

# Serendipity or Singularity: Endogenising Infinite Returns on Education

Natalie Lubenets

*European Commission, Rue de la Loi 200, B-1049 Brussels, Belgium*

*e-mail: Natalie.Lubenets@ec.europa.eu*

## Abstract

While education has been accepted as an important determinant of well-being, the empirical evidence on the impact of studying economics has been mixed. In this paper, the issue of measuring the impact of investment in economics education is addressed in several steps. First, based on the argument by Skidelsky (2015), the time-invariant model is proposed that allows estimating returns on studying economics. Second, the values of possible returns are estimated in the context of the economics studies offered in 1996-2000 at Tallinn University of Technology. Third, the behavioural properties relative to returns are established and suggestions are made to estimate returns using the acknowledged assumptions and proxies. The main novelty of the present approach is the combination of mathematical reasoning and retrospection. It is shown that returns on economics education will always be positive. It is shown that endogenous parameters may be relevant for assessing the overall impact of such education, and it is suggested that until the nature and properties of singularity and serendipity are explained, the returns on economics education cannot be measured.

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“Whether you can observe a thing or not depends on the theory you use”  
*Albert Einstein*<sup>1</sup>

## 1. Introduction and Discussion of Method

Discussing reforms of economics teaching, Skidelsky (2015) argues that the economic discipline must acknowledge that its approach developed since the 18th century has not been rigorously scientific because it has contradicted its own claim on scientific method. Reviewing the history of economic thought, Skidelsky shows how the economics profession has been influenced by the political environment and the evolving state of knowledge. Skidelsky claims that all economic laws are contingent and contextual and that whether economic ideas are successful or not depends on the structure of power. Consequently, the economics discipline is established as being endogenously deterministic. Skidelsky argues that economics teaching should be reformed in order to ensure relevance and usefulness of economics.

The point about deterministic features of economics is easy to illustrate. One could argue that the mainstreaming of Keynesian economics may have been driven, facilitated, or amplified by the parallel developments in statistics and national accounting as well as by the socio-political reality of the Great Depression. The methods of acquiring knowledge about such reality were themselves influenced by the development of technology, in turn conditioned by past policy choices and, among others, random factors that usually remain not or not fully captured in models. For example, one could argue that possible influences on the history of economics can be traced back to the mathematical innovations by Lagrange and Leibniz<sup>2</sup>, or to the formalisation of calculus and the preceding systematisation of the mathematical knowledge in the 17<sup>th</sup> century. One could go even farther and consider the impact of the introduction in Europe of the Arabic numerals<sup>3</sup>.

Skidelsky (2015) argues that the economics teaching has become insidious and dogmatic. He identifies the following five “what’s wrong with economics” of relevance for economics education: a) unrealism of assumptions made for convenience where some views on how reality is are intentionally not in focus; b) equilibrium thinking postulating that there is a meaningful equilibrium state of reality which can be defined although the equilibrium concept is not confirmed by modern physics<sup>4</sup>; c) methodological individualism, which assumes that economic agents behave in a predictable way and make decisions based on prices and known utility functions; d) a monoculture that excludes pluralist views and consequently comes across as doctrinaire; e) formalisation, which arguably resulted from over-reliance on mathematics. Skidelsky argues in favour of putting less focus in the economics curricula on maths and more focus on economic history, the history of economic thought and socio-

<sup>1</sup> Objecting to the placing of observables at the heart of the new quantum mechanics during Heisenberg’s 1926 lecture at Berlin

<sup>2</sup> “The principle of least action” can be attributed to Leibniz although formalisation of the concept was done by Lagrange, as explained by Witten (2015). It is possible to demonstrate how the understanding about physical reality enshrined in the principle may have been internalised by economists in developing the logic of rational behaviour and choice.

<sup>3</sup> The Arabic numerals were introduced when Al-Kwarizmi’s work on elementary algebra was translated into Latin in the 12th century. (Encyclopaedia Britannica, 2016). To measure the impact, one can estimate the number of Arabic numerals reproduced annually in Europe since the 12th century and contrast this with the total of ten digits.

<sup>4</sup> For example, the principle of equivalence can be shown to be in contradiction with quantum mechanics (see Penrose (2015)) and is also challenged by some theories in cosmology.

political history, since the role of history is a reality check. He concludes that, unless the economics education is reformed, the discipline is not sustainable in its present form and risks becoming useless.

