MATHEMATICAL FUTURES: DISCOURSES OF MATHEMATICS IN FICTIONS OF THE POST-2008 FINANCIAL CRISIS

Heather Mendick

Freelance academic

In this paper, I try to think against the view of mathematics as the most innocent and universal of disciplines, by exploring its implication in the ongoing 'crisis' following the 2008 financial crash. Mathematical instruments were at the heart of this crash. Yet, what are the stories we tell about the place, power and potential of mathematics through this crisis? To answer this question I analyse four financial-crisis fictions: the films Margin Call *(Chandor, 2011) and* The Big Short *(McKay, 2015), and the novels* Kapitoil *(Wayne, 2010) and* Capital *(Lanchester, 2012). I argue that these fictions offer tentative critiques of the objectivity and elitism of mathematics that we can use to open up different mathematical possibilities.*

INTRODUCTION

Jane Flax (1993, p. 32) wrote:

> I believe that four of the greatest tragedies of modern Europe – slavery, the oppression of women, Nazism and Stalinism – were potentiated by our collective wish that innocent and universal positions are possible and desirable.

Reading this and coming to MES during my doctorate helped me to think about how mathematics, positioned as the most innocent and universal of all disciplines, is implicated in terror and crisis. In this paper I try to develop this thinking by focusing on the ongoing crisis following the 2008 financial crash. The impact of the financial crash of 2008 has been global and devastating. In Greece, it has led to a public health crisis, with increases in the rates of suicide, mental health problems, tuberculosis, drug use and HIV infection (Chelala, 2015). Greece's education budget has been slashed by over 40% and youth unemployment remains above 50% (Education in Crisis, 2013). Mathematical instruments were at the heart of this crash. For example, mathematicians working in finance devised Collateralised Debt Obligations (CDOs) that bundle together thousands of debts and sell them off in slices with precisely calculated risks attached. Yet, what are the stories we tell about the place, power and potential of mathematics through this crisis? To answer this question I take a poststructural approach to analysing four financial-crisis fictions: the films *Margin Call* (Chandor, 2011) and *The Big Short* (McKay, 2015), and the novels *Kapitoil* (Wayne, 2010) and *Capital* (Lanchester, 2013). Stories matter. As Liakos and Kouki (2015), identify, they are central to how the crisis is playing out in Greece, as 'interpreting the past has been an arena of rival social visions, class divisions and interests over who is to blame, what is to be done and by whom'.

I first developed a poststructural approach when I investigated the intertwining of mathematics and gender for the study discussed in my book *Masculinities in*

Mathematics (Mendick, 2006). For those unfamiliar with poststructuralism and with the time and inclination to learn more, the opening chapter is available here: https://www.academia.edu/165900/Masculinities_in_Mathematics. In brief, we can define poststructuralism through two orientations on knowing and being.

First, truth is re/positioned as the subject rather than the object of research. Within poststructural research, the goal is not to find truth outside the research but to explore the interweaving of power and knowledge that results in some things acquiring the status of truth. This of course implies seeing everything as socially constructed. But:

> it is not very enlightening to be told repeatedly that something claimed as 'objective' is in fact 'socially constructed'. Objects of thought are constructed in thought: what else could they be? So the interesting questions concern the ways in which they are constructed. (Rose, 1999, p. x)

To explore these 'interesting questions', poststructural analysis focuses on discourses, the collections of meanings through which objects come into being (Foucault, 1972). Studies track discourses, their rules and regulations, continuities and disjunctions, mapping the broader discursive formations we find 'whenever, between objects, types of statement, concepts, or thematic choices, one can define a regularity (an order, correlations, positions and functionings, transformation)' (Foucault, 1972, p. 38).

Second, human being is produced through discourses as people position themselves and are positioned within networks of power. Discourses discipline us into certain ways of being and acting, creating within us specific relationships to selfhood. The term subjectivity is used in place of identity to capture how we are simultaneously the subject of and subjected by discourse, with no essence or individuality that can be thought outside of that. As mainstream philosophy and sociology define human agency in terms of the capacity of individuals to act, the idea that we can never escape power seems to foreclose possibilities for agency. However, I would agree with Judith Butler that:

> the reconceptualization of identity as an *effect*, that is, as *produced* or *generated*, opens up possibilities of 'agency' that are insidiously foreclosed by positions that take identity categories as foundational and fixed. (Butler, 1999, p. 187, original emphasis)

These poststructural positions on knowing and being are ones that recur through MES. They are also central to the interventions I want to make in this conference.

