

# Agents and commodities: a response to Brughmans and Poblome (2016) on modelling the Roman economy

Astrid Van Oyen\*

*This article responds directly to Brughmans and Poblome's (2016a) recent application of agent-based modelling to explore the relative integration of the Roman economy. The response will not only be of relevance to debates about the Roman economy, for it also asks critical questions about the use of formal modelling to interpret archaeological data. In posing open-ended questions rather than presenting definitive answers, it seeks to broaden and fuel discussion in a spirit of constructive critique.*

*Keywords:* Roman economy, agent-based modelling, networks, commodities

## Introduction

Was the Roman economy an integrated market-economy in which communication and transport were balanced against supply and demand, and averaged out prices? Or was it instead a fragmented mosaic of self-contained producers, with no way of judging risks in the absence of information about potential consumers, and widely divergent prices as a result?

Questions of market integration, volatile prices and communication have long been at the core of debates on the Roman economy (e.g. Duncan-Jones 1990; Scheidel 2009; Silver 2009; Temin 2013). While these debates are no longer explicitly defined in terms of opposing paradigms, the underlying structuring principles remain unresolved, and plot on two axes. Firstly, the modernist/primitivist axis revolves around whether the Roman economy is different to the modern, industrial one in scale only, or also in its nature (Morris 1999; Morley 2004: 32–50; Scheidel 2012). A linked but different pair of opposites—formalism and substantivism—conveys whether or not the tools and models of modern economists can be deployed in the study of the ancient economy.

The formalist toolbox has expanded dramatically in the last decade, not least through the increase in various network approaches (Brughmans 2010; Scheidel 2014). Agent-based modelling is one lineage in the family of formal network applications that is revolutionising explanation in diverse disciplines, from ecology to social sciences. It enables testing the outcome of various sets of parameters by simulating their effects over time on a predefined starting scenario (Bonabeau 2002; Brughmans 2013: 651). As a computational algorithm, agent-based modelling is undoubtedly formalist, but can it be used to clarify the position

\* Department of Classics, Cornell University, 120 Goldwin Smith Hall, Ithaca, NY 14853, USA (Email: [av475@cornell.edu](mailto:av475@cornell.edu))

of Roman economic processes on a scale running from modernism to primitivism? This is what recent, stimulating research sought to explore (Brughmans & Poblome 2016a).

Brughmans and Poblome compared two current influential concepts for the Roman economy: Bang's (2008) primitivist Roman bazaar, which imagines the Roman economy as built on small, local networks of information and trust, with little or no empire-wide integration; and Temin's (2013) modernist market economy, which envisions stable flows of information solidifying integrated economic feedback loops. Both models were condensed to a number of variables that were subsequently fed into an agent-based model and compared with the archaeological patterning of *terra sigillata* pottery in the eastern Mediterranean. *Terra sigillata* was the Roman Empire's most iconic mass-produced ceramic tableware, and its sheer quantity makes it a robust proxy for Roman trade patterns (Bes 2015).

The timeliness of Brughmans and Poblome's excellent article is beyond doubt. Along with other initiatives (e.g. Bowman & Wilson 2009), it pushes debates on the Roman economy beyond a merely conceptual dispute that has long ceased to be productive. Moreover, the paper's ability to make an ample archaeological database speak directly to the bigger picture of the Roman economy must be applauded. This response discusses three questions raised by Brughmans and Poblome's article, in the hope of contributing to a joint project of networking the ancient economy.

## Can formalist modelling yield primitivist results?

The particular contribution of agent-based modelling is that it forces studies of the Roman economy to articulate the actual parameters informing vague concepts, such as economic integration (Graham & Weingart 2015: 258). The translation of conceptual terminology to variables intelligible by a computer involves a reduction of complexity, which works to increase clarity. Agent-based modelling traces the complex patterns that emerge from simple, clearly defined starting assumptions. But this comes at a price. Pinning down traits, circumscribing and separating variables, and differentiating options are all typically modernist processes, in direct opposition to fluidity, ambivalence or messiness (Law 2004). The question, then, is whether such inherently modernist design principles can adequately explore primitivist hypotheses.

