Mathiness and Lying
Mathiness in the context of philosophical theories of deception

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Abstract: ‘Mathiness’ is a term introduced by Paul Romer in his paper “Mathiness in the Theory of Economic Growth”. It is referring to a phenomenon in the research area of economic growth; where it is common for researchers to add mathematical material into their published works, in a way that is not scientifically sound. Since this has become such a common practice within this field, these unsound papers are being accepted in peer reviewed journals, on account of the people doing the peer review being within the field and accustomed to these methods. The phenomenon has resulted in a significant amount of published research papers that claim conclusions on grounds that are less than adequate when the standards of this field is compared to standards in other fields. In particular, this is done through using the status of mathematics as scientifically rigorous, to raise the status of one’s research to an illusion of a rigorous mathematical standard, while theory of economic growth is a political science, not a mathematical one. From this background it seems as if there is some sort of deception involved in producing these research papers with mathiness influences, and the aim of this thesis is to define what kind of deception this is. I will also discuss the different implications that follow from what kind of deception one uses, and find that there might not be much of a difference between lying and other forms of deceiving in this case. This is because action is broadcasted, and so the intention of the author of the research does not play a big role in the results of the deception.
1. Mathiness

Mathiness is a term introduced in the paper “Mathiness in Theory of Economic Growth” (shortened to MTEG) by Paul Romer to explain a phenomenon in economics research. Romer is an economist who introduced the concept to urge a public debate, and so the philosophical exactness of the notion of mathiness was not a main interest when he introduced it. I will build upon Romer’s paper to further define the phenomenon, with help from follow-up articles and comments written by Romer and others to specify it more rigorously according to the analytical school of philosophy.

1.1 Summary

“The style that I am calling mathiness lets academic politics masquerade as science. Like mathematical theory, mathiness uses a mixture of words and symbols, but instead of making tight links, it leaves ample room for slippage between statements in natural versus formal language and between statements with theoretical as opposed to empirical content.”

Economics research is generally somewhat difficult to separate completely from the politics that the researcher assumes and/or believes in. In research areas where this is an admitted problem, there is a praxis of making one’s assumptions explicit. Romer says that the problem of mathiness appears when researchers try to circumvent the fact that their research is politically biased, by increasing their use of mathematics in their papers, which makes the papers appear to be scientifically sound, while that might not really be the case.

There has been no lack of criticism of the methods of economists before this paper by Romer. What he brings to the table is a well built argument with examples showing how this

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1 MTEG page 89.
“We find that arguments made to support [that bank equity is socially expensive] are fallacious, irrelevant to the policy debate by confusing private and social costs, or very weak.” Admati et al. (2013) “By fetishising mathematical models, economists turned economics into a highly paid pseudoscience” Levinovitz (2016)
specific problem arises, works, stays in business, and how it affects the whole discipline of economics. While in addition to all of this, he is currently part of academic economics research himself, so that his claims cannot simply be brushed off as something that someone who does not understand the methods properly might say.

Romer locates an instance of economics history in which it is possible that this phenomena was accepted into the area of economic growth;

“Solow’s (1956) mathematical theory of growth mapped the word “capital” onto a variable in his mathematical equations, and onto both data from national income accounts and objects like machines or structures that some-one could observe directly.”

This mapping of the term “capital” onto this variable made it look like a formalization of the concept had been made, and made it easier to understand the relation between the formula and reality. However, the term was not formally defined, and it was used to model and refer to a wide variety of things. This means that the term is not a formalization of anything. Instead of extending the mathematics used to be able to handle a previously informal concept, what happened was that an informal concept was treated as a formal one, thereby lowering the rigorosity of the calculations in which this term is used. This way of handling formulas is unacceptably sloppy from a mathematical point of view, meaning that trained mathematicians would not agree that such formulas could be used to back up any claims. Economists are generally trained in using some mathematics, but that training is far from the extent and rigorousness of mathematics that mathematicians learn.