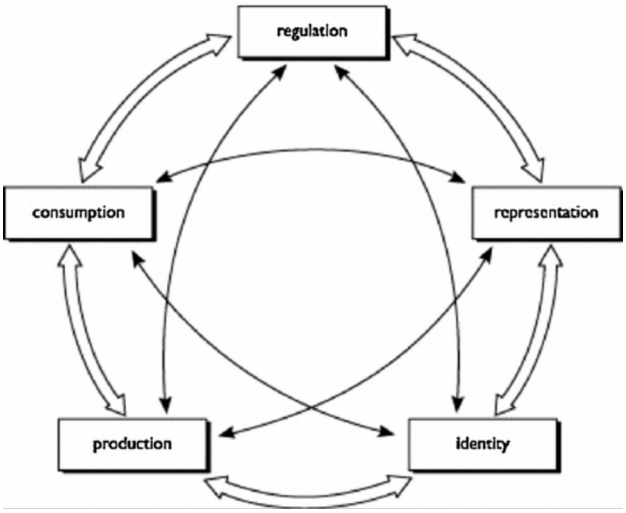
TWO INTERVENTIONS INTO MES

Like many others, MES is important to me. When I first encountered it while doing my PhD, I left feeling less isolated in my interests in the politics and sociology of mathematics. I have since moved away from the conferences as I have shifted from mathematics education research to studies of celebrity, youth aspirations and science education. More recently, I have moved away from academic conferences generally, as I have changed from being an institutional to a freelance academic. In returning to MES in 2017, I hope to intervene into two ongoing debates.

The theme of my last PME back in 2006 was ‘mathematics in the centre’. This reflects an ongoing concern to locate the mathematics in mathematics education. While ‘where’s the math/s?’ is not a question I expect to hear at any MES, I was asked it informally at MES7 in Cape Town. Via the ensuing conversation, I came to understand that my interlocutor and I were working with different ideas of mathematics, so that I could find it where she could not. Poststructuralism directs us to look not for what maths ‘is’ in an objective sense but for the discourses that bring it into being. If we view mathematics as a cultural text, we can find it by studying a circuit of culture (Figure 1), covering:

> its language or form of *representation*, its meanings; how it is used to mark *identity* and difference – what cultural identities it is helping to construct; its conditions of *production*; how it is transformed, and new meanings created, through circulation, *consumption*, appropriation and ‘use’; how its uses and circulation are regulated, and what norms of *regulation* this reinforces. (The Open University of Hong Kong, no date, additional emphasis)

Figure 1: The circuit of culture (du Gay et al, 1997)



By focusing on how mathematics is represented in financial-crisis fictions, I hope to contribute to re-imagining mathematics as a cultural text rather than a body of knowledge and so to think differently about where the mathematics is in MES.

Also at MES7, Anna Chronaki (2013) offered a poststructural analysis of mathematics teacher identity politics around technology use. The responses to her paper largely ignored both her substantive arguments on teachers’ social constructions of technology use for mathematics teaching and her original theorisation of the politics of ‘identity work’ based on Laclau and Mouffe (Lange, 2013; Pausigere, 2013). Her use of poststructuralism was subject to a level of critique not applied to the theories adopted by the other keynote speakers. In the subsequent discussion, the scepticism to poststructuralism seemed to be part of a commitment to activism that postmodern/poststructural approaches are often taken to preclude. Like Butler (2004, p. 48), I do not want to get tangled up in theoretical wrangling:

> We could have several engaged intellectual debates going on at the same time and find ourselves joined in the fight against violence, without having to agree on many epistemological issues. … If you saw me on such a protest line, would you wonder how a postmodernist was able to muster the necessary 'agency' to get there today? I doubt it. You would assume that I had walked or taken the subway! … We do not need to ground ourselves in a single model of communication, a single model of reason, a single notion of the subject before we are able to act.

However, also following Butler, in this paper, I am trying to make an implicit argument about the political potential of a poststructural move away from truth and essence, alongside my explicit argument about (representations of) mathematics.

SAMPLING FICTIONS OF THE POST-2008 FINANCIAL CRISIS

My focus on fictions about the post-2008 financial crisis is a response to the conference organisers' invitation 'to consider mathematics education, life and crisis as entangled and to explore … what might be the potentialities afforded by mathematics education and mathematics education research towards confronting crisis' (MES9, 2016). I have long been interested in discourses of mathematics in the varied accounts of the global financial crisis. For this paper I began to collect examples of these into a makeshift archive. My archive is eclectic and structured through my encounters: 'my archive is also my world, my life-world, my past as well as present, where [ideas of mathematics have] echoed so powerfully' (Ahmed, 2010, p.19). I have chosen texts for diversity of form, focus and year of release, to explore how mathematics is imagined across the visual and the verbal. The diverse texts that I have 'read' include documentaries, such as Michael Moore's *Capitalism: a love story*, Charles Ferguson's *Inside Job* and Terry Gilliam's *Boom Bust Boom*. But for this paper I focus on popular fictions that challenge divisions 'between fact and fiction, history and story, truth and lies' (Popple and Macdonald, 2012, p. 4).

