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# Reactivity in Economic Science

## Abstract

There is a fundamental difference between the natural and the social sciences due to reactivity. This difference remains even in the age of Artificially Intelligent Learning Machines and Big Data. Many academic economists take it as a matter of course that economics should become a natural science. Such a characterization misses an essential aspect of a social science, namely *reactivity,* i.e. human beings systematically respond to economic data, and in particular to interventions by economic policy, in a foreseeable way. To illustrate this finding, I use three examples from quite different fields: Happiness policy, World Heritage policy, and Science policy.

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## *I. Economics as a Natural Science?*

Many academic economists, among them very famous ones, take it as a matter of course that economics should become a natural science. It is *the* great example to be followed as strictly as possible with respect to rigor, model orientation and the use of mathematics[1].
This view has a long history, as exemplified in the "Scoping Paper for the Symposium concerning Economic Objects and the Objects of Economics" (January 2017). Thus, in 1792 Condorcet explicitly claims that the social sciences should imitate the physical sciences. So does Edgeworth in 1881. That this still holds today is shown by Gregory Mankiw (2018, 8th edition: 20) who in his leading textbook *Principles of Economics* states:

" Economists… approach the subject of the economy in much the same way as physicists approach the study of matter … they devise theories, collect data and then analyse these data in an attempt to verify their theories".

I will argue in this contribution that such a characterization misses an essential aspect of a social science, namely *reactivity,* i.e. that human beings, acting alone or in groups, systematically respond to economic data, and in particular to interventions by economic policy in a foreseeable way. Individuals do not passively accept what economists suggest on the basis of economic theory and econometric analysis. Rather, they react and therewith transform the data. It follows that "data" are not just "given" but they will be subject to the manipulation by human beings. (The term "data" is indeed a misnomer; it is the plural of "datum", the Latin word for "given". As people react and transform and manipulate the data, they are not given). This means that – unlike in the natural sciences – it is not (generally) possible to make reliable predictions. Even with the advent of Big Data, economic forecasts do not improve in precision but, if anything, get worse.
The crucial importance of reactivity for economic policy is discussed using three examples from quite different fields: Happiness policy, World Heritage policy, and Science policy. These examples are generalised, pointing out that the reactivity effects may have quite different consequences for society.
The insights gained suggest a much different approach to economic policy, which will be shortly sketched.

## *II. Reactivity: Economics as a Social Science*

Reactivity is a fundamental feature of any social science (see e.g. Espeland and Sauder 2007) including economics; it has in particular been noted in finance (e.g. Soros 2013 who uses the term "reflexivity"). Individuals are not passive human beings accepting economic, political or social conditions, and in particular they react to interventions coming from outside, such as by governmental policy. This insight is, of course, not new at all. After all, game theory has been developed to explicitly take into account that people react to each others' actions and to other external influences. Even a "stable" equilibrium among actors shifts if exogenous conditions

[1] There are, of course exceptions. A notable and most recent one is by Ariel Rubinstein (2017), himself a leading and highly mathematical game theoretician. He strongly attacks the over-mathematics in economics both with respect to educating students and undertaking research. It should be immediately added that such a critique has a chance to be published in a top academic journal only by a mathematical scholar, i.e. outsiders would be considered to be incompetent to judge.

change, for instance, if there is a natural disaster or a terrorist attack not taken into account in the model.
Surprisingly enough, reactivity is largely disregarded even in modern economics though game theory has partly been developed by an economist (Oscar Morgenstern) and is part of the curriculum every economics student has to learn. But as the citation above from Mankiw's (2018) textbook shows, reactivity is largely disregarded. Indeed, Mankiw speaks of the (passive) "matter" rather than of (reacting) *human beings* one has to study.

The difference between the natural sciences and the social sciences can be well demonstrated for the case of predictions. When a forecast is made, nature does not react but human beings often do[2]. Thus, when meteorologists *correctly* predict[3] that there will be a heavy and destructive storm, nature does not *therefore* change its course. In contrast, people have an incentive to change their behaviour so that the effects of the heavy storm will be mitigated or do not occur at all. The prediction of a destructive effect then does not occur. In this sense, the prediction was self-destructing. There are also self-fulfilling predictions, for example when somebody indicates that a bank will have problems meeting its obligations in the future. Even if that prediction as such is unfounded, it tends to induce people to withdraw their holdings with the bank, which in turn may lead the bank to not being able to fulfil its obligations (see already Venn 1888, Morgenstern 1928, Merton 1936). The bankruptcy of that bank may lead to a general banking crisis and to an economic downturn. Such a development demonstrates that in the social sciences reactivity must be an essential element of the analysis.

