

Nonlinearities in Passive Demand Shocks: An Explainable AI Approach to the Bank of Japan's ETF Purchases

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This paper examines the nonlinear effects of the Bank of Japan's ETF purchase program on stock returns. While passive demand shocks are generally expected to support stock prices, the expansion of securities lending may simultaneously relax short-sale constraints and offset this effect. We investigate whether these competing channels generate nonlinear return dynamics. To uncover such patterns, we employ an explainable machine-learning framework based on XGBoost and additive feature attribution methods. In particular, we compare SHAP (SHapley Additive exPlanations), which is based on the Shapley value — a leading solution concept in cooperative game theory — with ESENSC, a computationally efficient game-theoretic alternative. Using a panel of JPX400 constituent firms from 2010 to 2017, we find that ETF purchases are associated with positive return effects, but the marginal impact declines sharply once monthly purchases exceed approximately 0.1% of a firm's market capitalization. Beyond this threshold, additional purchases provide little incremental return support, producing a clear saturation effect. The evidence is consistent with a securities-lending channel that increases the supply of loanable shares and relaxes short-sale constraints. Our findings contribute to the literature on unconventional monetary policy, market microstructure, and explainable artificial intelligence in finance.