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Extreme value theory for large fork-join queues, with an application to high-tech supply chains

A typical property of high-tech manufacturing is that a large number of suppliers are involved, and are specialized in producing and delivering a very specific component of the final product. We aim to model the delays in the emerging complex supply chain. In such a supply chain, the delay of the manufacturer is determined by the slowest supplier. A fork-join queueing system is a stylized model of such a high-tech supply chain. First of all, we give a convergence result of the maximum of N queue lengths as the number of queues N becomes large. Secondly, we analyze a stylized newsvendor problem that enables us to study the resulting trade-off between shortage risk, inventory costs, and capacity costs. Our asymptotic extreme value results translate into various asymptotically exact methods for cost-optimal inventory and capacity decisions, some of which are in closed form.