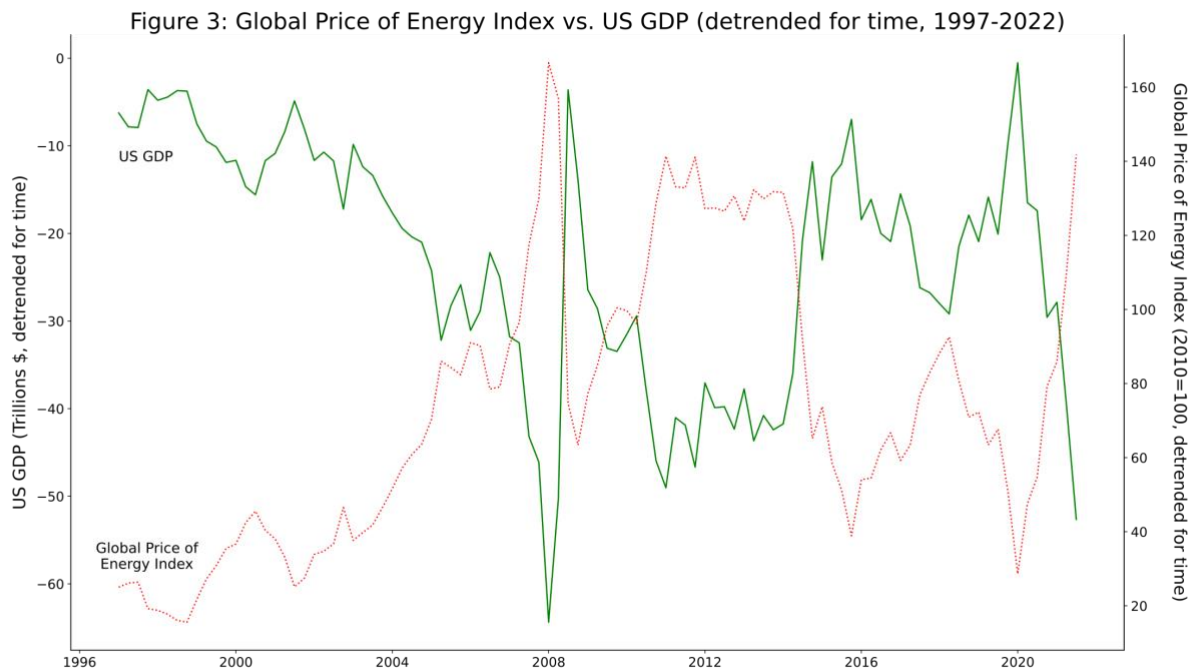
Additionally, recovery from the Covid-19 pandemic supply shocks has put incredible upward pressure on energy prices. Furthermore, supply is quite low given the slow nature of supply chain recovery, augmenting upward pressures.

## Energy Prices as a Proxy for US Economic Growth

By understanding the relationships between US GDP, energy prices, and current events, we can now begin to look at what these relationships can tell us about the future. To do this, I ran some regressions.