The films *The Big Short* and *Margin Call* centre on (mostly male, mostly white) workers in the US financial services sector. Their central characters notice problems in the derivatives markets before the rest of their sector and seek to profit from these. In *Margin Call*, we spend a night in the offices of an investment bank which has spotted an existential problem with their trading model. In a series of meetings between employees, they discuss how to respond, ultimately deciding to sell the assets that they now believe are toxic before a loss of market confidence renders them unsaleable. Being set mostly at night, inside the bank, it has a claustrophobic and eerie feeling. *The Big Short* is based on a true story of 'outsiders' who bet against the housing market, years before the bubble burst. We follow the financial crisis through their lives, as they take a risk and finally cash in their investments as the US economy and people's lives collapse around them. As I discuss more later, it is self-consciously postmodern with, for example, characters 'breaking the fourth wall', speaking direct to camera, to tell us whether the scenes depicted 'really' happened.

Kapitoil is a first person novel centred on Karim Issar, a young man from Qatar who is seconded to the Wall Street headquarters of his US employer, Schrub Equities, to tackle the Y2K bug. The book takes the form of his diary entries from 3 October to 31 December 1999 inclusive. Although set nearly a decade before the crash and two years before the 'war on terror' began, it can be read as a comment on both the financial crisis and post-9/11 US. We follow Karim as he creates a program (the eponymous Kapitoil) designed to use news reports on the Middle East to predict oil price fluctuations. We see how he deals with his company's attempts to control his program and with his developing sexual relationship with co-worker Rebecca.

Capital centres on a London street, Pepys Road, whose residents have benefited from the property boom. The novel's narration moves between 20 characters' points of view, including: Roger, a manager in an investment bank, Arabella, his shopaholic wife, and Mark, his ambitious deputy. Lanchester's sprawling 'state-of-the-nation' novel offers snapshots of its characters' lives in December 2007, and April, August and November 2008 as the financial crisis unfolds and Roger loses his job shortly before his bank goes under. Among the interlocking storylines is one focused on a campaign of harassment in Pepys Road, as residents begin to receive postcards bearing images of their homes and the words 'We Want What You Have'.

All four texts are broadly critical of the free market capitalist status quo that led to and sustains the ongoing financial crisis. The titles *Capital* and *Kapitoil* both reference Karl Marx's classic analysis of capitalism in *Das Capital*; *Margin Call* and *The Big Short* track that moment when it seems, in the words of the *Manifesto of the Communist Party*, 'all that is solid melts into air' (Marx, 1976; Marx & Engels, 1952). In this paper, I will argue that, because of this critical positioning, these fictions, while reproducing some dominant discourses of mathematics and mathematicians, also introduce new ways of viewing mathematics which trouble its objectivity and elitism.

In the past, I have written extensively about representations of mathematics and mathematicians (e.g. Mendick, 2015; Mendick, Moreau & Hollingworth, 2008). Perhaps because of this, I initially noticed the continuities between these four texts and the dominant discourses. But as I persisted in reading and rereading them, analysing them as part of wider discursive formations, I began to see discontinuities. I was drawn to 'optimistic readings that push the possibilities of both the dominant and the alternative as far as possible' towards mathematical ways of being that open up spaces for 'the pleasure of creative analytical media consumption … committed to social justice' (Projansky, 2014, p. 22). In the next two sections, I show how these texts both reproduce and trouble dominant discourses of mathematics as an objective and elite activity respectively, suggesting more subjective, open, democratic possibilities.

TROUBLING OBJECTIVITY: UN/FAMILIAR IMAGES OF MATHEMATICS

Typically films (and television programmes) use two visual techniques to represent mathematics (Mendick, 2015). First, there are specific images that stand in for the

process of doing mathematics, usually, people writing feverishly on windows, mirrors and transparent whiteboards. Second, there are scenes that seek to explain mathematics. These extract you from the normal mise-en-scène, as images change to depict structure and pattern, and naturalistic speech is replaced by a pedagogic voice-over from a mathematical 'genius'. Such scenes naturalise what Ole Skovsmose (1994, p. 42) calls the formatting power of mathematics, the way that:

> mathematics produces new inventions in reality, not only in the sense that new insights may change interpretations, but also in the sense that mathematics colonises part of reality and reorders it.

