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PRICES AND SPENDING

Why the prices of natural and synthetic rubber do not always bounce together

By Neil Wagner

The rubber industry is both global and diverse, providing important materials not just for the automotive industry, but also materials that are widely used in consumer products, construction, and industrial applications. The rubber-producing sector is divided into two types of products: natural rubber and synthetic rubber. Natural rubber is an agricultural good primarily produced in East Asia and accounts for approximately 25 percent of rubber used in industrial production. Synthetic rubber is produced globally and was created in response to the strategic importance of rubber during World War II.

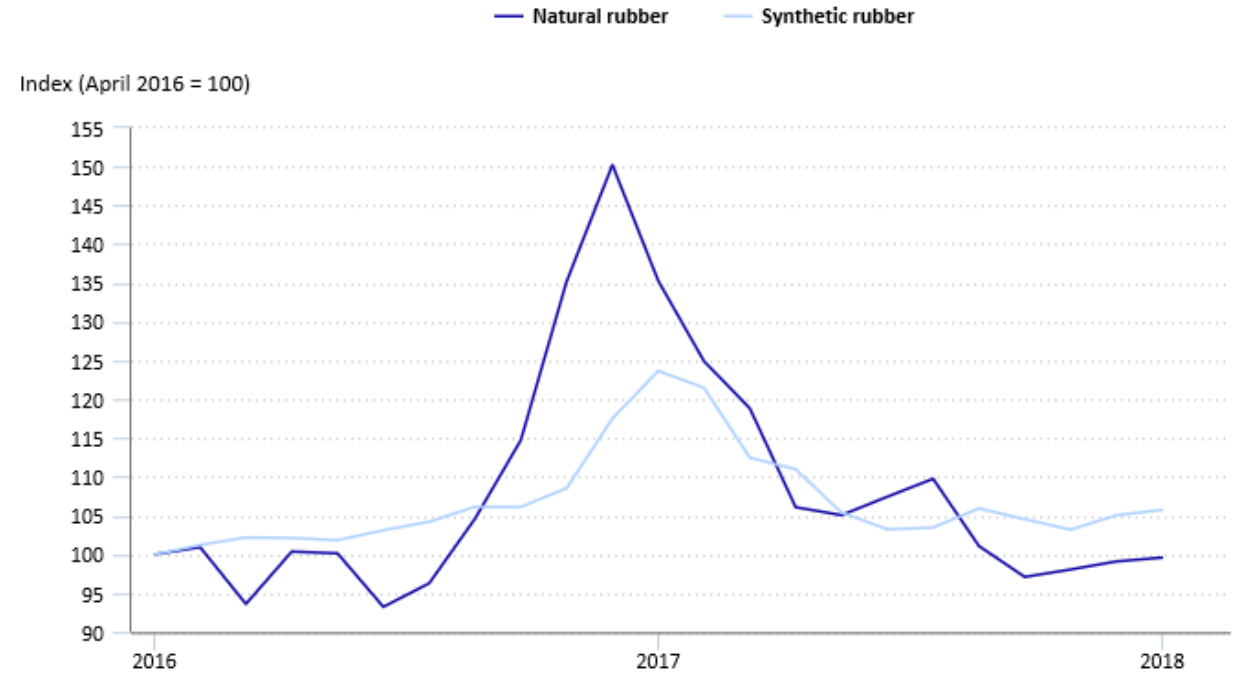
The origin of synthetic rubber as a substitute for natural rubber, and its extensive, market-leading use in industrial manufacturing, would lead one to believe that these products are highly substitutable; or even that synthetic rubber has superior properties. Looking at average producer price changes for synthetic and natural rubber from April 2016 to January 2018 would further this belief, because over this period prices for both products fluctuated similarly. However, these recent price trends may be misleading. This **Beyond the Numbers** article investigates why these two types of rubber are distinct products, what influences their prices over time, and how the pricing data between April 2016 and January 2018 may give the impression that synthetic and natural rubber markets are more closely related than in reality.