The arguments by Skidelsky (2015) are taken forward in this paper. Section 2 proposes a model of function of returns on education in economics. Section 3 establishes possible values of the returns for a special case of a bachelor degree at the Tallinn University of Technology (TUT) in 1996-2000. The method adopted for estimating values is retrospective. This approach is justified considering that the selection of the case was objectively unbiased and the selection can be understood as representing any of the graduates of the TUT economics department in the given period. In Section 4, the insights derived from the special case are generalised using the axiom of choice and transfinite induction. It is shown in Section 5 how the unbiased retrospective approach may enrich the current state of knowledge about the effects of investment in economics education, helping to understand the validity of common assumptions and proxies. Section 6 draws conclusions.

## 2. The Model

Skidelsky (2015) argues that there are five answers to the question “what’s wrong with economics”. Here those five features are modelled as returns function  $y = f(a, b, c, d, e)$  where  $a$  is unrealism of assumptions,  $b$  is equilibrium thinking (based on analogies with physics),  $c$  is methodological individualism,  $d$  is monoculture, and  $e$  is formalisation.

Skidelsky postulates that  $a, b, c, d$  and  $e$  are positive values attributable to the modern economics discipline<sup>5</sup>. Note that the model is time-invariant. Skidelsky argues that if he is right, there are no positive returns on economics education because then economics would have no claim for authority and become useless. The two possible outcomes for economics would be the “exit” (economics would cease to be) or “voice” (a change in the factor of endogeneity and evolution of the discipline).

The following section applies the model to derive a special solution for the function of returns. It also provides a framework to understand the factor of endogeneity, refining the argument of Skidelsky.

## 3. Special Solution

Consider the economics department in the late 1990s when the macro-economic policy context was defined by the Estonia’s accession to the EU. This section derives the confidence perimeter for special solutions of the function  $y_t = f(a, b, c, d, e)$ , where  $y_t$  is the returns function on economics education in Tallinn University of Technology (TUT) economics department during EU accession proceedings<sup>6</sup>.

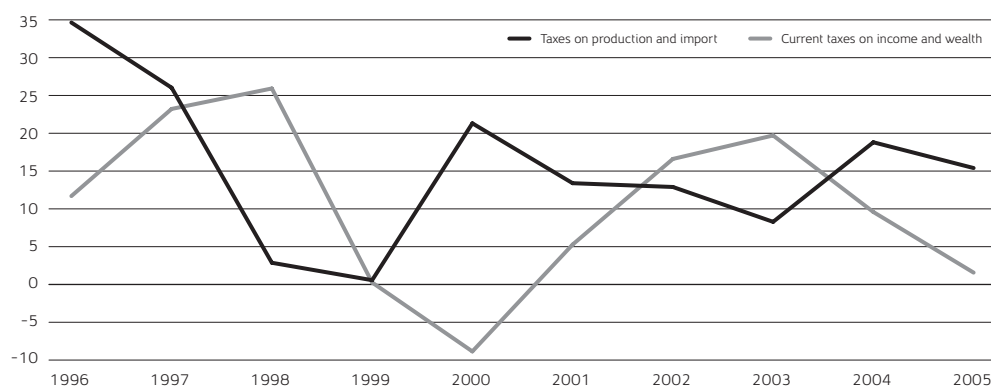
<sup>5</sup> By building on the assumptions expressed by Skidelsky, the author addresses the allegation that economists use assumptions for convenience excluding extraneous elements. In other words, the starting point in this paper is not the author’s views but precisely the problems others have identified as important (3’20”-4’30”): <https://www.youtube.com/watch?v=6rXBBqMmIP8>.

<sup>6</sup> Subscript  $t$  refers to the returns on bachelor education offered by the TUT faculty of economics in 1996-2000. The accession proceedings formally started on 31 March 1998 (European Commission (2016)).

The introspective approach brings to the surface the contextual evidence to establish values for parameter  $a$ . Principles of economics at TUT were taught on the basis of textbooks by Kerem et al. (1996, 1998). The main economic concepts were introduced historically, the modelling logic was clearly explained, points were illustrated with graphs. Such exposition was itself a salient example of the limitations of models as proxies of reality. In the Estonian context, Latin expressions are rarely used and therefore when used, they attract attention. The famous *ceteris paribus* is an expression that stood out in the economics textbooks. The many uses of *ceteris paribus* can push back the claim that economists educated in the TUT economics department were unrealistic about their assumptions. The presentation made it clear that assumptions were there as simplifications. In other words, the proposition that  $a$  is positive is not confirmed for the case of economics department in TUT; it is found that  $a$  can have any value below zero.