The agents in Brughmans and Poblome's model are traders, who decide whether to trade a pot, to sell it on to a consumer, or to store it while awaiting more favourable conditions. The goal of each trader is to maximise profits, and their calculation as to whether or not trading a pot will achieve that goal is based on the number of contacts they have with traders from other markets, and on the amount of accurate information shared by traders within the same market. As in game theory, with which agent-based modelling shares a genealogy, the agent is modelled on a fundamentally modernist paradigm of autonomous profit-seeking individuals, looking to maximise returns (Emirbayer & Goodwin 1994: 1428; Rauch & Hamilton 2001: 5; Baert & Carreira da Silva 2010: 130–36).

Another corollary of the modernist paradigm that implicitly pervades the formal method of agent-based modelling is the divide between the social and the economic (Latour 1993). Economic integration—the ability to trade pots—is plotted by a parameter distinct from its social corollary—the sharing of (accurate) information. As such, 'society' and 'economy' are

© Antiquity Publications Ltd, 2017

bound to remain separate, structurally unrelated spheres of action. On a similar note, ‘place’ is a noteworthy absence in Brughmans and Poblome’s model. At first glance, one might read a spatial definition into Brughmans and Poblome’s ‘markets’ (in the sense of marketplace), but this is nowhere specified, although ‘market’ is equated with ‘site’ (see Brughmans & Poblome 2016b for technical details). More generally, while ‘market’ serves as an arbitrary grouping of the model’s traders, it nevertheless is the crux of the model’s interpretation, which revolves around weighing inter- and intra-site links.

The general critique of formal models’ inherently modernist assumptions should by no means be read as a reason *not* to pursue modelling exercises such as Brughmans and Poblome’s. Instead, it poses the question of whether such modelling exercises, with their inescapable biases, can meaningfully aid in understanding where the Roman economy plots on a scale between modernist and primitivist readings. Modelling does not claim to be able to substantiate particular historical scenarios, but to weigh the plausibility of different sets of parameters. Despite these modest aims of agent-based modelling and a built-in self-consciousness of its own limitations (i.e. its modernist assumptions), to model the Roman economy, one must consider whether primitivist combinations of parameters are necessarily at a disadvantage in such modelling exercises. Expressed differently, could Bang’s (2008) Roman bazaar ever *not* emerge as an unlikely template for the fictive Roman economy produced by Brughmans and Poblome’s model?

This question is for algorithmists to resolve. Yet, it is important to urge the entire community of Roman economic historians and archaeologists to engage with the underlying assumptions of such modelling exercises. As with so many formalist methods, modelling carries a veneer of objectivity and lack of bias—after all, the computer processes the outcome. But it does so based on a predefined, non-neutral input, decided by the modeller. Agent-based modelling has the potential to inform other, qualitative, assessments of the Roman economy, but only if it can refute Bang’s primitivist model fairly. This does not necessarily mean exploring Bang’s scenario on its own terms, as these cannot easily be accommodated by a formalist mould, but it does entail adjusting the existing parameters or introducing new ones. Some interventions to this effect in Brughmans and Poblome’s model could include: valuing social cohesion over profit; building more dependencies between variables (to avoid the social/economic divide); and defining the spatial contours of the concept of ‘market’.

## Big data without commodities?

Brughmans and Poblome are rightly cautious not to push the interpretive remit of their model, referring repeatedly to the limited resolution of their macro-data. But a more fundamental theoretical question lurks behind this hesitation: does big data necessarily have to be commodified?