The adherents of the Big Data movement are convinced that predictions will generally greatly improve with the huge amount of data now available (in particular due to the Internet of Things, see e.g. Pentland 2014). In a joint study with Reto Cueni (Cueni and Frey 2014) we empirically show that this claim is mistaken: Using more and more data only improves the forecasting quality of natural phenomena but not the quality of forecasts dealing with human action and reactivity. We compare the predictions of the weather in six different Swiss cities with the predictions made by analysts about profits of companies represented at the two largest American stock exchanges (NYSE and NASDAQ) as well as to predictions of art experts for the selling prices of Chinese art at auctions. Each data set covers the period of 12 years, from 1999 to 2010. The precision of the predictions is measured by the yearly median of the absolute prediction error as a per cent of the actual outcome. We find that the forecasting error for the weather continually (and in a statistically significant way) falls over time. The prediction of this natural phenomenon improves due to more and better data as well as to better forecasting models. On the other hand, the predictions of future firm profits and auctions prices for Chinese art do not improve over time. Indeed, if anything, the forecasting errors tend to increase over time (though not in a statistically significant way). The reason is that people react to the forecast. If prospective buyers of Chinese art believe that the future

[2] The emphasis is on the reactions by human beings. This is different from the observer effect in physics proposing that observing a situation or phenomenon necessarily changes that phenomenon. For example, it is impossible to see an object without light hitting the object, and causing it to emit light. The object experiences a change.

[3] Metereologists do not always correctly predict the weather because this is extremely difficult to do. Moreover, at least local weather forecasters are sometimes pressured by interest groups (tourist and sports industry) to predict better weather than they objectively believe to be true in order not to prevent people to visit leisure resorts and sports events. It may even be that the weather is influenced when a lot of people are induced to use their cars and therewith pollute the environment. The same view is expressed by Róna (2017).

auction prices will rise to the extent predicted, they attempt to already buy now, or turn to other art. Such reactivity has a significant effect on prices, often totally changing the outcome originally predicted. Indeed, it is the purpose of forecasts of economic downfalls to muster reactions such that the unfortunate outcome does not come true.

## *III. Relevance of Reactivity for Policy*

The dependence of the social sciences on the reactivity of human beings is of great importance and should not be considered an irrelevant difference to the natural sciences. This will be illustrated with three policy areas: Happiness policy, World Heritage policy, and Science policy.

### A. Happiness Policy

Modern happiness research has been jointly developed by psychologists and economists (for surveys see e.g. Kahneman et al 1999, Lane 2000, Easterlin 2002, Frey and Stutzer 2002, Layard 2005, Frey 2008, Stutzer and Frey 2010, Frey et al 2014, Helliwell 2015, Helliwell et al 2017, Clark et al 2016, Ims 2017). It differs basically from happiness research undertaken over centuries by philosophers by its empirical orientation. The most important measure of happiness is subjective life satisfaction where a representative group of persons are asked: "Taken overall, how satisfied are you with the life you lead?" Careful research has established that the answers to this question are quite reliable as they correlate systematically with features normally attributed to happiness, such as being open, social and optimistic, having few problems at the work place, being less in psychic care, and committing less suicide attempts. The results of these surveys are analysed with advanced econometric methods, also taking into account effects of reverse causation[4].
Some of the insights of empirical happiness research correspond to common sense expectations, such as that higher income, more favourable personal relationships, better health, and living in a democratic and decentralized polity raises subjective well-being[5]. Other results are more surprising, for instance that the self-employed – who work longer hours, have to carry higher risk, and on average get a lower income – are happier. According to standard economic theory more money and leisure always contribute to utility. Empirical studies on well-being suggest that the opposite also holds. Those giving money to other persons, or engaging in voluntary unpaid work are more satisfied with their lives than those persons giving less or nothing to others. Many people also believe that artists must be unhappy in order to have an impetus to be creative. Empirical research suggests that this is not the case. Artists are happier than other persons mainly due to the greater autonomy in work they enjoy (Steiner 2017).

The happiness, or subjective well-being, scores collected from individuals may be aggregated to the country level. This allows us to compare countries according to the (average) happiness level of their population. Accordingly, the UN yearly publishes a "Ranking of Happiness". The newest "World Happiness Report 2017" lists 155 countries. The happiest are Norway, Denmark, Iceland and Switzerland; the unhappiest Syria, Tanzania, Burundi and the Central

[4] For instance, persons in good health are happier, but happy people are less prone to fall prey to contagious diseases.
[5] Though there are still people who believe that persons living in developing countries are happier than those in developed ones, presumably because they are thought to be less affected by stress. All serious empirical evidence rejects this view.

