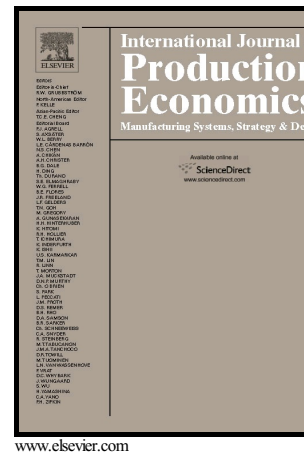


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Supply chain risk at simultaneous robust perturbations¹

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Abstract The focus of this paper is the risk management of total supply chains by identifying the risk drivers that could appear simultaneously, and the determination of their common denominator to mitigate supply chain risk using the Net Present Value (NPV) approach in Extended Material Requirements Planning (Extended MRP) models. Any risk driver that is likely to disrupt the procurement, production, transportation, warehousing, delivery or financing of a good or service constitutes a realisation of supply chain risk. Risk drivers often appear simultaneously. It is imperative, therefore, that an a priori assessment of the risk drivers that pose risk to the global supply chain is undertaken and that contingency plans are developed at every level to monitor and mitigate these risks, even when they appear simultaneously. To avoid the ruin of a supply chain we must ensure the availability of adequate funds in conjunction with safety stock. Therefore, the risk-mitigation approach pursued in our paper follows from our conviction that money is the stock of purchasing power of any activity cell in a global supply chain that could influence the perturbation of material flows—on many stages simultaneously. In the paper, we provide a method appropriate for preventing the long-term disruption of a supply chain with probability determined in advance.

How to assure resilience of a global supply chain is the question which has occupied the World Economic Forum since 2009. The Industry Agendas in Davos expressed the need to develop a risk assessment framework for the end-to-end supply chain which has not been developed yet. The article presents how company owners, regulators, and board members of supply chains can build the risk assessment framework on a similar requirement as that accepted in the insurance industry, capturing knowledge from the Solvency II framework, and embed the constraints in the extended MRP model. Such a quantitative tool can be used to exercise the “stress tests” of the total chain according to assumptions and plans.

In the presented methodology, as a novelty first developed here, we show how the perturbation of intensity in production and logistics, simultaneous perturbations in the timing of financial flows, information flows, flows of items and market perturbations can be better evaluated simultaneously through Laplace transforms and the NPV expression which allow for a control of physical and financial flows simultaneously. Our paper follows the Davos 2013 conclusions analysed by Forbes that “To maintain effectiveness, supply chain managers can arrange to share strategic stocks, or to enter into joint supply agreements. They can also pre-arrange ways to access critical stocks”. Therefore risks should be evaluated on the level of the end-to-end supply chain, and not only on the level of the companies involved. The paper suggests that resilience of a chain is measured by the probability that the NPV of the chain will not fall under the critical value determined in advance, and the yearly mathematical reservations are derived.

Keywords: NPV, risk management, disruption risk, supply chain, transport network, delay, production lead time, MRP Theory.

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