Romer argues that this method of misusing mathematics is done purposely with the intention of giving the political ideas of the authors more credit. The idea is basically that these economists are arguing using a fallacy of authority, by arguing that their claims are backed up with the authority of mathematical rigorosity, while the authority is a false one since they are not really using mathematics rigorously. Romer discusses the similarities and

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3 MEGT page 89.
4 For example, the bachelor in economics programme at Uppsala University contains one mandatory mathematics course, that is a quarter of a year of studies (15 credits) and is only on statistics specifically for economists. For contrast, completing that course will not give any advantage in the first year of study in a mathematics programme.
differences between scientific and political discourse, to show how mathiness has been able to sneak into research, and why it is bad to use such methods of argumentation. This contrast with politics does not seem to be a necessary component to the notion of mathiness. It is relevant in Romer’s discussion, and therefore in this essay, because of the intertwinedness of the discourse in economics that is the motivation for the critique. Discussing politics in academia is nevertheless not relevant for this essay, so there will not be any discussion of those of Romer’s arguments here.

Romer concludes that the widespread use of mathiness in theory of economic growth is making the field lose credibility.

1.2 Definition of Mathiness

We have now discussed the concept somewhat in the context in which it was introduced to give a good sense of what the thoughts and reasons surrounding mathiness are. To be able to use this concept in rigorous philosophical discussion it is necessary to give it a more concise definition, which I will try to do in this section.

The intent of Romer when he introduced his notion was to bring attention to a problem in the research culture of his subfield of economics. The focus of this part of this thesis will be on defining the phenomena by specifying its characteristics, as close as possible to the intent of Romer.

After his first paper on mathiness, Romer has published several comments with the purpose of specifying the concept, where he put forward several arguments not given in the original paper. From a quick reading of MTEG it can look as if Romer is only critiquing the political practice of growth theorists. In his comment “Illustrating mathiness” (2015), it becomes clear that it is in the translation between natural and formal language that the essence of mathiness lies, and that the political discussion is relevant for showing the problems of using mathiness and not central to defining the notion itself. This focus is one thing that makes Romer’s arguments different from the people who discredit economics research on the grounds of it being impenetrable for non-experts, and that they should be more transparent in what they mean. Those people argue for less use of formal language, while Romer’s

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Which is also a valid critique, example: “the ubiquity of mathematical theory in economics also has serious downsides: it creates a high barrier to entry for those who want to participate in the
arguments do not depend at all on the amount of formal versus natural language used in research papers. He is arguing against a misuse of formalisation, and not putting any value on a correct use of it. Mathiness happens when the difficulty in translating between formal and natural language is ignored or downplayed to the degree that there is no commutativity between the translations.

An example, to be further explained below:

<table>
<thead>
<tr>
<th>Formal language</th>
<th>Natural language</th>
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<tbody>
<tr>
<td>5</td>
<td>Five</td>
<td>No mathiness</td>
</tr>
<tr>
<td>You ∨ me</td>
<td>You or me</td>
<td>Risk of mathiness</td>
</tr>
<tr>
<td>Human capital</td>
<td>?</td>
<td>Mathiness</td>
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</tbody>
</table>

For the first example, it is clear that ‘5’ and ‘five’ means the exactly same thing in any regular context. We can translate back and forth between the two without any loss of meaning. In the second example, there could be confusion because the formal symbol “∨” generally translates to “You or me, or both”, and the “or both” part can be excluded from the natural language translation since that is how the word “or” usually is used. If “You ∨ me” was used to refer to “You or me, and not both of us”, then this would be an instance of misuse of the formalization, and could be considered an instance of mathiness. The third example is the example Romer gives of Becker (1962), where the term “human capital” starts being used as a formally, without there being some specification of which natural language term it correlates. The formal and informal notions are used as though they model exactly the same thing even though they do not. This leads to a vagueness that is unacceptable in all other fields that use some kind of mathematical rigour.

One of the papers that Romer uses as examples of mathiness is McGrettan & Prescott (2010). This article is filled with mathematical formulas, 29 instances in the 30 page paper (excluding the data appendix). There is of course nothing wrong in itself with using formulas to clarify what one means. However, it is easy enough for mathematicians to miss mistakes in professional dialogue, and makes checking someone’s work excessively laborious. Worst of all, it imbues economic theory with unearned empirical authority.” Moosa (2007)
mathematical steps. Every now and then we find mistakes in published mathematical research. To use such a mathematics heavy language in a political science is risky. One way this can go wrong is in the way that Romer points out that McGrettan & Prescott do it. They use a variable, knowing this variable has an established meaning in the field, and they use this variable with a different meaning than the established one, without making this difference explicit. This would be considered a significant research flaw in many research fields, unacceptable in a philosophy paper, but the situation is different in economics. The paper was accepted for publication, and the clear risk of misinterpretation that exists, has not been considered a significant problem since it was pointed out, since the article has not been retracted and has been cited 206 times (as of January 2020).