African Republic. The United States are ranked 14, Germany 16, the United Kingdom 19, France 31, Spain 34, and Italy 48.
The possibility to measure happiness as a proxy for social welfare has led a number of leading scholars in the field (such as Lord Richard Layard, John Helliwell, or Jeffrey Sachs) to propose that governments should maximize the happiness of the population. This idea fulfils an old dream in economics of "quantitative economic policy" as envisaged by Theil (1964) and Tinbergen (1956). Several countries follow this advice. Best known is Bhutan (who did so considerable time ago), France, Germany and the United Kingdom. The idea is that governments should undertake policies on the basis of the insights of happiness research, for instance with respect to health, education, culture, or sports.

Such an approach disregards reactivity. There are two reactions, which undermine the idea that governments should maximize happiness (Frey and Stutzer 2012, Stutzer 2017). First, the persons asked about their subjective happiness have a strong incentive to respond strategically. In particular, if a respondent is a strong left-winger and the government is right wing, he or she has a tendency to report a lower level of happiness than in reality in order not to honour the despised government politicians. The reverse is likely to happen for a right-wing person under a left-wing government. Second, the politicians in power have an incentive to manipulate the aggregate happiness indicator in their favour. Everyone knowing some statistics is well aware that this is quite easily possible.

As a result, the results of the happiness surveys do no longer reflect "reality" and are no longer dependable as a guide to policy. The reactivity induced by the goal of maximizing an aggregate social well-being indicator does not only distort reality but even provides politicians with new instruments to deceive citizens and to remain in power.

### B. World Heritage Policy

The UNESCO is engaged in the laudable goal to protect the common heritage of mankind. There is now a list of approximately thousand sites, mostly monuments, which should be protected against demolition and damage (see e.g. Frey and Steiner 2011). The sites included in the list are publicized both by UNESCO and the media, and they bear a sign officially indicating this honour.
Again, reactivity has not been taken into account. Unfortunately, in several wars and internal rebellions these sites have been attacked and partly or even wholly demolished *exactly because* they are part of the officially acknowledged heritage of mankind. Thus, in the Balkan War, the city of Dubrovnik was shelled in order to impose the highest possible damage to the adversary. The so-called "Islamic State" undertook a similar action in Palmyra. In 2001, the Taliban destroyed the world's tallest Buddha statues, which towered over Afghanistan's Bamiyan Valley for centuries. Thus, totally against the intention of UNESCO, reactivity has in this respect led to extremely bad consequences.

### C. Science Policy

Science policy today strongly relies on rankings based on publications and citations. Individual scholars, universities and other research institutions are ranked according to this measure[6]. This is a rather new development. In former times nobody would have thought to rank Newton, Kant or Einstein on the basis of such measures. They were considered great

[6] These measures are most doubtful and should, in fact, not be used. See e.g. the International Mathematical Union (2014), or the extensive discussion in Osterloh and Frey (2015).

scholars because of their contributions to science, which were identified in term of *content*, not of the number of publications or citations.
Here again reactivity undermines this policy. Individual scholars adapt by publishing as much as possible, and by driving up the number of citations by implicit or explicit cartels with colleagues. At the level of scientific institutions reactivity is also very strong because the amount of money received by the state and other sponsors depends on the rank. King Saud University improved its rankings by *several* hundred positions by offering a honorarium of 50,000 Euros to prolific and famous scholars if they indicate Saud University when publishing (Bhattacharjee 2011). In China a fully developed market for authorship in renowned scientific publication emerged. For 10,000 Euros one can claim main authorship in such a journal (Hvistendahl 2013).

## *IV Generalizing the Reactivity Effect*

In each of the three policy areas here discussed – happiness, world heritage and science policy – reactivity plays a major role, setting the social sciences apart from the natural sciences, and leading to unfortunate outcomes. There are, of course, many other areas in which reactivity works in an unexpected direction, for instance in the form of crowding-out effects (Frey 1997).