The big data trend across humanities and social sciences has an obvious appeal for archaeologists. In the field of the Roman economy, ‘big data’ has tended to be translated as ‘quantification’ (Bowman & Wilson 2009; Poblome *et al.* 2012). Quantified lists, graphs and tables of pots, shipwrecks or lead isotopes (de Callatay 2005) come closest to the historical price lists that are the prime datasets of economic historians who work on later

periods (Scheidel 2009; Temin 2013). But regardless of the type of data, things—the goods that are made, traded, sold and bought—are modelled as commodities. Economic anthropology, however, has long shown that commodities are only one of the many forms that things can take in exchange (*locus classicus* Appadurai 1986). Commodities are alienable: when sold or traded, they do not create social ties beyond the moment of transaction—although reality has been shown to be messier (Miller 2000). While modelling's principle of simplicity can be granted the necessary reductionism of filtering out the impurities of the commodity template (i.e. it can posit that *when* things operate as commodities, they do so as *idealised* commodities), it cannot assume that at a sufficiently scaled-up level of analysis, all things operate as commodities.

Limiting the role of objects to commodities fundamentally affects and restrains the dynamics of the model and the possible scenarios that can emerge from it. It assumes, for example, that from the exchange of information follows the exchange of goods (pots in this case). The key to building formal models that allow space for 'other-than-commodity' exchange lies in a better theorisation of material culture and its role in shaping—not just travelling along—the connections integral to the network (see Van Oyen & Pitts 2017).

The case has been made elsewhere that things (more specifically Roman *terra sigillata* pots similar to the ones used in Brughmans and Poblome's paper) are not commodities *by default*, but have to be *made* to act as commodities (Van Oyen 2016a). For example, the kind of economic competition envisaged to pertain to commodities relies on any two products being comparable—the proverbial 'not to compare apples and oranges'. Any two pots, however, were not *a priori* comparable—not even if they seem to be to the modern analyst. Comparability was a contextual creation. In production, it could be achieved by aligning technological choices, such as clays, firing method, forming technique and the like. During transport, in contrast, comparability would have hinged on weight, volume and so on. To continue the proverb, one can imagine contexts orchestrated such as to make apples enter into direct competition with oranges by creating, for instance, a category of 'healthy snacks' or even 'farm produce'. The point here is twofold: not everything is always defined as a commodity; and commodities behave in a particular way, allowing for a context-specific range of possibilities (e.g. comparison, competition).

Alternatives to commodities and their specific patterns of production, distribution and consumption need not be limited to their traditional opposite: the gift. Evidence for the production and consumption of Roman fine wares in the Western Mediterranean, for instance, prompted two alternative templates: 'rooted' and 'fluid' things (Van Oyen 2016b). Production practices of so-called 'Rhenish wares' (tablewares sometimes produced alongside *terra sigillata* pottery in the north-western provinces) exhibited a close practical and conceptual anchorage in their place of production. Production practices were not highly standardised, but highlighted the embodied handicraft of the potter/decorator, as in the manually applied barbotine decoration, or in the tolerated—perhaps even sought after—traces of fingerprints on the slip. And while Rhenish ware pots had as wide a distribution as *terra sigillata* ceramics, they were spread more thinly, with the most elaborate examples clustering near the production site. Rhenish wares appear to have been consumed in specific contexts, and are particularly visible in ritual and funerary assemblages. Another alternative constellation were the fluidly defined 'pre-*sigillata*' pots, whose production was

© Antiquity Publications Ltd, 2017

not characterised by specific technological choices, but closely interwoven with production lines of other kinds of ceramics. Their distribution depended on piggybacking along the major regional trade routes, and they were consumed not as a separate commodity but in close association with related products, such as amphorae.

Even though all three of the above types of ceramics were fine tablewares, occurring in similar shapes with exchangeable functions (eating/drinking), they were defined differently through practices of production, distribution and consumption. The specific identification criteria or dynamics of these alternatives do not matter here; instead it is important to recognise that differently defined objects behave according to a different logic, and that quantitative comparison of their distribution patterns can be historically meaningless.