The other articles that Romer gives as examples of Mathiness are Solow (1956) and Gary Becker (1962). Romer explains that both these articles introduce terms (“capital” and “human capital”) as tightly connected to the formulas that they put into these articles, without admitting that these terms are defined in different ways, and as such they are claiming the status of mathematical rigour without really keeping to that standard. In the above examples, the authors have used mathematical language to give the impression that they have rigorous and objective conclusions, while in reality, they have variables that are not well defined and as such, any conclusion based on them can be vague at most. Utilizing a non-mathematical concept in a mathematical calculation would not be done by any mathematician. If we take the non-mathematical word to be a variable, taking the space for any number that variable could take, then this is a completely different thing, and is acceptable. However, for a function to have any value, it must be clear which values it could take, and exactly why and how the rest of the equation plays a role in the calculations to give us a valid conclusion.

If I write an equation of the form \( x + 5 = y \), then define what values of \( x \) we can use in several different ways, then we could get drastically different in each case and how to interpret \( y \) will differ in each application of it. If \( x \) is a measure of human capital, measured in degrees of how useful a human can be with a range between 0 and 1, then \( y \) will always be a

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6 “In contrast, McGrattan and Prescott (2010) give a label—location—to their proposed new input in production, but the mathiness that they present does not provide the microeconomic foundation needed to give the label meaning. The authors chose a word that had already been given a precise meaning by mathematical theories of product differentiation and economic geography, but their formal equations are completely different, so neither of those meanings carries over.” MTEG page 89

7 MTEG page 89
number in the range between 5 and 6. If human capital instead is defined as the net worth of some human, then we could get y values that are in the billions. The y values in these examples differ so much that it is clear that we could not put in any of these x numbers and then expect to be able to interpret the formula and y-value in the same way for each case. They could both be useful, but they are clearly not interchangeable.

To define intentional mathiness as separate from unintentionally under-defining new concepts, I propose the following characteristics to define mathiness:

1. There is use of mathematical language.
2. At least one significant part of the mathematics used is under-defined.
3. The author(s) are aware of 1&2 and does not explicitly acknowledge that that is the case (this excludes notions that are just genuinely difficult to define to fall into the mathiness category).

A fourth criteria could be added to strengthen the connection to MTEG. This criterion excludes some papers from fitting into the mathiness category, however it also puts emphasis on the misuse of mathematical language and the fallacy of authority which is central to the negative consequences that follow from a wide use of mathiness.

4. The mathematics used in the presented research could, without significantly lengthening the paper, be substituted with natural language arguments.

So based on evaluating the source material and the discussion above, we can understand mathiness to be: a tactic used by some economists in their research, where informal notions are intentionally mixed in with formal notions, so that the authors and/or conclusions conveyed in the research can receive the respect it would receive if the “hidden” informal notions were formally valid. A research paper containing mathiness is a paper making conclusions that are badly founded and which do not hold scientific standards.

It is also worth mentioning the similarity, in both the word and motivation for introducing it, to the terms Scientistic and Scientism that were introduced by Freidrich Hayek to describe research that is done in an unscientific way, yet presented as proper research. Another similar concept is what Paul Pfleiderer calls Chameleons:

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8 Perhaps other researchers as well, however, such a discussion is outside the scope of this thesis.
9 Pfleiderer (2020)
“A model becomes a chameleon when it is built on assumptions with dubious connections to the real world but nevertheless has conclusions that are uncritically (or not critically enough) applied to understanding our economy.”