In this article, price changes for synthetic rubber manufacturing are measured by the Producer Price Index (PPI) for North American Industry Classification System (NAICS) industry 325212, Synthetic Rubber Manufacturing.[1] This index represents average changes in prices received by domestic producers for a variety of formulations of synthetic rubber. The price index for natural rubber used in this article was constructed by PPI from monthly averages of prices as reported by the Association of Natural Rubber Producing Countries (ANRPC).[2] This association is an inter-governmental organization established in 1970, made up of 13 countries that account for about 91 percent of global natural rubber production.[3]

Do prices paint the right picture?

It is logical to assume that natural and synthetic rubber would be close substitutes, and therefore, would have significantly related markets, given that the creation of the synthetic rubber industry was in response to the lack of availability of natural rubber. Such substitutability should come with a price relationship. If the price of one type of rubber rises, demand for rubber should shift over to the relatively cheaper substitute. That shift in demand for the substitute rubber may cause its price to increase as well, all things equal. A look at average prices for both products in recent years seems to reinforce this assumption. In early 2017, prices for both natural and synthetic rubber increased sharply within months of each other and retreated over a relatively similar period. Chart 1 shows price indexes for natural and synthetic rubber over time, with both indexes normalized to 100 in April 2016.

Chart 1. Price indexes for synthetic rubber and natural rubber, April 2016–February 2018

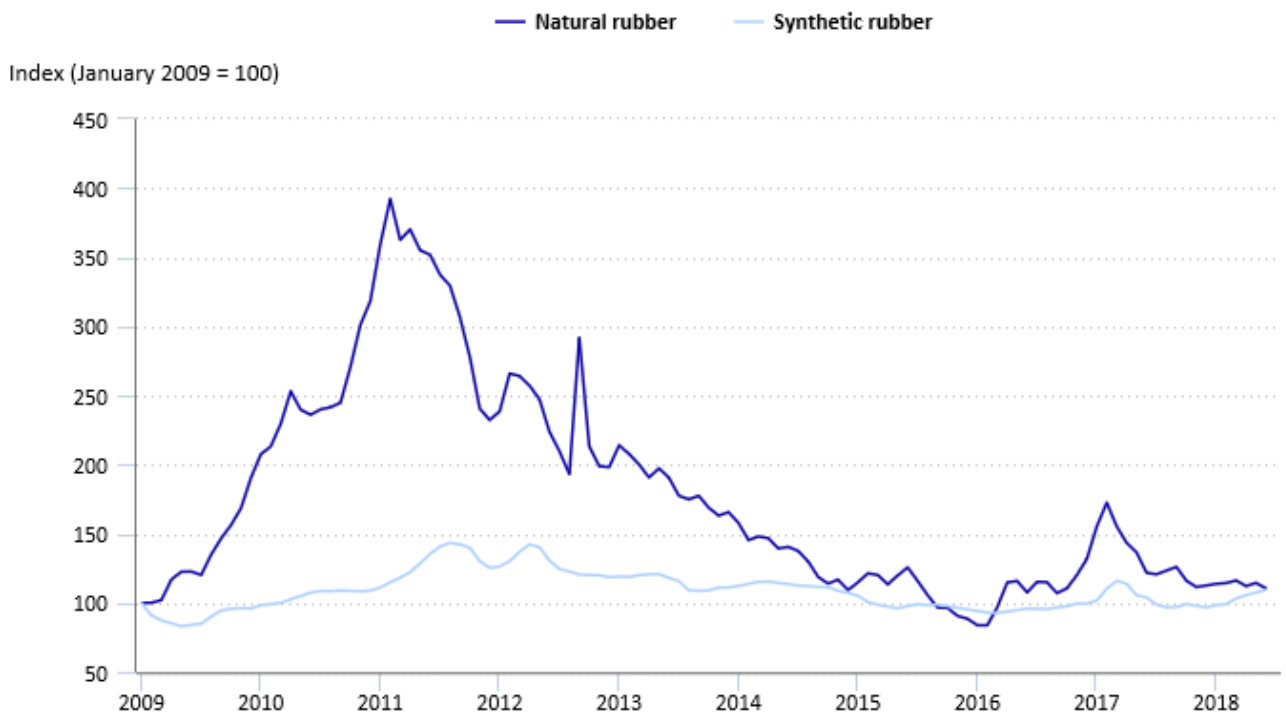


Click legend items to change data display. Hover over chart to view data.
Sources: The synthetic rubber index is from the U.S. Bureau of Labor Statistics, while the index for natural rubber is constructed from price data from the Association of Natural Rubber Producing Countries.