Modelling of the kind pioneered by Brughmans and Poblome could be of enormous value in better understanding the patterns at stake. Brughmans and Poblome interpret the different distribution patterns of Eastern Sigillata B, C and D with reference to their spatial integration with cities. But could these respective production lines have operated on different principles altogether? Could modelling identify and cope with products operating according to distinct parameters, with distribution patterns that are, therefore, not directly comparable? Part of the reason why these questions will probably remain unanswered for now is the limited resolution of the available archaeological data, which take the form of 'big data', with contextual evidence often at best represented by the name of a findspot. But another, more important reason to our current inability to answer these questions might simply be that they have not been considered before.

## **Multiple types of modernist agents?**

If the first question posed in this article revolved around the inherent limits of assuming modernist agents, it is necessary to move beyond a simple critique of reductionism, by urging for a complexification of the template of the 'modernist agent'. The modernist agent comes with arbitrary but necessary starting assumptions: its actions are prescribed by a cost-benefit analysis; it can weigh options; and any calculation is based on the 'then and there', with little social time depth. But can these predefined qualities lead to the emergence of multiple types of modernist agents?

Material culture theory has shown that people and things co-evolve (e.g. see Malafouris 2013 for a cognitive interpretation). The previous section has argued that things do not always behave like commodities: different types of things lend themselves to different economic possibilities, and create distinct distribution patterns. Now is the time to add that various types of (modernist) agents emerge out of engagement with such different types of things.

An example will make this question more tangible. The sudden appearance of specialised large-scale storage facilities for wine, grain and water on agricultural estates ('villas') in central Italy during the first century BC has been studied elsewhere (Van Oyen 2015a). The massive expenditure on storage facilities tends to be interpreted either as an increasing rationalisation of available resources and a maximisation of returns (modernist), or as a case of conspicuous display in a competitive political climate, without real investment in economic productivity (primitivist). In both of these versions, the stored staples feature as

'blank' exchangeable commodities. By analysing the material properties of these different staples and how they interacted with the new architectural vocabularies of the time, the different behaviour of grain, wine and water, and the divergent resultant economic and social possibilities, were exposed.

Grain deteriorates rapidly when stored above ground. The need for a fast turnover enforced centralisation of an estate's cereal produce in a single, large granary—a type of building that sent a message of ownership and control. Technique and monumentality converged to divide society into haves (with big granaries) and have-nots. Much like grain, water was a bulk good, stored in large cisterns. In contrast to grain, however, water did not degrade physically (even if contaminated, it would still be useable for its main functions, such as irrigation), releasing the pressure on turnover and allowing for a multiplication of cisterns. As not all water had to be stored in a central place, a cistern's location could be targeted closely to where the water was needed, thus allowing the development of new economic niches, such as intensive horticulture. For wine, fermentation through storage was part of its very production. By varying the length and nature of the fermentation process, wines of different qualities could be created, generating a socially sanctioned spectrum of both products and consumers.

The historical implications do not matter in this context; the point is methodological. The agents that emerged out of the specific human-thing interactions outlined in the preceding paragraph were respectively framed as: conservative owner (grain), avant-garde investor (water) or speculative entrepreneur (wine). All of these 'agent-types' could theoretically emerge from the same modernist first principles listed above: they all act according to a cost-benefit analysis, calculating returns and weighing investment options. They do so, however, not on a blank slate of shapeless 'commodities', but in direct negotiation with a variety of things and their material qualities and historical possibilities. As discussed in the previous section with regard to different kinds of ceramic tablewares, such differently defined things need not necessarily be as physically distinct as grain, water and wine. Could we imagine a network model in which things and agents co-evolve? A network in which the modernist agent comes in the plural? Just as with the previously posed questions, limited data availability can never completely excuse not considering and attempting to address these possibilities. Modelling may be precisely the way to do so, as it enhances archaeological data with arbitrary, exploratory structural input.