2. Philosophy of deception

2.1 Short introduction to the difference between lying and deceiving

In many contexts there are wide differences between lying to someone and merely deceiving that same person. Cases where lying occurs is a subset of cases where deception occurs. Generally, telling a lie is considered to be worse than conducting other forms of deceptions, so I will in the following subsections discuss if it is possible to categorize all instances of mathiness as lies. There are differences in the intentions of people performing deceiving acts, how ethical the act is, how the deceived person (or group of people) might react to learning they were deceived, etc., that all make a difference in how one can categorize some deceiving speech act. A simple example to illustrate these differences is a case of deceiving a romantic partner. It is common to have a mutual agreement of truthfulness towards each other in romantic relationships, which means that even a small lie could be the cause of a breakup, while this is not the case for all deceptions. In such a relationship, one partner could say “Come home at 6pm and I’ll bring take-out”, while really intending to have made a really nice homemade meal ready at 6pm. This act would not be considered wrong at all in most contexts, while it is still an obvious deception. Since the intent of the deception was only to give the other partner joy, it would generally not be considered a lie. If the first partner made the same statement, but instead of having a homemade meal waiting, only say “I didn’t bring any food, I just wanted you home by 6pm”, the intent of the deception has changed from bringing joy into personal gain. This would generally be considered a lie.

In the philosophical literature on deception it is clear that there are difficulties of drawing lines between deception and lying, and deception and non-deception, that could be used in all relevant contexts. There are many different ways in which one can be deceiving, and there are many different ways in which it can be considered right or wrong to be

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10 Pfleiderer (2020).
deceiving. It is clear that the intention of the person performing the deceiving act plays a significant role in the categorization of her speech-act. Deception can be created in a variety of ways, lies are always some kind of speech act. While it is difficult to make a universal definition of lying, since there always seems to emerge exceptions to any definition, the general idea is that lying is not centered on a difference between a statement and the truthfulness of that statement (so that someone is not necessarily lying if she claims it to be raining, if it was raining when she was outside 10 minutes ago, and it has since stopped raining). Lying is rather a relation between a statement and the intentions of the person making the statement. If someone makes a statement which that person knows to be false, then that person is being deceiving. If the intention of the statement is to make others believe in something false, it is considered lying. The intention of the person making claims is important, and there is no clear cut way to access the true intentions of any one person. Without knowing the intention behind a statement, the difference between a lie and a mistake is difficult or impossible to tell. The generally accepted definition of lying in philosophical literature, which we will use here as well, is the following:

“A lie is a statement made by one who does not believe it with the intention that someone else shall be led to believe it”\cite{Mahon2016}

James Mahon adds that this is insufficient in that it “does not specify the addressee”. This is not a problem in our current discussion since Mathiness occurs mainly in contexts that are addressed to a general population of some category of scientists or the public, not to some particular person. This leads to a specific outcome of the deceit. The general audience will believe that the parts they do not understand are true and valid, without being able to check for themselves since the general reader of an economics paper is not a mathematician. A researcher consciously misusing research methods is deceiving, and not necessarily lying.

\cite{Mahon2016}
2.2 Where does mathiness fit in?

The context of mathiness has another difference from the above general definition of lying; the part of the definition which states “... by one who does not believe in it”, is not necessarily true in cases where Mathiness is part of any statement. The economist might very well believe that all the statements they make in their research are true. Nevertheless there is a sort of intentional deception involved; the economist knows that the relation between the statements they are making is less rigorous that it is presented as. They are then not necessarily stating something they know to be false in their published arguments and conclusion, but they are presenting their reasoning in a deceptive way. It is difficult or impossible to know exactly what a specific researcher knows to be true and what they are overstating. In the examples that Romer provides us we can tell that it is beyond reasonable doubt that the researchers are aware of their use of mathiness, and since these examples are taken from well established researchers in their field, there is reason to doubt the general ideas towards deception to be at a desirable level for a research field.

This kind of deception has the form that Sorensen has identified (2017); it is not the statements themselves that are false or deceptive, rather it is the claimed relations between the statements that are deceptive. In all cases where mathiness is used, the authors of that piece of research is aware that their methods are of a lower standard than what they are presented to be. This allows us to consider all conclusions that rely on arguments containing mathiness to be intentionally deceptive. So the above definition of lying fits onto our definition of mathiness, when “a stated connection between statements” is included in what can be considered a statement.

