Research Statement

My current research focuses on crude oil prices. I try to answer the following questions: how can one model the dynamics of crude oil prices? What drives such dynamics? How much of the fluctuations in crude oil prices can be explained by market fundamentals?

In my job market paper, I study the dynamics of crude oil spot and futures prices, and, in particular, focus on the persistence. I document a dramatic change in the persistence in crude oil spot and futures prices that occurred around 2002 to 2004. To better understand this change in price persistence, I propose an unobserved components model derived from the arbitrage conditions in competitive storage and futures market. The competitive storage theory states that in equilibrium, trading now and incurring storage cost and benefit should be equivalent to trading later. Efficient futures market requires trading futures and bearing risk to be equivalent to trading physical oil in the future in equilibrium. These arbitrage conditions provide intuition of the dynamics of crude oil prices, and unobserved components models allow for uncovering the unobserved storage costs and benefits and futures risks.

I decompose crude oil spot price into a long-term component reflecting the equilibrium price process, and a short-term component reflecting the storage cost and benefit, that is, net convenience yield. Futures prices, in addition to having these the components, have an additional risk premium component. Fitting this model to weekly WTI prices, I show that the change in persistence can be explained by the substantial increase in the volatility of shocks to the unobserved components. In particular, the long-term component has become relatively more volatile compared to the short-term component. For futures prices, the risk premiums have become more volatile and have changed signs on average, indicating different behavior on the part of futures market participants.
and different market perception of the risks. These observations imply dramatic fundamental changes in dynamics of the crude oil market.

In my second essay, I turn to the crude oil market fundamentals and explore their structural relation to prices. I propose a rational expectation model where in equilibrium the spot price and expected future spot price follow the arbitrary condition implied by the competitive storage theory, and the net convenience yield is affected by inventory level relative to demand for crude oil, or the effective inventory. Defining effective supply as supply relative to demand, I consider the effects of effective supply shocks and of news shocks about future effective supply. When there is a negative effective supply shock, effective supply will be lower spontaneously, price higher, and inventory drawn down. When there is news about negative effective supply shock in the future, inventory will be accumulated in expectation of higher price in the future, leaving less oil available on the market, and drive up the price spontaneously. In two cases, effective inventory responds differently to different shocks that simulate similar price responses. The difference in the effective inventory responses indicates that inventory data will help disentangle the mixed sources of price changes. Fitting the model to data also helps uncover the unobserved net convenience yield and its relation to inventory, demand and supply. This will help better understand how the market fundamentals drive the crude oil prices, and shed light on understanding the turbulent price fluctuations during recent years.

In my third essay, I take a deeper look at oil supply to better understand the lower frequency movement in oil prices. With co-authors Nathan Balke and Mine Yücel, I examine the strategic interaction of a price-setting cartel (OPEC) and a competitive fringe. This model focuses on the supply side of world crude oil market, and links together crude oil price movement with non-OPEC production, OPEC capacity utilization, and total world consumption. Specifically, we consider a limit pricing model in which supply is capacity-constrained and investment in addition to capacity is irreversible. We apply this model to explore the effects of these constraints on the resulting nonlinear responses of price to supply and demand shocks. This project is currently in working progress.