As regards the equilibrium thinking, the economic reality in Estonia in the late 1990s makes it possible quickly to falsify the proposition that equilibrium thinking might have been relevant in the policy context. The impact of changes in population dynamics, trade, perceptions and technology was too exotic and unpredictable to fit the equilibrium frame (see Graph 1 for an illustration of the contextual volatility).

Graph 1. Growth Rates of Tax Incomes in Estonia in 1996–2005



Source: Ameco data, European Commission

The pre-accession EU structural funds<sup>7</sup> were important to foster the economic convergence and catching-up, and it was required that rigorous methods were applied to estimate the potential economic effects of different types of structural EU investments. Since there was no “ready-made” economic framework to analyse transition, there was correspondingly no policy-relevant general equilibrium framework in use. The available solutions were calibrated (Bradley et al. 2001, 2003). Nevertheless, the economics department at TUT encouraged the use of different models and methods, including *inter alia* those provided in the general equilibrium framework. In other words,  $b$  belongs to  $(-\mu; \mu)$  where  $\mu$  is close to zero.

The argument that economics teaching at TUT could have been affected by the methodological individualism is not to be taken lightly. In fact, the claim could be verified in terms of both “levels” and “changes”. Therefore, it must be assessed whether  $c$  is likely to be positive, zero, or negative; and if the behavioural properties of  $c$  are static or dynamics.

<sup>7</sup> PHARE and ISPA were the main instruments for restructuring and structural policies for pre-accession (Mändmets, 2009).

In terms of levels, any attempt to assign a value to capture the impact of economics teaching on the worldview and mental frameworks of the economics graduates is inevitably subjective. Any graduate starts his or her journey in the university having studied history, physics, chemistry, biology, geography, etc. in high school. The introspective analysis shows that  $c$  is negative because thinking about the world was enriched, rather than limited, by discussing additional analytical frameworks used in economics. Since this special solution is random, as explained earlier, it is unbiased.

Nevertheless, to establish confidently whether  $c$  can be positive as suggested by Skidelsky, the value of  $c$  can be estimated with greater precision by combining qualitative and quantitative methods<sup>8</sup>. For example, it could be estimated by interviewing all relevant actors of and around the department asking them if and to what extent they thought they were taught to reason in terms of pricing and discounting individual behavioural choices, or in terms of maximising utilities of the stylised functions when they made choices to study or to work. In fact, the economics studies attracted many talented school graduates who were often both studying and working. In the overall context of volatility and uncertainty, it was unlikely that students were biased by one methodology, *ceteris paribus*, although it could be that their choices were indeed rationally individualistic. Inherently, however, they may have had biased perceptions. For example, if a student would understand ideas about individual decision patterns taught in the economics textbooks differently from how the authors of the textbooks intended, their thinking would then be biased.

This shows that the special explanation is always subjective, and the possible solution based on a combination of qualitative and quantitative methods presented above would in any case be only a subset of infinitely many possible explanations that cannot be objectively verified because verifying would require measuring the cogency of understanding, which is not yet possible. It is therefore concluded that the “level” of  $c$  cannot be determined in economics due to “pure endogeneity” and no possibility to validate the subjective views.

To control for any important omissions in the argument above, it is useful to consider the dynamic properties of  $c$ . Retrospectively, the changes in the curricula of the TUT economics department could be described as evolution rather than revolution, but it is true that the overall perception was that the curriculum needed more focus on quantitative methods<sup>9</sup>. This suggests that the value of  $c$  in the special case might have been below  $c$  median if  $c$  could be established.

Monoculture is defined by Skidelsky as the belief that there is only one right way to do economics. He argues that economics is a persuasive science that ultimately strives to be useful, and that it has grown into a limited number of schools of economics, which have developed successively and can be best understood in terms of interactions with the socio-political reality. Note that assigning a value to  $d$ , the faculty of monoculture, will always be epistemically objective even though the phenomenon itself can have elements of ontological subjectivity<sup>10</sup>. For example, for a Japanese student who could have studied in the TUT economics department in 1996-2000, the culture in the department might have indeed appeared as a monoculture due to the absence of many other foreign students or due to the contrasting reality as seen by Japanese. The culture might have appeared as foreign, plural, different or infinitely anything,

<sup>8</sup> The excellent course on qualitative methods in research was taught by Katrin Paadam as part of the PhD curriculum in economics at TUT in early 2000.