There is a serious *counterargument* to this view:
The social sciences must take reactivity into account in a calculated way. In that case the difference between the natural and social sciences disappears because the reactions of individuals and organizations to an intervention are included in the model. It is claimed that this procedure is enabled by the great progress made using an "Ultimate Learning Machine" built on a "Master Algorithm" (Domingos 2015). It would also allow producing precise forecasts with Big Data.
A valiant attempt to take into account reactivity has been undertaken by entertaining the idea of "rational expectations" (Muth 1961, Lucas 1976). However, the concept today has been strongly questioned (Blinder 1998, Frydman and Phelps 2013). Most importantly, rational expectations theory does not, and cannot, include human creativity being able to react in new and unexpected ways.
I consider the idea to take reactivity into account in a calculated way to be unreachable – at least in the foreseeable future (which we have to deal with). There are three major reasons why the counterargument does not hold:

1. A game theoretic model would be required which takes into account all reactions by all relevant actors. Even if such a huge and complete model could be constructed, it remains open if an equilibrium exists and if it is stable, i.e. whether there is a situation in which no actor has an incentive to deviate from his or her individually optimal strategy.
2. A model meeting the requirements of the natural sciences must be able to account for the many different perceptions people form when confronted with an intervention. Such interpretations are important for predicting the reactions, but they are difficult or impossible to anticipate because they may be formed due to very specific conditions and states of mind.
3. It seems impossible to foreseen all kinds of reactivity. Human beings often exhibit immense creativity to react to outside interventions. Innovative reactions are by definition not predictable – not even by a "Master Algorithm" – because they would otherwise have already been used. Whether a learning machine can foresee such creative reactions boils down to how innovative human beings are considered to be. In

> my view they are creative and able to find completely new ways to react. If this were the case, not even a very extensive game theoretic model would suffice.

The effort to have an "Ultimate Learning Machine" to completely solve social issues in the same (mechanistic) way as done in natural science paradoxically leads to a stronger emphasis on human behaviour and social relationships. If the world of learning algorithms wants to make progress in the direction of the natural science, reactivity must be fully understood: the type of reaction, its direction, strength and speed. I argue that this is an impossible task for the problems with which we are currently faced.

A totally encompassing model of society seems impossible. Rather, this idea follows the lead of technocratic social planners whose complete error was dramatically exposed by the breakdown of the socialist planning models in the Soviet Union and elsewhere. Technocrats (such as Domingos 2015) have to believe in the almighty power of algorithms. They will certainly much change our societies but it most doubtful whether they can adequately deal with creative reactivity.

## *IV Conclusions*

I propose that there is a fundamental difference between the natural and the social sciences due to reactivity. I submit that this difference remains even in the age of Artificially Intelligent Learning Machines and Big Data.

This view requires a different policy approach from governments claiming to maximize social welfare in the form of happiness. What is needed are basic constitutional provisions, or "rules of the game", decided behind the veil of ignorance (as suggested by Buchanan and Tullock 1962, Brennan and Buchanan 1985, Mueller 1996). Economic researchers, in particular those dealing with happiness, can inform the citizens about the relationships they have identified. On that basis, they may propose policies in which both their advantages and disadvantages are carefully communicated. It must then be left to the individuals as citizens how they evaluate these options. It seems impossible that a machine implanted in our brains is able to perform that task – and if so, we are in a world of machines and not of human beings.

## *References*

Bhattacharjee, Yudhijit (2011). Saudi Universities offer Cash in Exchange for Academic Prestige. *Science* 334(61):1344-1345.

Blinder, Alan S. (1998). Central Banking in Theory and Practice. Cambridge MA: MIT Press.

Brennan, Geoffrey and James M. Buchanan (1985). *The Reason of Rules. Constitutional Political Economy.* Indianapolis: Liberty Fund.

Buchanan, James M. and Gordon Tullock (1962). *The Calculus of Consent. Logical Foundations of Constitutional Democracy.* Ann Arbor: University of Michigan Press.

Clark, Andrew, Sarah Flèche, Richard Layard, Nattavudh Powdthavee, and George Ward (2016). Origins of Happiness: Evidence and policy implications, *VOX CEPR's Policy Portal*, December 12.

Cueni, Reto and Bruno S. Frey (2014). Forecasts and Reactivity. *CREMA Working Paper, Center for Research in Economics, Management and the Arts*, No 10-2014.

Domingos, Pedro (2015). *The Master Algorithm. How the Quest for the Ultimate Learning Machine Will Remake Our World.* London: Penguin.

Easterlin, Richard A. (ed.) (2002). *Happiness in Economics*. Cheltenham: Edward Elgar.

Edgeworth, Francis Ysidro (1881). *Mathematical Psychics: An Essay on the Application of Mathematics to the Moral Sciences*. London: C. Kegan Paul & Co; reprinted New York: A.M. Kelley, 1967.

Espeland, Wendy Nelson and Michael Sauder (2007). Rankings and Reactivity: How Public Measures Recreate Social Worlds. *American Journal of Sociology* 113(1): 1-40.

Frey, Bruno S. (1997). Not Just For The Money. Cheltenham, UK and Brookfield, US: Elgar.

Frey, Bruno S. (2008). *Happiness: A Revolution in Economics.* Cambridge MA: MIT Press.

