

Dear Prof. Borgonovo,

Thank you for the opportunity to revise and resubmit my article, "Are Solar Panels Commodities?" to the European Journal of Operational Research.

I have done a thorough revision based on the comments of the three referees. Attached you will find detailed, point-by-point replies to each of the reviewer's suggestions and critiques in addition to the revised article.

I wish to highlight a few of the main changes to the article. As you mentioned in your letter to me, referee 2 was particularly critical and felt that the article lacked a decision-making perspective. In addition, the referee felt a lack of methodological novelty. I have taken the referee's critique to heart and agree that the initial submission did not do an adequate job of conveying the article's relevance to decision makers nor did it sufficiently convey the article's methodological novelty. A substantial part of the revision consists of righting these weaknesses.

Referee 2 is correct in suggesting that the article could, thematically, also fit into a pure economics or finance journal. But I chose to submit to a top operations research journal, in part, because of the practical implications of the research to decision makers. As an example of how I have tried to convey this in the revision, I write on p. 2:

From the perspective of a purchasing manager responsible for procuring solar panels, whether panels can be considered a commodity is of great importance. If panels are known to be commodities with standardised quality and similar pricing, then the decision for purchasing manager is substantially simplified. They need only to decide on the observable form factor, for example dimension and capacity. In addition, purchasing managers responsible for large projects with long lead times could make use of forward markets to hedge price movements. On the other hand, if solar panels are known to vary significantly by quality, then the decision becomes substantially more complex and costly. Purchasing managers would need to weigh the price of panels against expected quality. They may also need to make use of specialised engineering firms that test and certify panel quality. Since the purchasing decision is likely to be linked to a specific manufacturer, the purchasing manager is subject to risks such as bankruptcy or other supply disruption associated with that firm.

The methodological focus of operations research is another reason I would prefer EJOR as an outlet over a finance or economics journal. Bayesian methods are generally rare in economics and finance, apart from a few small subfields. Hierarchical Bayesian models are even more sparse. On the other hand, hierarchical Bayesian models have recently become prominent in the operations research field, and in EJOR in particular. In the revision I have worked at highlighting the relative novelty of the hierarchical Bayesian model I use, as well as presenting a more extensive review of the recent applications of hierarchical Bayes models in the operations research field. For example, on pages 4-5 I write:

... I use a Bayesian hierarchical model estimated using Markov Chain Monte Carlo (MCMC) simulation techniques. Bayesian hierarchical models have long been one of

the primary tools in statistical decision theory (Berger, 1985). This form of modelling is increasingly common in operations research and management science. One of the main advantages is superior out-of-sample predictive properties with data with distinct groupings. Recent advances in computation have also allowed for the construction and simulation of increasingly complex models. In particular, I use the Stan probabilistic programming language (Stan Development Team, 2014) that makes use of Hamiltonian Markov Chain Monte Carlo (MCMC) (MacKay, 2003) and a No-U-Turn sampler (Homan and Gelman, 2013). Unlike earlier MCMC simulation routines and software, notably Gibbs sampler, Hamiltonian MCMC is able to reach convergence for models, like the one I present in this article, with several hierarchies. Importantly, it is not necessary to use conjugate distributions, opening up to a wider variety choice of prior distributions (Kruschke, 2014).

Later I write:

In part due to increasing computational tractability, Bayesian hierarchical models have recently become a common and useful tool in the operations research field. A common application is to incorporate expert opinion into quantitative decision models (Rufo et al., 2010; Szwed et al., 2006; Utkin, 2006). In this application, the Bayesian hierarchical model is flexible enough to aggregate the information of the expert opinions while also being able to explicitly handle and propagate the uncertainty in these opinions. Hierarchical models have also been used to identify default risk among lenders and improve credit scoring models (Liu et al., 2015; Bhattacharya et al., 2019). In this context, the hierarchical Bayesian models are found to provide superior out-of-sample prediction for the censored sample of the data. Other operations research related applications include a fund manager's portfolio selection problem (Soyer and Tanyeri, 2006; Bodnar et al., 2017) and conjoint analysis in operations management (Karniouchina et al., 2009; Gensler et al., 2012). A commonality among all these applications is the need to aggregate information from heterogenous groups without over-fitting the data with many fixed effects.

I am happy to address any further questions or issues you or the referees should have with the revised paper. I thank you for your time and consideration.

Best wishes,

Johannes Mauritzen