These scenes convey the power of mathematics and the role of mathematicians in mediating that. Their specific mathematical content is irrelevant to the story.

There is no frantic writing in the *The Big Short* and *Margin Call*. The new visual shorthand for doing mathematics in these and other financial-crisis films is typing into computers, as small screens of numbers and graphs flicker across the big screen. This shift, from old-fashioned to contemporary images, arguably makes mathematics appear more accessible. This is supported by the four scenes explaining mathematics in *The Big Short*. Three exist outside of the main narrative, as in other mathematical fictions, using glamour, celebrity and metaphor to describe the financial mathematics of mortgage-backed securities, shorting a market, CDOs and synthetic CDOs. They feature: actor Margot Robbie sipping champagne in a bubble bath; celebrity-chef Anthony Bourdain preparing food in his restaurant; and 'Dr Richard Thaler, father of behavioural economics' and 'International Pop Star' Selena Gomez playing 21 in Vegas. In a change from previous representations of mathematics, the film invites its audience to understand the ideas and these are integrated into the subsequent narrative. The film's narrator, banker Jared Vennett, sets these scenes up in opposition to the confusing use of 'financial jargon' that he describes as a deliberate strategy to exclude by making 'you feel bored and stupid'. This financial jargon is implicitly mathematical.

Beyond this focus on the accessibility of mathematics we find a challenge to its objectivity. In a key scene, Jared tries to sell the idea of shorting the housing market. He is asked 'You're completely sure of the math'? In reply, he points to 'my quant', an East Asian man. Jared explains he speaks no English, is called Yang and came top in a China mathematics competition. The film instantly cuts to the 'quant'. Looking directly into the camera, he tells us that he speaks English, is called John, and came second in the competition. This draws attention to stereotypes of Chinese people as 'naturally able' at mathematics. It also exposes mathematical truth as reliant on social factors for authentication: who makes a claim is more critical than any 'objective' criteria.

In *Margin Call*, similarly, what is important is less the detail of the mathematics (glossed as an 'equation' or 'formula') than its meaning. The bank's CEO asks Peter, the young risk analyst who uncovers the problem, to 'speak as you might to a young child or a golden retriever'. Peter's immediate boss exclaims, 'Oh, Jesus. You know I can't

fucking read these things. Just speak to me in English'. Thus, even those on 'the inside' are exposed as fallible. Uncertainty and questioning echo through the film. The 'formula' on which the bank has relied for so long is 'worthless. … It's broken'. When someone objects, 'there are eight trillion dollars of paper around the world relying on that equation', the terse response is, 'well, we were wrong'. The equally terse response to that is: 'No, you mean *you* were wrong'. The film thus starts with a loss of mathematical certainty, that is never resolved. This is symbolised by the CEO's statement that, 'one and one no longer makes two'. Other characters ask 'Do we even know if he's right'? 'Is that figure right'? And 'You think he's right'? The responses, whether certain or uncertain ('looks pretty fucking right to me', 'I don't know, I can't be sure' and 'I know he's right'), are never final. There is also ambiguity around the film's use of 'right', which refers both to the 'rightness' of mathematics and to moral 'rightness'. Different characters take different views on whether the bank should liquidate their position. As one puts it, 'in acute situations such as this, often what is right can take on multiple interpretations'. While, this is a reference to disputes about what is morally right, given the continuing questioning of mathematical certainty in the film, it could also apply to mathematics. Thus, both films draw attention to the formatting power of mathematics, and so they *denaturalise* it.

In novels, the lack of visual signifiers seems to make it more difficult to represent mathematics. Sometimes mathematics is an absent presence (as in Dan Brown's *The Da Vinci Code*), or the story is patterned by mathematics (as in Michael Crichton's *Jurassic Park*), or a first person narrative gives access to mathematical ways of being (as in Yevgeny Zamyatin's *We*). *Kapitoil* uses the latter technique to question the objectivity of mathematics.

Karim's first person narration in *Kaptoil* gives insights into his mathematical way of being. For example, his account of visiting an art gallery includes this comment on the paintings of Piet Mondrian: 'His lines are perfectly straight like geometric Islamic designs and would extend infinitely if the frames did not restrict them' (p. 16). Mathematical references and analogies recur through Karim's diary, for example:

> Sometimes small details tell you more about someone than the big picture does, in the same way, e.g., that the infinity of real numbers between 0 and 1 is actually greater in cardinality than the infinity of all integers. (p. 114)

Karim's mathematical approach is also evident in his precise use of language: he lists new words beneath each diary entry and his Kapitoil computer program relies on nuanced distinctions, such as, between 'claiming' and 'taking' responsibility for terrorism. His distinct voice and approach are labelled Karim-esque and are linked to his mathematical and coding skills, but they are also related to the postmodern:

> musicians like Bob Dylan and Leonard Cohen are also appealing because they sing about subjects that reject binaries and are mysterious in the way math can be mysterious, e.g., sometimes you locate an answer and the universe becomes almost magical because in the

> middle of chaos there is still order, and sometimes there is no answer, and because of that the universe is even more magical since it has secrets that humans can never understand. I told Rebecca this, and she said, 'You're turning into a real postmodernist' (p. 272)

The connection of the mathematical to the postmodern, via the Karim-esque, suggests a mathematics beyond certainties and binaries, where 'sometimes there is no answer'.