Sorenson discusses deception in between statements, defining statements made about and in between other statements as “secondary assertions”. Primary assertions are statements such as atomic propositions and sentences, and secondary assertions are statements about the relation between primary assertions. In the language of logic, one could say that secondary assertions are the connectives and conclusions of formal sentences. Making observations and drawing connected conclusions from them are two very different ways of building arguments, that can look very similar in their way. This similarity, between an argument of the form “A and B” and “A implies B”, is then easy to use for anyone who wants to intertwine the two and downplay the difference between them. In Sorensen’s (2017) there is a thorough examination
of lies of the form “I assert that P follows from Q, by knowing that P is true and Q is true, and also knowing that it is a lie that P follows from Q”. Or in other words, when “the explainer does not believe the explanans explains the explanandum”. This model of an argument is a perfect fit for how the economists using mathiness are misrepresenting their arguments. They believe both their arguments and their conclusions to be correct, but also that the mathematics used to show the connection is not up to mathematical standards and is presented as if it was.

Since the economist using mathiness either knows that she is making a deceiving translation, or knows too little of the mathematical language to realize she is making a faulty translation, (which in itself is doing research wrong since one should not use methods which one does not know how to use properly) this can be considered making a statement which she knows to be false. In the examples that Romer provides us with, McGrettan & Prescott (2010), Romer claims he has pointed out the faulty reasoning to the authors and the journal in which it was published, but there has not been any acknowledgment of his comments. If there were mistakes made, there might have been some acknowledgement, refutation and tries at minimizing the damage. To simply ignore when one is called out on doing something wrong, seems to be more close to pretending nothing is wrong and hoping that few people notice, than doing one’s best to create valid research. Seana Shiffrin, in her book on the philosophy of lying, states:

“Agnostics about the truth of their assertions who nonetheless assert them without qualification tell lies”

According to this argument, all those who use mathiness are lying. They make assertions based on incomplete or misrepresented data, so while they use mathiness to make it seem as if their claims are true and well-founded, they do not really know if their claims hold true.

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12 “You can lie with an argument without any of your premises being a lie. You can lie with an argument without your conclusion being a lie. Therefore, you can lie with an argument without any of your premises or your conclusion being a lie.” Sorensen (2017) page 105.
2.3 Does the difference matter?

As introduced in section 2.1, there is a significant difference between lying and deception in different contexts. Categorizing argument in one of the two did not have an obvious path, yet with the help of Sorenson’s argumentation we can say that most cases that are definitely fulfilling the criteria for mathiness are also fulfilling the necessary criteria to be considered lying. Since we cannot access the intentions of the researchers, there will be no easy way to see if any person that could be suspected of using mathiness is lying or merely deceiving. We reach an important question: in the context of mathiness and research, does that difference matter? Assuming that any researcher that publishes their research does it because they want to learn something about reality, and spread what they have learned, we can henceforth in this discussion assume that those who intentionally deceive others that they have conducted good research when they have not, are doing something morally undesirable.

In the example of the difference between deception and lying for a romantic couple, the difference is obvious, and the intention of the deception plays a crucial role. In that example, the person that is deceived learns from the source that they were deceived, and the intention of the deception was to bring the partner greater joy by giving them a surprise. That situation is very different from the case of mathiness in economics research. In the case of mathiness, the deceiver is the author(s) of some research paper. The people who are deceived are the people who read the paper, those who in other ways learn and trust the conclusions of the paper, and those who do these things with research which builds further on the deceiving research. There is no acknowledgement that a deception has been made, and no one might even realize there is a deception that is part of the arguing. There is certainly an intention that the deception should go unnoticed. The negative effects of such deception is not that someone's feelings get hurt, it is instead (at the very least) that the quality of, and respect for, some research subject lowers. The dinner deception was made to be discovered, mathiness is covered up.

15 While this is quite a meek statement from the point of view of ethics, it is clear and contentful enough for this discussion.
When an area of research gets diluted with sub-standard articles, there are many things that are usually relied on, that do not realistically work any more. For example, good advice on how to learn to write research suddenly becomes bad advice:

“And it bears repeating that the best way to learn how to write a data section is to read several data sections in the literature and pay attention to the kinds of information they contain.”