Data for mid-year 2016 show prices for both types of rubber were relatively stable, with more volatility in the natural rubber index. The end of 2016 through the beginning of 2017 was a volatile time for both indexes. From November 2016 to February 2017, the natural rubber index increased 43.6 percent, from 104.6 to 150.2. The synthetic rubber index increased from 106.1 in December 2016 to 123.7 in March 2017, a 16.6-percent increase. Both indexes fell over the next several months back to their mid-2016 levels.

Chart 1 also shows the natural rubber index increasing before the synthetic rubber index. An educated guess would surmise that the price of natural rubber increased first, and therefore, producers who use natural rubber as an input substituted towards synthetic rubber, thus increasing the demand and the price of synthetic rubber. However, this theory quickly breaks down when the period is expanded. Chart 2 plots the same data series going back to January 2009 (and rebased to that period). Natural rubber prices have been much more volatile over time than synthetic rubber. Prices for natural rubber increased substantially from 2009 to the beginning of 2011; while synthetic rubber prices inched up slowly by comparison. The price decline for natural rubber between 2011 and 2015 appears to have had little impact on the long-term trend of the price of synthetic rubber. Over time, the price ratio between synthetic and natural rubber hardly stays fixed as one might expect for closely linked products.

Chart 2. Price indexes synthetic rubber and natural rubber, January 2009–June 2018



Click legend items to change data display. Hover over chart to view data.
Sources: The synthetic rubber index is from the U.S. Bureau of Labor Statistics, while the index for natural rubber is constructed from price data from the Association of Natural Rubber Producing Countries.

The article “Natural rubber prices remain cyclical,” discusses general substitutability between natural and synthetic rubber.[4] It suggests that substitution between natural and synthetic rubber occurs when relative prices change for rubber used in applications that are less demanding. However, the extent of this switching is limited for technical reasons. For example, the sole of a sneaker potentially could be produced with either form of rubber, given its simple performance requirements. For a product with more demanding specifications, such as electrical device insulation, synthetic rubber’s superior flame resistance could not be replaced easily with natural rubber, which reacts poorly to extreme temperatures.[5] In reality, the demand for rubber is application dependent. With more than half of rubber being consumed by tire manufacturers, and because tire manufacturing permits only limited substitution between synthetic and natural rubber, more than half of the rubber marketplace is relatively fixed. The article goes on to state that the prices of natural and synthetic rubber show considerable divergence over prolonged periods, and that actual substitution has been limited; any that does occur is slow to take place.[6]