Frey, Bruno S., Jana Gallus, and Lasse Steiner (2014). Open Issues in Happiness Research. *International Journal of Economics* 61(2): 115-126.

Frey, Bruno S. and Lasse Steiner (2011). World Heritage List: Does it make sense? *International Journal of Cultural Policy* 17(5): 555-573.

Frey, Bruno S. and Alois Stutzer (2002). *Happiness and Economics: How the Economy and Institutions Affect Well-Being*. Princeton und Oxford: Princeton University Press.

Frey, Bruno S. and Alois Stutzer (2012). The Use of Happiness Research for Public Policy. *Social Choice and Welfare 38(4): 659-674.*

Frydman, Roman and Edmund S. Phelps (2013). Which Way Forward for Macroeconomics and Policy Analysis? In: Roman Frydman and Edmund S. Phelps (eds), *Rethinking Expectations. The Way Forward for Macroeconomics*. Princeton: Princeton University Press: 1-45.

Helliwell, John F. (2015). The Economics of Happiness. NBER Reporter 14(2).

Helliwell, John F., Richard Layard, and Jeffrey D. Sachs (2017). *World Happiness Report*. New York: Sustainable Development Solutions Network.

Hvistendahl, Mara (2013). China's Publication Bazaar. *Science* 342(6162): 1035-1039.

Ims, Knut J. (2017). Happiness and Human Flourishing. In: Peter Róna and Laszlo Zsolnai (eds), *Economics as a Moral Science*. Cham: Springer: 79-94.

International Mathematical Union (2014). Recommendation on the evaluation of individual researchers in the mathematical sciences. Endorsed by the IMU General Assembly on August 10, 2014.

Kahneman, Daniel, Ed Diener, and Norbert Schwarz (eds.) (1999). *Well-Being: The Foundations of Hedonic Psychology*. New York, NY: Russell Sage Foundation.

Lane, Robert E. (2000). *The Loss of Happiness in Market Economies*. New Haven and London: Yale University Press.

Layard, Richard. (2005). *Happiness: Lessons from a New Science*. New York: Penguin Press.

Lucas, Robert E., Jr. (1976). Econometric Policy Evaluation: A Critique. In: Karl Brunner and Allan H. Meltzer (eds). The Phillips Curve and Labor Markets. New York: Elsevier: 19-46.

Mankiw, N. Gregory (2018, 8th edition). *Principles of Economics*. Boston, MA: Cengage Learning.

Merton, Robert K. (1936). The Unanticipated Consequences of Purposive Social Action. *American Sociological Review,* 1(6): 894-904.

Morgenstern, Oscar (1928). *Wirtschaftsprognose: Eine Untersuchung ihrer Voraussetzungen und Möglichkeiten*. Berlin: Springer.

Mueller, Dennis C. (1996). *Constitutional Democracy.* New York: Cambridge University Press.

Muth, John F. (1961). Rational Expectations and the Theory of Price Movement. *Econometrica* 29(3): 315-335.

Osterloh, Margit und Bruno S. Frey (2015). Ranking Games. *Evaluation Review*, 39(1): 102-129.

Pentland, Alex (2014). *Social Physics*. New York, NY: Penguin.

Róna, Peter (2017). *Objects of Nature and Objects of Thought*. Mimeo, Blackfriars Hall, Oxford University.

Rubinstein, Ariel (2017). Comments on Economic Models, Economics and Economists: Remarks on *Economics Rules* by Dani Rodrik. *Journal of Economic Literature* 55(1) (March): 162-172.

Soros, George (2013). Fallibility, Reflexivity, and the Human Uncertainty Principle. *Journal of Economic Methodology* 20(4): 309-329.

Steiner, Lasse (2017). Artists Are Poor and Unhappy. In: Bruno S. Frey and David Iselin (eds). *Economic Ideas You Should Forget.* Cham: Springer: 135-136.

Stutzer, Alois and Bruno S. Frey (2010). Recent Advances in the Economics of Individual Subjective Well-Being. *Social Research* 77(2): 679-714.

Stutzer, Alois (2017). Governments Should Maximize the Happiness of the Population. In: Bruno S. Frey and David Iselin (eds). *Economic Ideas You Should Forget.* Cham: Springer: 145-146.

Theil, Henry (1964). *Optimal Decisions for Government and Industry.* Amsterdam: North Holland.

Tinbergen, Jan (1956). *Economic Policy: Principles and Design.* Amsterdam: North Holland.

Venn, John (1888). *The logic of chance: an essay on the foundations and province of the theory of probability, with especial reference to its logical bearings and its application to moral and social science, and to statistics* (third ed.). London: Macmillan.