## **Farewell to *the* Roman economy**

In summary, Brughmans and Poblome's paper and the modelling it pioneers signify an important step forward in the study of the Roman economy. Although it has not quite escaped the underlying issues of the established debates, it has enabled these to be articulated in new, productive ways. In particular, this brief response has distilled three central methodological questions: can formal modelling legitimately be used to clarify the modernist/primitivist debate regarding the Roman economy? Is it possible to work at a macro-scale without universalising commodities and their particular exchange patterns? And can the modernist agent be multiple? These are challenges that can only be addressed through cooperation between scholars steeped in the technicalities of modelling, those

© Antiquity Publications Ltd, 2017

analysing the archaeological material and those grappling with socio-economic dynamics—as exemplified by the ICRATES team in Brughmans and Poblome’s contribution.

The final aim should be to understand and explain not *the* Roman economy, but the presence and proportion of different *kinds* of patterning, across space and through time. Just what part was ‘integrated’? Just how did the share of commodity trade compare to, or morph into, other types of exchange? The results of Brughmans and Poblome’s paper show that proximity to cities was probably a major driver behind the observed dynamics in the distribution of eastern *terra sigillata* pottery, at the very least for Eastern Sigillata A. None of the main production centres for Gaulish *terra sigillata* pottery in the first and second centuries AD, in contrast, were located in or near a city. Methodologically, the distance of these production sites from major distribution arteries defies a simple rationalist calculation made by the modernist agents imagined in agent-based modelling. Historically, this shows that the city did not have the same role in shaping all pottery distributions (cf. Van Oyen 2015b). Rather than declaring that the Roman economy was (not) integrated, can we instead chart changes in network topology and its variables in time and space?

## Acknowledgements

I would like to thank Jeroen Poblome and, especially, Tom Brughmans, for open and generous discussion of their work. Jennifer Carrington, Carl Knappett, Justin Leidwanger and Martin Millett kindly read previous drafts, and, along with the peer reviews, their comments much improved the argument. Any remaining errors are my own.

## References

- APPADURAI, A. 1986. Introduction: commodities and the politics of value, in A. Appadurai (ed.) *The social life of things: commodities in cultural perspective*: 1–63. Cambridge: Cambridge University Press.
- BAERT, P. & F. CARREIRA DA SILVA. 2010. *Social theory in the twentieth century and beyond*. Cambridge: Polity.
- BANG, P. 2008. *The Roman bazaar: a comparative study of trade and markets in a tributary empire*. Cambridge: Cambridge University Press.
- BES, P. 2015. *Once upon a time in the East: the chronological and geographical distribution of terra sigillata and red slip ware in the Roman East* (Roman and Late Antique Mediterranean Pottery 6). Oxford: Archaeopress.
- BONABEAU, E. 2002. Agent-based modelling: methods and techniques for simulating human systems. *Proceedings of the National Academy of Sciences of the USA* 99: 7280–87. <https://doi.org/10.1073/pnas.082080899>
- BOWMAN, A. & A. WILSON (ed.). 2009. *Quantifying the Roman economy*. Oxford: Oxford University Press.
- BRUGHMANS, T. 2010. Connecting the dots: towards archaeological network analysis. *Oxford Journal of Archaeology* 29: 277–303. <https://doi.org/10.1111/j.1468-0092.2010.00349.x>
- 2013. Thinking through networks: a review of formal network methods in archaeology. *Journal of Archaeological Method and Theory* 20: 623–62. <https://doi.org/10.1007/s10816-012-9133-8>
- BRUGHMANS, T. & J. POBLOME. 2016a. Roman bazaar or market economy? Explaining tableware distributions through computational modelling. *Antiquity* 90: 393–408. <https://doi.org/10.15184/aqy.2016.35>
- 2016b. MERCURY: an agent-based model of tableware trade in the Roman East. *Journal of Artificial Societies and Social Simulation* 19. <http://dx.doi.org/10.18564/jasss.2953>
- DE CALLATAÿ, F. 2005. The Graeco-Roman economy in the super-long run: lead, copper and shipwrecks. *Journal of Roman Archaeology* 18: 361–72. <https://doi.org/10.1017/S104775940000742X>
- DUNCAN-JONES, R. 1990. *Structure and scale in the Roman economy*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9780511552649>
- EMIRBAYER, M. & J. GOODWIN. 1994. Network analysis, culture, and the problem of agency. *American Journal of Sociology* 99: 1411–54. <https://doi.org/10.1086/230450>