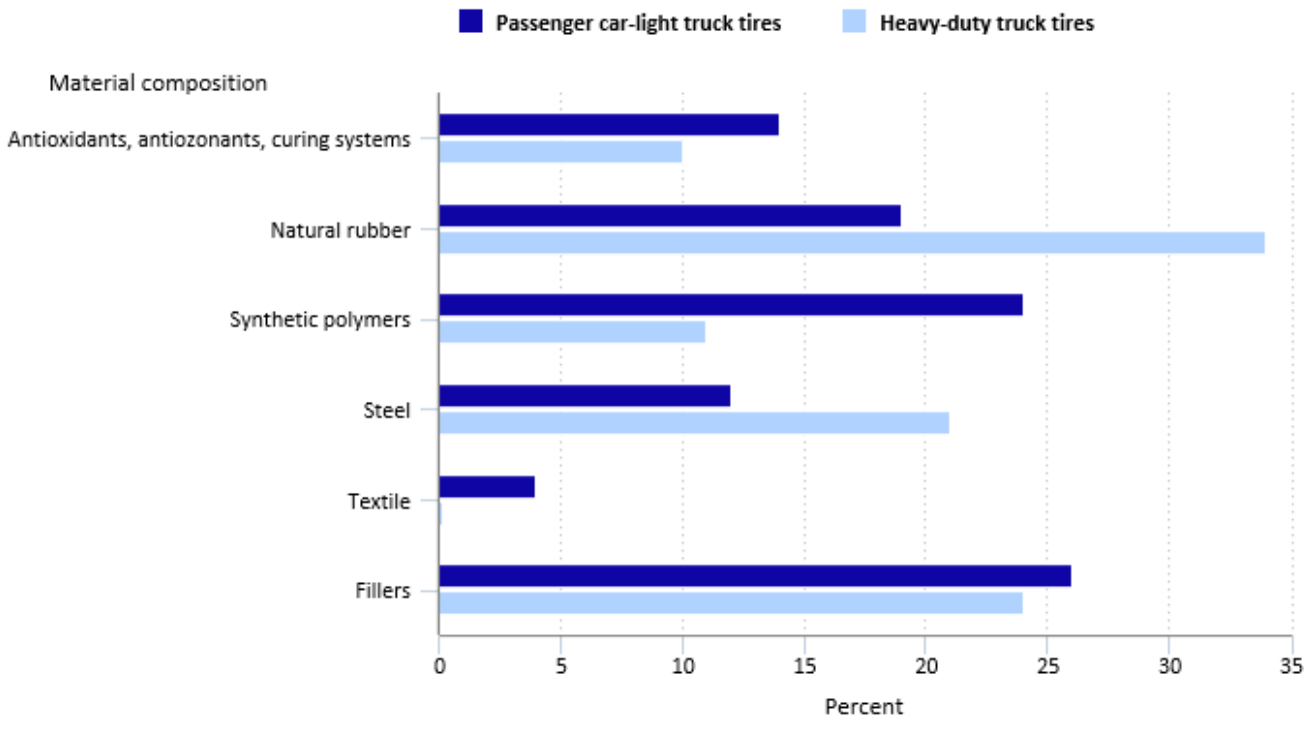
If natural rubber and synthetic rubber are not completely substitutable goods, there is little reason to expect their prices would move together between 2009 and 2018. This does not, however, explain why prices moved similarly during the price spike of early 2017. In the absence of substitution effects amongst the types of rubber, a further examination of demand and supply for each type of rubber may highlight the true reason behind their misleadingly similar price movements during that period.

Demand-side factors

As previously stated, the demand for natural and synthetic rubber depends on the characteristics of the products being produced. Natural rubber has high strength and resistance to fatigue, excellent ability to stick to itself and other materials, moderate heat resistance, low rolling resistance, and high resistance to cutting, chipping, and tearing. Conversely, some superior properties of synthetic rubber include better abrasion resistance, good elasticity, better heat and aging resistance, flexibility at low temperatures, and resistance to grease and oil.[7] Some product specifications may require only natural rubber, only synthetic, or a combination of the two. A prominent example of a product that requires both types of rubber is tires.

Tire manufacturing employs both types of rubber in its production, among other inputs. Chart 3 provides the general makeup of passenger-light truck tires and heavy-duty truck tires. Natural rubber is used for its tear and fatigue resistance, whereas synthetic rubber (synthetic polymers) is used for various physical and chemical properties.[8] This chart shows that heavy-duty truck tires require a greater ratio of natural rubber to deal with the increased physical strain of supporting heavier duty vehicles. This is a good example of the physical property characteristics required to manufacture specific products restricting the ability to substitute between types of rubber, even in the presence of significant price differences. In the case of tires, synthetic rubber and natural rubber behave more like complimentary goods than substitutes.

Chart 3. Comparing the material composition of passenger car-light truck tires and heavy-duty truck tires, by percentage



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Tire Manufacturer's Association.

In addition, synthetic and natural rubbers are global commodities used in a variety of industries, tying the growth of both to the health of the world economy. In 2016, China was the world's largest rubber market, accounting for nearly 40 percent of world natural rubber consumption. China uses 80 percent of its natural rubber for tire manufacturing.[9] As economies in the Asia Pacific region grow, including their automotive sectors, it makes sense that the demand for rubber will continue to grow. Other applications of rubber include: hoses, tubes, and bearings in the construction industry; footwear, erasers, and sporting goods in the consumer goods industries; and surgical gloves, contraceptives, and catheters in the healthcare industry. Because demand for specific types of rubber is product-specific, dictated by the requirements of the application, and it takes time for the global economy in these industries to grow, it does not seem likely that the price spike of both synthetic and natural rubber in 2017 was due to demand-side factors.