<sup>9</sup> According to the curricula, econometrics amounted to less than 3% of the total time-points that had to be accumulated to receive a bachelor degree.

<sup>10</sup> See the formalisation of this argument in Searle (2014).

but it is unlikely that its precise cognitive definition would be monoculture. The perception of culture is necessarily subjective and observer-relative, but there is only one objectively possible way to describe the perception: to explain it intentionally as it is perceived. Notice also that  $d$  may be easily postulated as being infinitely negative if it was assumed that  $d$  expresses a subjective perception that the reality in general is anything but a monoculture, *ceteris paribus*.

Turning to the parameter of formalisation, it is useful to recall that according to Skidelsky (2015), formalisation occurs due to economics curricula being too much focused on mathematics. Skidelsky proposes that formalisation may be 'remedied' by changing the standard curricula to teach more economic history and social sciences<sup>11</sup>. In this context, the value of the parameter of formalisation  $e$  can be determined by looking in retrospect at the standard bachelor curricula at TUT. In fact, 20% of the bachelor programme consisted of courses in history, psychology and social sciences which were a consequence of the natural evolution of the department, while only 7% was dedicated to maths. Therefore, staying strictly within the framework identified by Skidelsky (2015) it is reasonable to argue that the TUT economics department was not formalistic and it was not out of touch with reality by putting unduly strong emphasis on maths. Therefore,  $e$  did not exist in TUT if defined as postulated in Section 2.

To sum up, for  $y_t = f(a, b, c, d, e)$  where  $y_t$  is the returns function on economics education in TUT economics department in 1996-2000, the parameters are as follows:  $a$  can be any negative value;  $b$  is close to zero;  $c$  cannot be measured because it is purely endogenous;  $d$  will always be a subjective value and it was estimated as  $-\infty$ ;  $e$  is  $\emptyset$ .

Taking into account that the found values of the parameters  $a, b, c, d$ , and  $e$  are different from the values estimated by Skidelsky (2015), the returns  $y_t$  are found to be infinitely positive albeit subject to unmeasurable endogeneity.

Importantly, the analysis above made it possible to identify with some precision the factors of endogeneity in the function of returns: parameter  $c$  is a source of "pure endogeneity" because its value cannot possibly be assessed or estimated, and parameter  $d$  is a source of systemic endogeneity related to the system defining itself as culture<sup>12</sup>. These are two significant parameters because they show that value of education depends on non-observable factors that relate to individuals themselves (pure endogeneity) and to observer-relative and subjective understanding of culture of the system. In contrast to  $c$ ,  $d$  can be measured, but both  $c$  and  $d$  are factors of endogeneity.

## 4. Generalisation of the Special Solution

In this section, the special solution derived above is generalised using mathematics, namely the axiom of choice<sup>13</sup> and the method of transfinite induction<sup>14</sup>.

<sup>11</sup> Skidelsky (2015) recommends primarily expanding curricula with the branches of history of economics, history of economic thought and socio-political history. It is worth pointing out that in early 2000s, two similar outcomes – increased focus on history and less focus on maths – were arrived at by two different systems: the western universities had started to reform their established curricula in economics (the 'post-autistic movement') while in TUT the established curricula were being gradually altered and economic history, political science and sociology were important features of the teaching programme in 1996-2000. This means that broadly at the same time polar processes happened in reaction to idiosyncratic features of the economics teaching systems in Eastern and Western Europe. This suggests that the Eastern European models of economic teaching may be relevant for teaching experiments carried out today.

<sup>12</sup> See Lotman (2015) for discussion about the mechanisms of culture.

<sup>13</sup> See Encyclopedia of Mathematica (2010)

<sup>14</sup> The proof based on transfinite induction is inspired by Penrose (2015).

Postulate  $Y$  as a property of giving returns on economics education. Consider the estimated returns on economics education  $y_t$ . The value of  $Y_t$  will be given at a specific moment in time  $t^{15}$ . Suppose that  $Y$  needs to be established at any moment in time  $n$  such that  $t < n$ . Having accomplished the bachelor studies in economics, the value of  $Y$  becomes 'fixed' in time and property of giving returns on education  $Y_n$  follows from  $Y_t$  if no other economics education is obtained.  $Y_n$  would then be infinitely positive returns on economics education, as established in Section 3. Moreover, there can be  $\lambda$  such that  $t < n < \lambda$ , where  $\lambda$  denotes time when a second degree in economics is acquired. Given that the choice of economics departments is wide from the perspective of a single individual, the property of  $Y_\lambda$  follows from  $Y_t$  since values of  $a$ ,  $b$ , and  $e$  in the function  $y$  would be intrinsically determined by the earlier teaching (learning) experience.