If this advice is followed within a field which contain a significant amount of mathiness among its literature, the next generation of students will replicate the substandard research methods and the new literature will be even more diluted. The foundational methods of how we perform research becomes undermined when a pool of published research contain some form of deceit. The difference between falsifying laboratory data and using mathiness might seem wide since one is clearly fraud and the other could be chopped up to sloppiness, however, the results these actions have for the research community are basically equal. This means that making a difference between them, between intentionally lying and being some degree of deceiving with ones numbers, both create the same problematic result. If there is no guarantee that the research in ones field is reliable, then each researcher will have to go through the details of each paper they read and want to cite to make sure it is “one of the good ones”, which will take significant time away from other parts of doing research. The peer review system is in place to put another door in the way for research that might not be good enough, however this door becomes wide open when the doorman believes “a little deception” is good enough. Calling someone a liar is provocative, and it is not generally accepted conduct. It is also not acceptable to state lies, especially in the context of research.

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16 Dudenhefer (2006)
17 “As is noted in an addendum, Lucas (2009) contains a flaw in a proof. The proof requires that a fraction $\alpha / \gamma$ be less than 1. The same page has an expression for $\gamma$, $\gamma = \alpha \gamma / \gamma + \delta$, and because $\alpha$, $\gamma$, and $\delta$ are all positive, it implies that $\alpha / \gamma$ is greater than 1. Anyone who does math knows that it is distressingly easy to make an oversight like this. It is not a sign of mathiness by the author. But the fact that this oversight was not picked up at the working paper stage or in the process leading up to publication may tell us something about the new equilibrium in economics. Neither colleagues who read working papers, nor reviewers, nor journal editors, are paying attention to the math.” MTEG page 90.
18 “If mathiness were used infrequently to slow convergence to a new scientific consensus, it would do localized, temporary damage. Unfortunately, [...] mathiness could do permanent damage because it takes costly effort to distinguish mathiness from mathematical theory.” MTEG page 92.
This unfortunate combination creates possibilities to publish research containing lies, since there are many who follow the conduct of not calling out liars. Romer says this problem could lead to mathematical statements losing all their rightly earned respect:

“After readers have been disappointed too often by mathiness that wastes their time, they will stop taking seriously any paper that contains mathematical symbols. In response, authors will stop doing the hard work that it takes to supply real mathematical theory. If no one is putting in the work to distinguish between mathiness and mathematical theory, why not cut a few corners and take advantage of the slippage that mathiness allows? The market for mathematical theory will collapse. Only mathiness will be left. It will be worth little, but cheap to produce, so it might survive as entertainment.”

Some who could be called out as using mathiness could try do defend themselves by saying that they made a mistake, and were not intentionally publishing deceiving mathematics. This defense takes the responsibility of proper research conduct from the researcher, and puts it instead onto the peer reviewers and readers of the research. This defense is ignorant of the difference between owning up to one's faults and proper research conduct. If you have deceived a friend, he might forgive you and the problem becomes a problem of the past. When you publish research it leaves your hands and can affect many people quickly and drastically, and it is not always easy to track everyone who made decisions based on the faulty research if one realizes a mistake after some time. This is why there is usually a hard push for rigorous research methods, and the reason for why mathematical language holds such high authority. Publishing research is putting your seal of approval on it, which should mean that your reliability as a researcher is on the line if there is some mistake discovered. Apologizing for a mistake does not make the problems move into the past in research, and whether or not you apologize for the mistake only affects your future research opportunities, not the effect your false statement has done on those who reads your research and miss that you withdraw it.