Supply-side factors

The supply side factors of natural and synthetic rubber markets likely cause a substantial portion of the divergence between their prices due to the products' origins and input materials. Natural rubber was used centuries before synthetic rubber was developed. A French explorer first reported its use in South America for footwear and bottles. It was obtained from the latex of the rubber tree that is native to the region.[10] Although useful, natural rubber froze in the winter and melted in the summer, making it difficult to work with. In 1839, Charles Goodyear invented a chemical process used to harden rubber called vulcanization, which made natural rubber more resistant to temperature changes, thereby contributing to growth in the industry. By 1910, Asian rubber plantations, using seeds from the Amazon Basin, became the primary source of natural rubber. Thailand, Malaysia, and Indonesia currently account for two-thirds of global production of natural rubber.[11]

Because natural rubber is an agricultural good, farmers need to make long-term planting decisions based on expectations of current and future market conditions. There is a 7-year lag between planting and actual production of natural rubber. The level of plantings is a function of market prices, the availability of land and seedlings, and the profitability of rubber versus other crops. Research on the supply and demand fundamentals of Thai natural rubber listed the commodity price of natural rubber, rainfall, and the price of alternative crops as the main factors having an impact on supply.[12] Overall, the supply side of natural rubber is mainly dependent on agricultural fundamentals.

Synthetic rubber has different origins and supply-side fundamentals. Early research in synthetic rubber production occurred because of the volatile nature of natural rubber prices. However, the commercial production of synthetic rubber did not truly grow until World War II, when the United States lost access to 90 percent of its natural rubber supply. With U.S. government sponsorship, a group of companies involved in rubber research and production pioneered the creation of Government Rubber-Styrene (GR-S) on a commercial scale with the help of research from the government, academics, and independent laboratories.[13] Research and production continued after the end of the war and thus created the modern synthetic rubber industry.

There are currently many forms of synthetic rubber manufactured, including Styrene-Butadiene Rubber (SBR), Polybutadiene Rubber (BR), Polyisoprene Rubber (IR), and others, all with distinct characteristics. SBR and BR are the most widely produced because of their importance in the production of tires.[14] In general, synthetic rubbers are produced by combining monomers (molecules that can be bonded to other identical molecules to form a polymer) originating from refined sources of hydrocarbons such as coal, crude petroleum, and natural gas. For example, SBR is produced from copolymerization (combination of more than one unique monomers) of styrene and butadiene, both derivatives of other hydrocarbons.[15] The production of synthetic rubber is constrained by the

availability and price of refined hydrocarbons, largely different from the agricultural constraints faced in the natural rubber manufacturing process.

What happened in 2017?

Given that synthetic and natural rubber are not perfect substitutes, and thus face different levels of demand and have different supply functions, why did the price of both commodities increase drastically during the first quarter of 2017? Although the automotive industry significantly drives the demand for both types of rubber, demand for both products did not grow suddenly and significantly from this one source. The shared price movement actually occurred because each type of rubber faced unique supply constraints owing to occurrences that similarly impacted their manufacturing processes.

The price of natural rubber jumped in early 2017 because of widespread flooding in southern Thailand, resulting in damage to infrastructure that significantly hampered rubber production.[16] The president of the Natural Rubber Council of Thailand described the damage as the worst in a decade, due to the combination of heavy flooding and recent drought in that farming region. This had significant market implications, given that Thailand supplies 37 percent of the global supply of natural rubber, according to ANPRC.[17] This shock to the supply of natural rubber occurred while the already growing Chinese automobile sector tightened the market, resulting in a supply shortage and a significant increase in the price of natural rubber.

While natural rubber faced a reduction of working land in early 2017, U.S. synthetic rubber prices increased because of growing costs in inputs to SBR, which were already facing tight supply in the market.[18] In February 2017, technical issues related to equipment failures at several manufacturing locations affected around 40 percent of U.S. styrene production capacity.[19] Also, scheduled production outages and plant issues caused a shortage of butadiene as well as its feedstock materials.[20] SBR prices in the United States, which moved higher during this time, resulted from several months of shortages of multiple input materials.