- GRAHAM, S. & S. WEINGART. 2015. The equifinality of archaeological networks: an agent-based exploratory lab approach. *Journal of Archaeological Method and Theory* 22: 248–74.  
<https://doi.org/10.1007/s10816-014-9230-y>
- LATOUR, B. 1993. *We have never been modern*. Cambridge (MA): Harvard University Press.
- LAW, J. 2004. *After method: mess in social science research*. Oxford: Routledge.
- MALAFOURIS, L. 2013. *How things shape the mind: a theory of material engagement*. Cambridge (MA): MIT Press.
- MILLER, D. 2000. Introduction: the birth of value, in P. Jackson, M. Lowe, D. Miller & F. Mort (ed.) *Commercial cultures: economies, practices, spaces*: 77–83. Oxford: Berg.
- MORLEY, N. 2004. *Theories, models and concepts in ancient history*. London: Routledge.
- MORRIS, I. 1999. Foreword, in M.I. Finley, *The ancient economy*: ix–xxxvi. Berkeley & Los Angeles: University of California Press.
- POBLOME, J., P. BES & R. WILLET. 2012. Thoughts on the archaeological residue of networks: a view from the East, in S. Keay (ed.) *Rome, Portus and the Mediterranean* (Archaeological Monographs of the British School at Rome 21): 393–401. London: British School at Rome.
- RAUCH, J.E. & G.G. HAMILTON. 2001. Networks and markets: concepts for bridging disciplines, in J.E. Rauch & A. Casella (ed.) *Networks and markets*: 1–29. New York: Russell Sage Foundation.
- SCHEIDEL, W. 2009. In search of economic growth. *Journal of Roman Archaeology* 22: 46–70.  
<https://doi.org/10.1017/S1047759400020584>
- 2012. Approaching the Roman economy, in W. Scheidel (ed.) *The Cambridge companion to the Roman economy*: 1–24. Cambridge: Cambridge University Press.
- 2014. The shape of the Roman world: modelling imperial connectivity. *Journal of Roman Archaeology* 27: 7–32.  
<https://doi.org/10.1017/S1047759414001147>
- SILVER, M. 2009. Historical otherness, the Roman bazaar and primitivism. *Journal of Roman Archaeology* 22: 421–40.  
<https://doi.org/10.1017/S1047759400020821>
- TEMIN, P. 2013. *The Roman market economy*. Princeton (NJ): Princeton University Press.
- VAN OYEN, A. 2015a. The moral architecture of villa storage in Italy in the 1<sup>st</sup> c. B.C. *Journal of Roman Archaeology* 28: 97–124.  
<https://doi.org/10.1017/S1047759415002421>
- 2015b. The Roman city as articulated through *terra sigillata*. *Oxford Journal of Archaeology* 34: 279–99.  
<https://doi.org/10.1111/ojoa.12059>
- 2016a. *How things make history: the Roman Empire and its terra sigillata pottery*. Amsterdam: Amsterdam University Press.
- 2016b. Historicising material agency: from relations to relational constellations. *Journal of Archaeological Method and Theory* 23: 354–78.  
<https://doi.org/10.1007/s10816-015-9244-0>
- VAN OYEN, A. & M. PITTS (ed.). 2017. *Materialising Roman histories*. Oxford: Oxbow.

Received: 18 October 2016; Accepted: 23 January 2017; Revised: 24 January 2017