Lanchester's *Capital* also presents a subjective uncertain mathematics. The novel mentions the mathematics within investment banking but does not seek to explain it. Yet it identifies a mathematics happening outside of banks (and other specialised spaces) through consumption. In a long passage, after Roger Yount has lost his highly-paid job in investment banking, he considers their outgoings, particularly Arabella's:

> *The worst of it was the maths*. The Younts' outgoings were still what they had been. Two houses to run and maintain, neither of them cheap, clothes and holidays, Arabella's completely out-of-control discretionary spending. … Talking to Arabella about money was like trying to talk to a child about nuclear physics. (p. 488, additional emphasis)

Their consumption and its costs is 'the maths' of the Younts' situation. It is analogous to 'nuclear physics'. If consumption is mathematics, then, within capitalism, everyone does mathematics. The novel reinforces this point through the 'We Want What You Have' harassment, that targets people's greed and delight in their soaring house prices. Similarly, in *Margin Call*, one banker justifies his role to another: '[If] people want to live like this, in their cars and the big fucking houses they can't even pay for, then you're necessary'. These can be read as ways of shifting responsibility for the financial crisis from the bankers to 'ordinary' people. However, they can also be read as an opening up of mathematics, towards democracy and away from elitism.

TROUBLING ELITISM: UN/FAMILIAR IMAGES OF MATHEMATICIANS

Typically, in mathematical fictions, people doing mathematics combine features of the socially-awkward geek/nerd and the heroic genius (Duchin, 2004, Mendick et al, 2008). The gender, race and class of central/peripheral figures align mathematics with masculinity, whiteness and middle-classness. All four texts reproduce these dominant discourses, but, as I indicated above, they also represent alternatives.

Margin Call's Peter is a former 'rocket scientist' who chooses to stay late at the office doing mathematics rather than going for a drink with his workmates. *The Big Short*'s Michael, who develops the idea of shorting the housing market, wears no shoes in the office and admits: 'I don't know how to be funny. I don't know how to work people. I just know how to read numbers'. He is one of the 'outsiders and weirdos' who saw the 'lie at the heart of the economy'. Although weird, they are presented as society's innovators: the man who invented Mortgage Backed Securities has 'changed your life more than Michael Jordan, the iPod and YouTube put together'. *Kapitoil*'s coding genius Karim's nerd status is evident in his Karim-esque voice, and when his girlfriend Rebecca refers to this as a trait they share. We see *Capital*'s Mark's social awkwardness through

his boss Roger: 'His weirdo deputy was looking down at his feet and scowling, as if he'd suddenly realised that he was wearing the wrong shoes' (p. 340). Mark casts himself as both 'genius' and villain, against '[m]iddle-class mediocrity' (p. 448, 192).

These characters are simultaneously geeks and geniuses. But they are not the heroes of most mathematical fictions. As Jared chides us towards the end of *The Big Short*, after his $47M bonus for 2008, is announced, 'Hey I never said I was the hero of this story'. These characters provoke more alienation than empathy. Mark's arrogance lands him in jail. The 'long black cars and executive perks' in *Margin Call* are: 'paid for with what was inescapably fraud. One of the characters has a sick dog. The dog is the only creature in the entire film that anyone likes' (Ebert, 2011). Their nastiness and fallibility are a warning that we should not leave finance, and so mathematics, to an elite.

In the previous section, I argued that, by defining capitalist consumption as mathematics, *Capital* writes us all as participants in it. This implicates us in the crisis and asks us to intervene and not 'pretend [we] have no idea where it came from' (*Margin Call*). Similarly, breaking the fourth wall in *The Big Short* implicates us by placing us inside the action. This is most obvious at the end of the film, when Jared says:

> In the years that followed, hundreds of bankers and rating-agencies' executives went to jail. The SEC [Securities and Exchange Commission] was completely overhauled and Congress had no choice, but to break up the big banks and regulate the mortgage and derivative industries.

