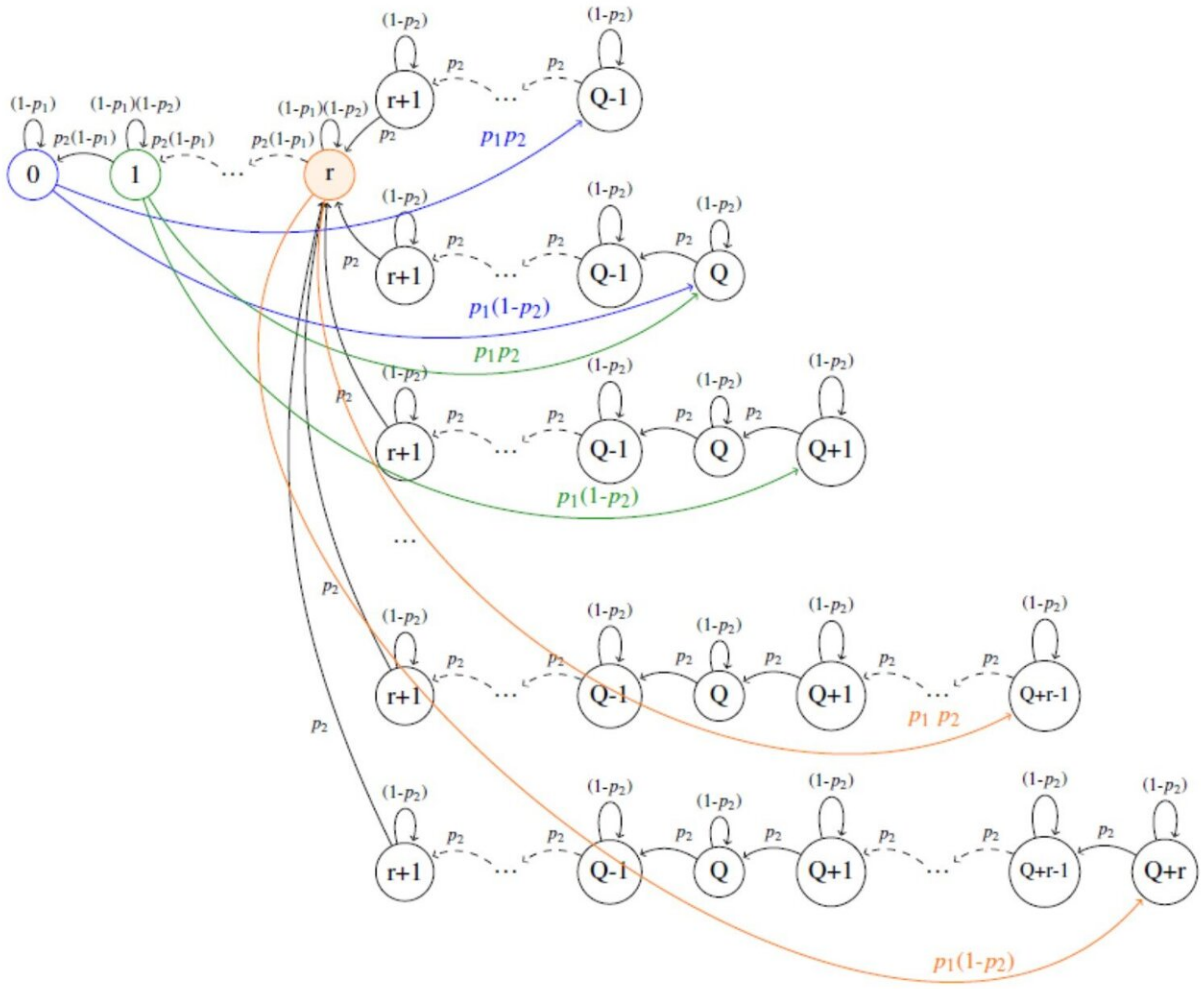
Every stock you take, AI could be watching you

August 14 2025, by David Bradley



Exploded transition graph with r + 2 state-partitions (see online version for colors). Credit: *International Journal of Integrated Supply Management* (2025). DOI:10.1504/IJISM.2025.148011

Researchers have developed a new way to model how inventory behaves when both customer demand and supplier deliveries are unpredictable, and when missed sales cannot be recovered. The approach provides more accurate estimates than common industry rules-of-thumb, and so might help businesses avoid costly overstocking and damaging shortages.

The work, discussed in the *International Journal of Integrated Supply Management*, builds on the Economic Order Quantity (EOQ) model. This is a well-known tool for helping stock controllers decide how much to order. The standard EOQ assumes that demand is steady and deliveries arrive on time. The new model is more realistic and recognizes that demand and supply can vary from day to day.

In their model, each day's demand and supply are treated as a series of simple "yes or no" events: a unit is either sold or not, and a unit is either delivered or not. In probability terms, these are called Bernoulli trials. When combined over several days, familiar statistical patterns emerge in the distribution for demand and the geometric distribution for delivery times. This approach allows the model to capture both steady daily sales and highly irregular demand.

The researchers were able to calculate an exact "steady-state" picture of how much stock a business is likely to have on hand in the long run, after short-term fluctuations even out. To do this, they used a Markov chain, a type of mathematical model in which the next step depends only on the current state, not the full history.

From this steady-state analysis, the model gives precise numbers for important measures: the average inventory level, how long an inventory cycle lasts, how often the business runs out of stock, and the "fill rate." Fill rate is the share of customer demand that can be met immediately from stock. One key result is a new formula for average inventory that has been shown to work better than the current estimation tools,

especially when demand is patchy and deliveries are unreliable.

The researchers explain that this matters in many real-world situations where lost sales are permanent. A supermarket cannot sell yesterday's spoiled fruit, a retailer cannot ship a promotional item after the promotion ends, and a factory may lose an urgent order for spare parts if they are not in stock at the moment they are needed. In all such cases, even small errors in estimating average inventory can have significant financial and reputational costs.

More information: Elisa Gebennini et al, Discrete-time EOQ with lost sales, binomial demand, and geometric lead time: inventory level distribution and performance analysis, *International Journal of Integrated Supply Management* (2025). DOI: 10.1504/IJISM.2025.148011 www.inderscience.com/info/inar … cle.php?artid=148011

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