

The case for computational modelling of the Roman economy: a reply to Van Oyen

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We thank Astrid Van Oyen for a highly constructive and important discussion piece that will improve our own future work, as well as that of others. We wish to elaborate on one issue: that formalist approaches do not necessarily have inherently modernist theoretical assumptions.

Simulation and other formal modelling methods differ from conceptual modelling (hypotheses defined verbally, that is, in natural language), in that they use the explicitly defined language of mathematics, allowing for the formal expression of any theoretical concept. Our answer to Van Oyen's question (above) on whether formalist modelling can yield primitivist results is therefore a firm 'yes'. It follows that the connection between primitivist theories and substantivist approaches on the one hand, and modernist theories and formalist approaches on the other, is misleading and unnecessary. This connection is largely a construct of an academic research tradition, with aspects of modernist/primitivist theories commonly studied with formalist/substantivist approaches by key players in the field. With MERCURY (Brughmans & Poblome 2016a & b), we have demonstrated that a formalist approach succeeds in addressing a selected aspect of a primitivist theory that is not exclusively the domain of substantivist approaches: we test scenarios of individuals' extremely limited availability of reliable information and of strongly limiting effects of social community structures. Moreover, our interpretation of the results emphasised new research avenues that might be appropriately explored through both formalist and substantivist approaches: the differing roles of the behaviour of those different types of agents and institutions able to be commercially active on varied markets.

Van Oyen proposes other more primitivist factors that can be explored in such formalist treatments of primitivist theories, and we particularly welcome the arguments made about multiple types of modernist agents. Indeed, some of Van Oyen's arguments mirror critiques voiced in the field of economics about equation-based models in the 1970s–1990s; more specifically, critiques by behavioural and complexity economists against the dependence of neo-classical economics on equilibrium models and their limitations: lack of heterogeneity among modelled entities, assumptions of rational profit maximisation and assumptions

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of global knowledge (Simon 1972; Epstein 1999; Hamill & Gilbert 2016). Agent-based modelling (the approach used in our paper) has been specifically developed to counter these limitations and is a key method in behavioural and complexity economics (Arthur 1999). The specific primitivist theories mentioned by Van Oyen are entirely within the remit of agent-based modelling and we could usefully incorporate them into our future work.

Formal models therefore do not *necessarily* have “inherently modernist assumptions”, and we disagree with some of Van Oyen’s arguments (above) on this point. Rational profit-maximising agents are not a fundamental assumption of agent-based modelling, but merely a common use of it; economic integration and the sharing of accurate information are not divided in our model, but defined by the same variable. (We define economic integration as the agent’s ability to gather accurate non-local information through the social network, which determines its behaviour when buying/selling pots; for technical details, see Brughmans & Poblome 2016a: 3.4.)

We strongly agree, however, with Van Oyen in that we should urge “the entire community of Roman economic historians and archaeologists to engage with the underlying assumptions of such modelling exercises” (Van Oyen above). Such debates (including the current one) are made possible thanks to the key feature of using the formal language of mathematics: all assumptions in the model are explicit and unambiguously communicable. This allowed Van Oyen (and any other reader) to identify and engage with our model’s assumptions, and to recognise easily what is meant by, for example, such theoretical concepts as ‘social network structure’ or ‘agents’ limited availability of information’. In order to foster the ability to engage critically and constructively with theoretical models of the Roman economy, we need a shift in research traditions towards more formal descriptions to present the ideas of the models’ authors unambiguously (for details, see Brughmans & Poblome 2016a: 5.6, 2016b: 406).

All models, both verbal and formal, have to face the same challenge: the need to simplify past human behaviour in focused studies to improve our understanding of it. To reconstruct the full complexity of *the* Roman economy within one model can never be a realistic aim of such studies—it certainly was not our aim—and Van Oyen raised a number of important topics revealing different aspects of this complexity. We argue that computational modelling alongside substantivist approaches can aid in investigating such aspects within both primitivist and modernist theoretical frameworks. Progress in our understanding of the complex Roman economy can only be made—to the extent that the rich but fragmentary archaeological and historical records allow us—through the cumulative effect of such focused studies using diverse approaches.

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