As Jared speaks we see images representing the events he describes. Then, after a pause, he announces 'just kidding', reminding us of the bank bail outs, bonuses and lack of reform. The brief fantasy 'moves us beyond what is merely actual and present into a realm of possibility, the not yet actualized or the not yet actualizable' (Butler, 2004, p. 28). It suggests we need democratic accountability in our financial systems, something which would also require a democratic mathematics. I look next at how such forms of mathematics are tentatively articulated through these texts' multiple masculinities.

With the exception of *Kapitoil*'s Karim and Rebecca and *Margin Call*'s Sarah, all the central financial characters are white middle-class men. The alignment of masculinity with mathematics is stronger in these than other mathematical fictions, reinforced by their financial settings. The gender identities of the isolated female bankers (Sarah and *Capital*'s Michelle) are subject to question. *Capital*'s Roger explains that: 'Female traders … either went super-girly and manipulative, or were more like alpha males than the alpha males. Michelle was the second type' (p. 282). The women in *The Big Short* are there to service the men's development. For example, the heterosexuality of the film's central male characters is secured by their two largely-silent wives; and a female actor in a bubble bath and an exotic dancer deliver exposition. The films' few black and Asian characters are also marginal and narratively subordinate to the white men. Aligning mathematics with masculinity is not only related to bodies but practices. A banker in *Margin Call* jokes to a man he manages: 'Have I ever told you how much I

love your bag? … Do you have a little dress that matches it? … Because you could bounce around in it like a fucking girl'. Similar comments feature in all four texts.

Yet these excessive performances of masculinity evidence its fragility. Masculinity like mathematics in these texts is never secure: 'Masculinity is something that we have to be constantly trying to prove. It isn't anything that we can feel easy or relaxed with' (Seidler, 1997, p. 39). These men, their masculinity and their mathematics, are fallible. As I elaborate next, this fallibility demystifies them and opens up mathematics to different ways of being, as class and race function in intersection with gender.

Repeatedly within financial-crisis fictions we see two contrasting masculinities juxtaposed: a middle-class masculinity of mental labour within the financial services sector and a working-class masculinity of manual labour within construction. For example, *Capital* contrasts British banker Roger and Polish builder Zbigniew. Matya, the Younts' Hungarian nanny, has come to London to find a wealthy husband. She goes on dates with both Roger and Zbigniew. Yet it is Zbigniew to whom she is attracted despite his relative poverty and her commitment that 'a serious boyfriend should have serious money' (p. 529). She overcomes her distaste that he 'work[s] with his hands' because this work 'gave Zbigniew his body', and she is drawn towards his physicality: 'firm and taut … muscled and compact and clean' (p. 531). In *Margin Call*, a disillusioned quant reminisces: 'I built a bridge once … It spanned 912 feet above the Ohio River. And it cut out 35 miles of extra driving each way'. He focuses on the physical over the intellectual. Although, the speaker was an engineer who likely played no part in actually building the bridge, he appropriates this classed manual labour. Similarly, when sales manager, Sam (the owner of the likeable dog) reflects on his work, his boss dismisses his regrets telling him: 'You could have been digging ditches all these years'. Sam responds: 'That's true. And if I had, at least there'd be some holes in the ground to show for it'. The film's final image is of Sam digging a hole to bury his dog in his ex-wife's garden.

These texts set up an a series of oppositions: middle class vs working class; mental labour vs manual labour; abstract vs concrete; intellectual vs physical; doing finance/mathematics vs building and digging. Breaking with dominant discourses, they value the second over the first term in each opposition. Thus they implicitly critique the abstractness of mathematics when they critique middle-class financial masculinity. By valuing working-class physical masculinity, they assert the concrete over the abstract. But they stop short of dissolving the distinction between the two, so that we could understand the abstract as always already concrete and vice versa.

In Karim, *Kapitoil* offers a central character who, as a Qatari Muslim, is Other to whiteness and the West, and who is Other to dominant masculinity, preferring the company of women, and rejecting the laddish culture in his workplace. The use of Muslim characters to articulate resistance to US capitalism, is increasingly common in post-9/11 fictions such as Mohsin Hamid's *The Reluctant Fundamentalist*. It draws on

Orientalist oppositions (Said, 1995), even while depicting the Muslim position as morally superior. In line with this, Karim refuses to reduce relationships to commodities. For example, he aims to network 'to build social capital. But whenever I meet someone, I have difficulty thinking primarily of that person as part of a future network' (p. 134). When Karim has 'nearly finished' programming his mathematical model in Kapitoil, he 'evaluate[s] the big picture of what I am creating':

> When violence occurs, especially in the Middle East, my program will attempt to leverage it for financial gain. But this violence will happen with or without my program. Therefore, by making money, the program produces at least some positives from a very negative situation. It turns the violence into a zero-sum game, because the money and violence cancel each other out, instead of producing exclusively a negative game. (p.42)

However, ultimately he rejects this zero-sum game, hoping for a positive game. He refuses to sell his program to Schrub Equities, sacrificing his right to live in the US (with Rebecca) and his family's financial security, to make his code freely available so that it can support global health and development. 'The code must be on the open market for the best people to utilize it. And there may be applications we have not thought of' (p. 281). Despite retaining a notion of 'the best people', this is largely a democratic vision of crowd-sourced mathematics, in opposition to the elitism of private ownership.

