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Observations on Risk Transmission Across Supply Chains

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This is an invited commentary on the perspective paper by Sheridan Titman concerning the drivers of risk transmission across supply chains that have fundamental commodity inputs.

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1. Observations

In the engaging paper by Sheridan Titman (2021), the impact of supply-side and demand-side shocks to a supply chain are shown to create a need for intricate hedging strategies which depend on the price elasticities at the various stages involved in the transformation of a commodity input. A consequence of this is the conclusion that the practical hedging task is much more challenging than a volatility reduction task and that the research agenda is a rich one in terms of risk estimation, operational modeling, and competitive analyses.

A major source of these challenges comes from the observation that the various stage elasticities have an endogenous relationship to each other so that shocks at one stage can affect prices at the other stages. Oil is a good example and Sheridan makes a very clear exposition of how consumer responses to airline prices can both influence and be influenced by crude oil process. For hedgers, this presents a financial engineering problem with the econometrics of estimating the endogenous shock spill-over process being a particularly challenging ingredient. Thus, in empirical energy finance, there has been an active analysis of the extent to which oil prices have been driven by supply-side shocks in production, for example, through OPEC restrictions, and/or demand-side shocks, for example, from China (Hamilton, 2009, Kilian, 2009). The econometric techniques of vector autoregression and vector error correction have been required to jointly estimate these inter-related elasticities and their cross-impact responses of shocks. The challenge is that the estimates are not constant over time with structural changes in the market leading to evidence of regime switching that further undermine the robustness of estimation techniques appropriate for practice. So, the problem of hedging with multiple elasticities that Sheridan lucidly portrays presents, in practice, some econometric awkwardness for time series specification even before the pricing model for the hedges is considered.

The dynamic implications of these supply and demand-side elasticities are particularly interesting. Essentially, they can lead to business cycles, if their effects are strong enough, but if their effects weaken, the dynamics change, not just gradually, but fundamentally. The oil price example is a good manifestation of this. During the 1990s, supply and demand-side elasticities mitigated the effects of shocks over time so that oil price cycles were manifest and the time series specification was mean-reverting (Pindyck, 2001). The mean-reverting tendencies were induced by the both supply-side and demand-side elasticities at the peaks and troughs of the price cycles. With high prices, demand fell and production increased leading to lower prices. The opposite happened with low prices leading to a classic business cycle effect. Then there was the financialization of commodities from the turn of this century, with oil becoming a major asset class, attracting speculators to the extent that its time series properties became less driven by the elasticities in the supply chain, and more the co-movement with capital markets, thereby acquiring more of a random walk than mean reverting characteristic (Bunn et al., 2017, Manera, 2013). Oil became part of systematic investment

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in commodity portfolios by institutional and other investors, such that its price formation reflected the capital market demand, thereby diluting the elasticity of the physical fuel sector demand. In addition, the physical demand-side elasticity itself started to decline as there was less oil used in power generation and heating as well as more subsidies of oil by developing countries. Finally, with greater financial interest, the impact of speculators adds an extra layer of complexity to oil price dynamics, beyond the supply chain elasticities. Their impacts also bring greater liquidity, which of course is beneficial in reducing the transaction costs of hedging. The key point is therefore that the elasticities are crucial, but confounded by other price drivers and model-switching.

Not far from oil in the energy commodity space, natural gas also presents a good example of these drivers toward alternative models. In markets were a substantial amount of electricity has been generated from coal and gas, the so-called fuel-switching level has been an important factor in analysts' thinking about prices. The fuel switching level is the point at which gas and coal prices lead to similar marginal costs for electricity generation. When gas prices are below this, demand for gas will be high, because most gas fired generators will be running, but if gas prices rise to the fuel switching level, demand will drop off precipitously as the electricity fleet switches to more coal production. Similarly, in periods when the natural gas price is above the fuel switching point, when it falls to the fuel-switching level, it will increase power demand for the fuel and that will provide some price support. Thus, it has been common to see gas market analysts (e.g., Timera 2018) project prices evolving between two bounds, one linked to the fuel-switching levels and the other linked to oil prices. Evidently, this role of the coal–gas fuel switching elasticity will decline as coal power generation is phased out as a result of decarbonization policies. However, it is still an important manifestation of this supply-chain elasticity driver in gas price formation.

The focus of this discussion has been upon hedging commodity-induced price risks though financial instruments. Of course, considerations of supply chain risks have often led to strategic remedies in the form of vertical integration. Ownership of more than one stage in the value chain can internalize relative fluctuations in the prices and this is an obvious corporate solution. An interesting consequence is the extent to which this risk management solution by major players in the supply chain influences the prices and their risk dynamics. Economic research on vertical foreclosure is well established, insofar as increasing the market concentration in the upstream stages can increase prices and reduce the competitiveness of the unintegrated players downstream (Hortaçsu and Syverson, 2007). What is less understood is how these strategic effects mitigate or amplify other fundamental shocks to the supply and demand elements. Again, this is an extra layer of analytical challenge above the operational fundamentals. Optimism that more speculators would make the supply chain markets more efficient may be misplaced, to the extent that speculators generally do not like to enter markets where physical players have both an informational advantage and the ability to move prices.

These observations are consistent with the analysis and thoughts in the position paper by Sheridan Titman, and furthermore, support the contention that the analytical challenges of understanding risk transmission in supply chains are not only substantial already, but also likely to become greater as supply chains become composed of more specialized stages and markets become the preferred transactional process between them.

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