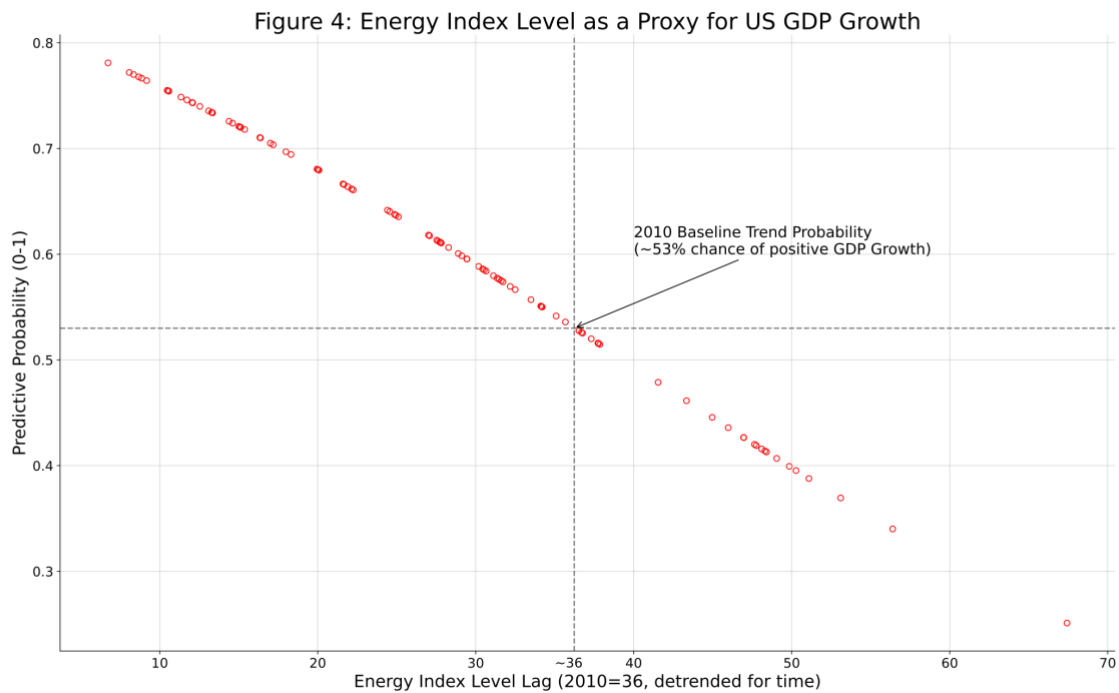
Before I did this, however, I checked the correlation between the energy prices I chose. I found that a most of them were highly correlated and therefore dropped them to avoid misleading results. I only kept the Global Price of Energy Index (Energy Index) because it provides the best summary of the entire energy market.

Next, I detrended the data of any linear time trends. As shown in Figure 3, the true relationship between US GDP and the Energy Index is easier to see.



Clearly, the two are very negatively correlated—they are almost exact inverses of each other. This indicates that we can perhaps use the Energy Index as a legitimate proxy for future GDP growth.

Next, I created a logistic model in which lagged Energy Index values were used to determine whether US GDP saw positive or negative growth in the following quarter. The results of this regression are seen below in Figure 4. A higher y-axis value is associated with a higher chance that US GDP will see positive growth in the following quarter.



This regression is consistent with the idea that Energy Index levels and US GDP growth are negatively correlated. While the Energy Index levels were statistically significant, they gave a low R-squared value of 0.04 (a value between 0-1 that describes how well the independent variables account for a change in the dependent variable). Because there are so many factors that affect US GDP, I was not expecting a high R-squared value. This regression does, however, show that energy prices are a significant factor to consider when forecasting US GDP.

## Forecasting

Using this model, we can get a rough idea of where future GDP growth is headed. The associated probability with the most recent Energy Index observation (338.33 as of March 2022, not shown) is ~0.27 (27% chance US GDP sees growth in the next quarter). This runs far below the trend probability of 53%, which makes sense when considering the other graphics. Figure 2 shows unusually high growth in Energy Index levels over the recent months. Figure 3 tells a similar story, showing an extremely steep, inverse slopes in Energy Index levels and US GDP levels. Trends in energy prices suggest a low probability of economic growth in Q2 of 2022.

## Final Notes/Reflection

In my executive summary, I suggest that US GDP and energy prices are positively correlated. Through some statistical analysis, I have shown otherwise. This is because US GDP is affected by countless factors, which creates a lot of noise amongst the raw numbers. I believe that Figure 3 does a good job at illustrating the true relationship because it shows detrended data.

As stated above, I understand that countless factors affect US GDP and therefore was not expecting stellar results in my forecasting. My probability prediction for Q2 growth is a bit flawed, as it is just a proportional calculation based on previous detrended data. If I had more time, I would incorporate the newest GDP data that were released last week to get a more robust probability prediction (though real GDP *did* fall from Q4 2021 to Q1 2022...victory!)

## Data

All data was gathered from [fred.stlouis.org](https://fred.stlouis.org), the Federal Reserve's online database of economic information.