CONCLUSIONS

In this paper I have contributed to the work of understanding the relationship of mathematics to the post-2008 financial crisis by looking at the stories we tell about it.

> It is through such stories, or representations, that we develop understandings of the world and how to live in it. The contest between rival stories produces our notions of reality, and hence our beliefs about what we can and cannot do. (Sinfield, 1989, p. 23)

I have looked at how these fictions expose the fallibility and social construction of mathematics, displacing the dominant discourses of its objectivity and abstraction. Normally in mathematical fictions, from *Enigma* to *Numb3rs*, from *A Beautiful Mind* to *The Theory of Everything*, we see the subject's power – to solve crimes, win wars, analyse human behaviour and understand the universe. In mathematical fictions of the financial crisis, we encounter its failure and its intertwining with capitalist consumption.

Debate about the natural and physical sciences has long contained an idea of the abuse of scientific concepts. Research in the sociology of scientific knowledge has shown that scientists need to work to reconcile the idea of scientific proof with its political entanglement, in order to rescue the innocence of science (Gilbert & Mulkay, 1984). There is no comparable debate on mathematics, which is still largely seen as objective and apolitical. But these financial-crisis fictions represent mathematics as dangerous, something that has different political possibilities:

> My point is not that everything is bad, but that everything is dangerous, which is not exactly the same as bad. If everything is dangerous, then we always have something to do. (Foucault, 1983, p. 343)

Normally, mathematical fictions encourage us to view the subject as the province of an elite, who are special because of their 'ability' to do mathematics and whose specialness manifests in other ways from geekiness to mental health problems. But these texts suggest that this elite is not to be trusted with (financial) mathematics and implicates us all in the mathematical. If (financial) mathematics cannot be left to the experts, this opens up possibilities for discussing a democratisation of mathematical knowledge. This needs wider public engagement in mathematics alongside the accountability of professional mathematician. It is modelled by Karim, when he releases his own mathematics into the world, trusting other people's expertise over his own.

By sidestepping questions of what mathematics *is* and looking instead at what mathematics *does*, poststructuralism helps us to re-imagine 'the hard and masculine body [of mathematics] that penetrates [non-mathematics] but is not itself susceptible to penetration' to re-envision it as 'open and permeable' (Gibson-Graham, 1996, p. 544). This indicates the subversive political possibilities of focusing on discourse over essence. Although the truth claims in this paper are simply a few among many, competing for space in academic and public arenas, so too are those of mathematics.

Through such analyses, we see mathematics as a cultural object. Here I have focused on the *representation* element in the circuit of culture, arguing that new meanings are attaching to mathematics post-2008. However, these representations also have implications for the *identities* constructed through mathematics. Alongside the heroic mathematician figure they place a more equivocal, fallible and morally ambiguous financial operator, and so shift the power relations between 'them' and 'us'. How this does or does not change the identities people construct in relation to mathematics and the subject's *production*, *consumption* and *regulation*, are topics for further research.

ACKNOWLEDGEMENTS

My thanks go to Dieuwertje Dyi Huijg for discussing the ideas in this paper with me and to Gwen Ineson, Peter Gates and Sarmin Hossain for commenting on an earlier draft.

REFERENCES

Ahmed, S. (2010). *The promise of happiness*. Durham: Duke University Press.

Butler, J. (2004). *Undoing gender*. Abington, Oxfordshire: Routledge.

Butler, J. (2004). *Precarious life: the powers of mourning and violence*. London: Verso.

Chandor, J.C. (Director). (2011). *Margin Call*. USA: Before The Door Pictures.

Chelala, C. (2015). Effect of Greece's Economic Crisis on Public Health Retrieved 22 August 2016, from http://www.counterpunch.org/2015/07/28/effect-of-greeces-economic-crisis-on-public-health/

Chronaki, A. (2013). Identity work as a political space for change: the case of mathematics through technology use. In M. Berger, K. Brodie, V. Frith & K. l. Roux (Eds.), *Proceedings of the seventh international Mathematics Education and Society Conference (volume 1)* (pp. 1-18). Cape Town: MES7.

du Gay, P., Hall, S., Janes, L., Mackay, H., & Negus, K. (1997). *Doing Cultural Studies: The Story of the Sony Walkman*. London: Sage.