Conclusion

It is easy to assume that synthetic and natural rubber may be substitutable, especially when comparing price movements in 2017 and 2018. The price spike that occurred in U.S. synthetic rubber and worldwide natural rubber markets in the beginning of 2017 gives the impression that both markets move similarly, possibly owing to substitution effects. It is true that both goods are heavily affected by the world demand for tires, but substitution between the two products is limited. A consistent relationship between prices for these two goods does not appear to exist when examining prices beyond this 2-year period.

The supply-side drivers of synthetic and natural rubber are quite distinct, resulting in strong differences in prices over time. Natural rubber production faces agriculturally based supply constraints where, in the long run, prices are affected by the cost of land and labor, weather, and global market prices for natural rubber. All of these variables impact supply because of their influence over planting and harvesting decisions. Synthetic rubber, on the other hand, is produced with hydrocarbon monomers that come from petroleum and natural gas. The price of various types of synthetic rubber will, therefore, react to the availability of inputs which can be affected by plant shutdowns and long-run price movements for crude petroleum and natural gas.

This **Beyond the Numbers** article was prepared by Neil Wagner, formerly an economist in the Office of Prices and Living Conditions, U.S. Bureau of Labor Statistics. For more information, contact Frank Congelio, supervisory economist with the Producer Price Index, at Congelio.Frank@bls.gov or (202) 691-7712.

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NOTES

[1] For current Bureau of Labor Statistics PPI data reflecting changes in prices received by the synthetic rubber manufacturing industry, visit https://data.bls.gov/timeseries/PCU3252123252212&output_view=data#.

[2] Since PPIs track changes in prices received by U.S. producers, and natural rubber primarily is produced in East Asia, a PPI for natural rubber is not calculated. As a result, for this article a proxy index reflecting monthly average price changes for natural rubber was calculated using data from the Association of Natural Rubber Producing Countries. The data included in this calculation were average prices of Malaysian Latex, Ribbed Smoked Sheet #4 from India, Thailand Ribbed Smoked Sheet #3, and Thailand Technically Specified Rubber (TSR). These average prices were selected because they were continuously reported by ANRPC from January 2009 to June 2018. See http://www.anrpc.org/html/weekly-prices.aspx?ID1=26&ID=27&PID=36.

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[4] Bruce Meyer, "Natural rubber prices remain cyclical," *Rubber and Plastics News*, August 5, 2019, on the web at https://www.rubbernews.com/suppliers/natural-rubber-prices-remain-cyclical. For additional information, visit The European Tyre and Rubber Manufacturers' Association (ETRMA) website at https://www.etrma.org/. A link to an ETRMA report on the natural rubber market from 2019 is located at https://www.etrma.org/wp-content/uploads/2019/09/20181119-booklet-event.pdf.

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[13] "United States Synthetic Rubber Program, 1939-1945,"*American Chemical Society*, August 1998, https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/syntheticrubber.html.

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[17] "ANRPC: Natural rubber production impacted by flooding, tree disease," *Rubber and Plastics News*, August 24, 2018, https://www.rubbernews.com/article/20180824/NEWS/180829962/anrpc-natural-rubber-production-impacted-by-flooding-tree-disease.

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[19] Maria Tsay, Pamela Sumayao, John Calton, "Analysis: Extreme US styrene shortage turning global trade flows upside down," *S&P Global Platts*, February 16, 2017, https://www.spglobal.com/platts/en/market-insights/latest-news/petrochemicals/021617-analysis-extreme-us-styrene-shortage-turning-global-trade-flows-upside-down.

[20] "News focus: US butadiene spikes 15.5 cents/lb to 5-year high," *ICIS News*, March 3, 2017, https://www.icis.com/resources/news/2017/03/02/10084420/news-focus-us-butadiene-spikes-15-5-cents-lb-to-5-year-high/. Butadiene is the organic compound with the formula $(CH_2=CH)_2$. It is a colorless gas that is easily condensed to a liquid. It is important industrially as a monomer in the production of synthetic rubber.

SUGGESTED CITATION

Neil Wagner, "Why the prices of natural and synthetic rubber do not always bounce together," *Beyond the Numbers: Prices and Spending*, vol. 9, no. 2 (U.S. Bureau of Labor Statistics, February 2020), https://www.bls.gov/opub/btn/volume-9/why-the-prices-of-natural-and-synthetic-rubber-do-not-always-bounce-together.htm