19 MTEG page 90.
20 “I am trying to push the discussion about the problems in economics out into the open precisely because science must depend on open, public statements, backed by a person’s reputation.” Romer ([4] 2015).
In most everyday life situations, the obligations of truthfulness and the weight of proof, and trust between people varies significantly and often. I trust the busdriver to drive safely, but have no reason to trust them with my passwords or valuables. I trust my partner with the safety of my passwords, but have no reason to take them on their word when they tell me news about economist research, because while I trust that they would not intentionally deceive me on such subjects, I also know that they aren’t knowledgeable enough in those subjects to give me an accurate explanation of what the research says. What kind of deception is performed is reliant partly on the relation between the deceiver and the deceived. So for mathiness, this relation is between the author and the readers of the research. It is not only other researchers, educated in that field, who will read and use the arguments and results of any research papers in economics. The effect the research can have on societies is quite significant, since these papers are the basis for significant political decisions. There will be journalists and semi educated people who read the research as well. It cannot be the responsibility of researchers to make all research readable by non-experts, yet it should not be ignored that something can be interpreted differently by experts and laymen, if such different interpretations can be avoided with some added dictionary or change of words. The weight on making sure that what is claimed to be true, really is true, lies completely on the author of the research (some weight is on the peer reviewers, however that weight that they pull is not subtracted from the weight the author carries. It is only an extra step to make sure that the author keeps to the standard). If I make a sarcastic comment to a friend, then I need to count on my friend to make the proper interpretation of my comment for it to be seen as truthful instead of deceiving. When I am publishing research I need to make sure that as far as possible, no one will misunderstand what I mean and that I provide sufficient information to show what the correct interpretation of my arguments and conclusions are. For practical reasons the demands of the author varies between different fields, however it is always the responsibility of the author to make sure that their research is sound and that they present it truthfully.

Since it is difficult to define exactly what one needs to make explicit and what one can assume a reader to know, we get a gray area where there are different opinions between
different people. This gray area is usually not too troublesome, but it certainly allows for possible intentional under-defining of significant words and arguments.\textsuperscript{21} In everyday situations one can get away with small lies, white lies, and much else without it necessarily be considered bad. In research, we need to keep a much higher standard of truthfulness, so that we can read and cite each other quickly without having to be critical of everything constantly. Every publication should be able to stand up to close scrutiny if it was tested, and the realm of “published unrefuted research” should be kept as clean as possible from less-than-sufficient standard dilution. This means that it does not matter if some author intends to lie or do some lighter form of deception. The result will be the same, less-than-good research gets presented as belonging in the same category as the rest of published research, and there is a truthfulness dilution and a distrust of science can creep in.\textsuperscript{22}

“In physics, if you write down an equation, you expect the variables to correspond to real things that you can measure and predict. If you read the macro literature, you see that almost every famous, respected paper is chock full of these sort of equations that don’t match reality.” Romer (July 2015)

3. Conclusions

“This year 2000 is divisible by four. Therefore, 2000 is a leap year.”\textsuperscript{23}

This is two arguments, separately true, but the connection between them is false. 2000 is not a leap year because it is divisible by 4, nevertheless it is a leap year. Someone who is not inclined to reflect upon such things as “divisible by four” and what decides which year is a leap year, might just right out accept the relation to hold. Presenting the above statement as true is to use mathiness. Using people's trust in the truthfulness of mathematics to present

\textsuperscript{21} Pfleiderer gives us an example defence from someone presenting a chameleon model: “Our job as theorists is just to produce models that are internally consistent”. This removes the blame of deception from the theorists and puts it onto whoever used their research for real life applications. Or in the gray area where no one is to blame and there is only an unfortunate misunderstanding that the empiricist thought that this theoretical model could be applied to reality. Pfleiderer (2013) page 13.

\textsuperscript{22} In Romer’s words: “1. Economist \textit{N} did \textit{X}. 2. \textit{X} is wrong because it undermines the scientific method.”

\textsuperscript{23} Sorensen (2017) page 106.
them with false conclusions, is to use mathiness on them, and it is to deceive them. When we include secondary assertions into what can be considered an assertion, we find that using mathiness is not only deceiving, it is also fulfilling the standard definition of lying. From this we can conclude that there are lies in several popular articles published in the area of Economic Growth theory, and since these articles have passed through peer reviews there is reason to believe there is a widespread acceptance of the use of mathiness in that area.

There is still no easy way to find out the true intentions of any one researcher, and to know for certain if they simply made bad mistakes or if they are intentionally publishing bad research. From going through what kind of arguments should be considered mathiness, and from what kind of deception mathiness is, we can conclude that the method of using mathiness in one's research has no place in a scientific community that strives towards objective and useful truths.

I end this thesis with a quote from Romer:

“If someone uses math the way that Newton did, the math will be clear and the words will be precise. If someone is incapable of using math this way, they should not be allowed to use it at all.”\textsuperscript{24}

\textsuperscript{24} Romer (2018).
References


- Dudenhefer, Paul “Writing about data”, a handout to economist students, 2006.