Duchin, M. (2004). The sexual politics of genius Retrieved 8 July 2015, from http://mduchin.math.tufts.edu/genius.pdf

Ebert, R. (2011). *Margin Call* Retrieved 23 August 2016, from http://www.rogerebert.com/reviews/margin-call-2011

Education in Crisis (2013). *Greece* Retrieved 23 August 2016, from https://www.educationincrisis.net/country-profiles/europe/item/414-greece

Flax, J. (1993). *Disputed subjects: essays on psychoanalysis, politics and philosophy*. Routledge: London.

Foucault, M. (1972). *The archaeology of knowledge*. London: Routledge.

Foucault, M. (1984). On the Genealogy of Ethics: a work in progress. In P. Rabinow (Ed.), *The Foucault Reader* (pp. 340-372). London: Penguin.

Gibson-Graham, J. K. (1996). Queer(y)ing Capitalist Organization. *Organization* 3, 541-545.

Gilbert, N., & Mulkay, M. (1984). *Opening Pandora's box: a sociological analysis of scientists' discourse*. Cambridge: Cambridge University Press.

Lanchester, J. (2012). *Capital*. London: Faber & Faber.

Lange, T. (2013). Whose identity? Response to Anna Chronaki's keynote address at MES 7. In M. Berger, K. Brodie, V. Frith & K. l. Roux (Eds.), *Proceedings of the seventh international Mathematics Education and Society Conference (volume 1)* (pp. 19-24). Cape Town: MES7.

Liakos, A., & Kouki, H. (2015). *Narrating the story of a failed national transition: discourses on the Greek crisis, 2010–2014* Retrieved 3 November 2016, from http://chronosmag.eu/index.php/narrating-the-story.html

Marx, K. (1976). *Capital: a critique of political economy (volume one)*. London: Penguin.

Marx, K., & Engels, F. (1952). *Manifesto of the communist party*. Moscow: Progress Publishers.

McKay, A. (Director). (2016). *The Big Short*. USA: Plan B Entertainment.

Mendick, H. (2015). Mediated Mathematics: Representations of Mathematics in Popular Culture and Why These Matter. In N. J. Higham, M. Dennis, P. Glendinning, P.

Martin, F. Santosa & J. Tanner (Eds.), T*he Princeton Companion to Applied Mathematics* (pp. 943-952). Princeton, NJ: Princeton University Press.

Mendick, H. (2006). *Masculinities in mathematics*. Maidenhead: Open University Press (McGraw-Hill Education).

Mendick, H., Moreau, M.-P., & Hollingworth, S. (2008). *Mathematical Images and Gender Identities: a report on the gendering of representations of mathematics and mathematicians in popular culture and their influences on learners*. Bradford: UK Resource Centre for Women in Science Engineering and Technology.

MES9 (2016). *Mathematics Education and Life at Times of Crisis* Retrieved 17 October 2016, from http://mes9.ece.uth.gr/portal/

Pausigere, P. (2013). On maths teacher identity: A response to Anna Chronaki's 'identity work'. In M. Berger, K. Brodie, V. Frith & K. l. Roux (Eds.), *Proceedings of the seventh international Mathematics Education and Society Conference (volume 1)* (pp. 25-30). Cape Town: MES7.

Popple, S., & Macdonald, I. W. (2012). Introduction. In S. Popple & I. W. Macdonald (Eds.), *Digging the Seam: Popular Cultures of the 1984/5 Miners' Strike* (pp. 1-5). Cambridge: Cambridge Scholars Publishing.

Projansky, S. (2014). *Spectacular Girls: Media Fascination and Celebrity Culture*. New York: New York University Press.

Rose, N. (1999). *Governing the soul: the shaping of the private self (2nd ed.)*. London: Free Association Books.

Said, E. W. (1995). *Orientalism: Western conceptions of the Orient*. London: Penguin.

Seidler, V. J. (1997). *Man enough*. London: Sage.

Sinfield, A. (1989). *Literature, politics and culture in postwar Britain*. Oxford: Basil Blackwell.

Skovsmose, O. (1994). *Towards a philosophy of critical mathematics education*. Dordrecht: Kluwer Academic Publishers.

The Open University of Hong Kong. (no date). *Culture, Media and Identities* Retrieved 22 August 2016, from http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191149037200&lang=chi

Wayne, T. (2010). *Kapitoil*. London: Duckworth Overlook.