Suppose  $\alpha$  and  $\beta$  denote systems such as universities which have departments of economics subject to  $y = f(a, b, c, d, e)$ , ordered according to the international ranking of the departments (in other words,  $\alpha$  and  $\beta$  are ordinals<sup>16</sup>). Postulate that  $y_t$  belongs to  $\beta$ .  $Y_\beta$  is a property of giving infinitely positive returns on economics because it was shown that  $y_t$  is infinitely positive returns.

Transfinite induction allows us to derive the value of  $Y$  for all ordinals from the true value of  $Y_\beta$  for any  $\beta < \alpha$  assuming that whenever  $Y_\beta$  is true for all  $\beta < \alpha$ , then  $Y_\alpha$  is also true. This can be derived from the original conditions of randomness: as shown above, the special case selection was unbiased. It can also be derived from the fact that the international university ranking is not an exact science.

Proof<sup>17</sup>:

1. It is obvious that the property of giving returns on economics education if no economics education was acquired is  $Y(0) = 0$  since no possible returns on economics education can be derived from having no economics education (zero case).
2. Suppose  $\alpha+1$  refers to the system  $\alpha$  containing one additional (marginal) student in the given department of economics  $\alpha$ . It is possible to show that  $Y_{\alpha+1}$  will follow from  $Y_\alpha$ : as demonstrated above, factors  $a$ ,  $b$ , and  $e$  can be factually established and they are observer-independent parameters of the function of returns that will remain unaltered for any additional student in the department. Hence,  $Y_{\alpha+1}$  follows from  $Y_\alpha$  (successor case). It is easy to see how the same will hold true for  $Y_{\beta+1}$  for any  $\beta < \alpha$ .
3. In the discussion above demonstrating the validity of the axiom of choice and showing that the model considered here contains well-ordered relations it was shown that there can be a limit ordinal  $\lambda$  such that  $Y_\lambda$  follows from  $Y_\beta$  for all  $\beta < \lambda$ . For completeness, note that  $\lambda$  is neither zero nor a successor ordinal and that whenever  $\beta$  is an ordinal less than  $\lambda$ , then there exists an ordinal  $n$  such that  $\beta < n < \lambda^{18}$ . In this case,  $Y_\lambda$  would be unknown but its

<sup>15</sup> Notice that notation  $t$  can be understood as simultaneously referring to economics education in TUT as considered in Section 3 and also as referring to any moment in time  $t$  when returns on economics education in TUT are estimated. If easier, in Section 4 one could substitute  $t$  with any alternative notation, for example  $t_1$ , where  $t_1 = t + \delta$  when  $\delta$  approaches zero. In author's view, the superposition of notation makes it easier to understand the method of transfinite induction.

<sup>16</sup> <http://www.oxforddictionaries.com/definition/english/ordinal>

<sup>17</sup> The proof follows the three-pronged method of transfinite induction, see Mints (2011) as well as an excellent Wikipedia entry ([https://en.wikipedia.org/wiki/Transfinite\\_induction](https://en.wikipedia.org/wiki/Transfinite_induction)). The three elements discussed in this sub-section are components the method, which requires to elaborate a zero case, a successor case and a limit case.

<sup>18</sup> The value of  $\lambda$  could have been any but suppose it was the department of economics at the University College Dublin.



property of giving returns would follow directly from  $Y_{\beta}$ , the past teaching experience being intrinsically deterministic.

Therefore, it is established by transfinite induction that  $Y$  is a property of giving infinitely positive returns for any ordinal number.

## 5. Alternative Approaches to Estimate Returns on Education

This section returns to the established economic framework to provide a contribution to the estimation of the returns on economics education empirically. Having demonstrated the absence of biases due to non-formalistic perspective taught in TUT economics bachelor curriculum, it would be logical to refine the previous analysis to identify more precise values of the returns function  $y_t$  where  $y_t$  is returns on economics education at TUT in 1996-2000.

The economics discipline has extensively analysed the economic effects of investment in education<sup>19</sup>. The theoretical growth literature emphasises at least three mechanisms through which education may affect growth. First, education can increase the human capital inherent in the labour force, which increases labour productivity and leads toward a higher equilibrium level of output (as argued in the neoclassical growth theories, cf. Mankiw et al. (1992)). Second, education may have endogenous effects on growth through an intrinsic increase in the innovative capacity, new technology, knowledge, etc. (see, for example, Romer (1990)). Finally, education can facilitate the diffusion and transmission of knowledge, which should have positive effects on growth.

Was the insight derived from the economics scholarship about the returns on education useful in the context of the Estonian socio-political reality during the EU accession? The answer is likely yes: that insight corresponded to the common sense (“the more one studies, the better off one gets”), and therefore the choice made by society was to invest in education.

At the same time, empirical evidence about the impact of education on economic growth has been mixed due to measurement problems. The econometric estimates require measuring the endogenous effects of investments in education since the existence of endogeneity in relation to education is widely accepted. The endogenous effects have been notoriously difficult to measure in practice essentially due to singularities that have to be controlled or accounted for. Usually, returns on education are estimated by including the quantity of schooling as an explanatory variable, the most common measure being years of schooling. However, this assumes that a year of schooling delivers the same increase in knowledge regardless of the education system and individual capacities and skills, as noticed by Hanushek and Woessmann (2010). It is easy to extend this argument: the value of a year of schooling depends on the individual characteristics of students as well as on individual’s understanding of the effects at the moment of measurement, the environment, and the interactions – and all that in an unpredictable ways. This is endogeneity as discussed in Section 3. Sometimes, the quality of education is proxied by the average mathematics or science scores obtained in various tests. This approach totally ignores the impact of cognitive or “soft” skills, which are not discussed in the present paper but can be shown to be acquired during the years of schooling and to be essential for understanding the impact of (economics) education.

On the output side, the effects have often been captured by proxies based on labour income or wealth. To conclude this section, three possible measurements are suggested if the value of

<sup>19</sup> The following discussion of the literature is based on Hanushek and Woessmann (2010).



yt were to be estimated precisely: 1) employment status after having completed the economics education at TUT (full employment at any subsequent moment of time); 2) wealth and income (derived from the factual information); 3) health and other qualitative indicators.

## 6. Conclusions

This paper contributes to the state of knowledge about returns on education by considering possible returns on education in economics. The analytical framework is based on Skidelsky (2015), where returns are modelled as a function of unrealism of assumptions, a general equilibrium framework, methodological individualism, monoculture, and formalisation.

It is shown that in the special case of the economics education at TUT in 1996-2000, the returns on education are estimated to be infinitely positive. If more conventional approaches established in the economic literature are used, the precise proxy estimates can be derived using the years of schooling, average grades in science and maths, and values for labour income, wealth, and employment status.

Besides providing a contribution to the state of knowledge about returns on economics education, the paper used retrospective method in relation to Skidelsky's argument about economics teaching. It is suggested that differences between education systems (Western and Eastern European economics education) as regards establishing standard economics curricula should be examined more closely. It is suggested that the apparently converging systems may have emerged independently. Looking at the Central and Eastern European teaching systems more closely can inform the ongoing education reform experiment supported by Skidelsky.

The generalisation of the special solution by transfinite induction demonstrates that giving positive returns will always be a property of any economics education although the precise value of returns is not possible to establish. That is to say, it is more relevant to accept some insights as common sense and turn to valorising those insights by focusing on the endogenous parameters related to culture and the individual. The method used in the paper is innovative for economics and therefore enriches the scholarship.

The main novelty of the paper is the refinement of the discussion about endogeneity. It is shown that returns on economics are indeed subject to intrinsic endogeneity, as widely accepted by the scholarship, but endogeneity can be understood in terms of both "pure endogeneity" and "systemic endogeneity". This in itself is a pluralist view derived from Skidelsky's proposition that economics is endogenously deterministic.

It is suggested that the impact of endogeneity on returns can be extremely large but the precise effects are unknown. In particular, the "systemic endogeneity" could not be defined on the basis of an agreed observer-independent reference frame, and therefore any estimated value has to be accepted.

It is shown that the value of "intrinsic" or "pure endogeneity" cannot be possibly established by economics. Arguably, properties of endogeneity in education are similar to quantum singularities in bifurcation points discussed by Prigogine and Stengers (1984), and it may therefore be appropriate if physics provided explanations about the properties of the observed "pure" endogenous parameter. Since education is based on interaction and dialogue, the singularities in education can be understood as serendipities.

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