Emergence and Selection in the Academic System

Sabine Hossenfelder

Perimeter Institute for Theoretical Physics
Waterloo, Canada N2J 2W9
Email: sabineperimeterinstitute.ca

Abstract

We investigate the emergence of macroscopic trends in the scientific community from the structure of incentives on the micro-level. After summarizing the factors of change that scientific research has been subject to in the last decades, we identify four sorts of pressure that put in place selective mechanisms. We discuss which strategies are favoured by this present organization of the academic system and what their drawbacks are. We end with recommendations for improvement.

1 Introduction

Science is a community enterprise. Based on an evolving educational system, we maintain and build a growing body of knowledge. The insights scientific research provides are what eventually allows us to shape our future, and drive progress. The availability and accessibility of necessary knowledge are essential to make this possible. This requires we pay special attention to both the internal organization of scientific research, as well as its embedding into our societies. The more knowledge, the more scientists, and the more complex our social systems become, the more of a challenge becomes the organization of the scientific endeavor. As we will argue here, the key to facing this challenge lies in scientific research itself.

In this paper we will characterize the changes scientific research has undergone in the last decades, and examine the challenges arising from this. We will argue that to meet these challenges, the process of knowledge discovery needs to be closer studied and insights be used in application. The academic system must be enabled to dynamically learn and adapt to the changes it is subject to.

2 Change

Without doubt – times are changing. And this change does not stop at the front door of the academic ivory tower. The last century was marked by an unprecedented pace in progress, most pronounced in the last decades through a rapid advancement in information technology and computational power. With this, also the procedures of scientific research have changed.

These changes go back to five major causes:

1. **The total number of scientists is increasing**
   The number of scientists is increasing not only because the world population is still growing, but also because more countries transition to knowledge economies and expand in higher education. This trend is not yet saturated and continuing still in the developed nations. In the USA, number of doctorate holders in science and engineering in the USA grew by more than a factor three from 1973 to 2006. More than 5.4 Americans work today in science and engineering, up from 3.3 millions a decade ago and from fewer than 200,000 in 1950 [1]. In the European Union (27 countries) the number of total researchers in higher education grew from 795,723 (0.165 %) in 2000 to 925, 294 in 2006 (0.188 %) . This means today almost 2 out of 1000 Europeans are researchers [2].

2. **More knowledge needs to be managed**
   With more scientists, we have also more publications, more data, more textbooks, and more websites that collect information and (attempt to) convert it into useful knowledge. To this we can increasingly add pictures, audio and video files. This abundance of information and increase of knowledge is especially challenging for our educational system that has to select the essential knowledge to be taught the next generation, and for the process of scientific publication necessary to organize and filter this knowledge.

3. **Information is easier accessible**
   Information has become much easier available due to online resources and powerful search tools. However, with this also our dependence on these search tools increased, which can cause a bias from selection through computer algorithms. Different ways to structure information that have become more fashionable during the last years are social tagging or reliance on recommendations made by people one knows (typically contacts on a friends list). This way of filtering of information is in some regards superior to impersonal search algorithms, but brings with it a potentially increased susceptibility to social effects that constitutes its own bias. There are further various possibilities to combine these options that are being actively explored.

4. **Better connected**
   The scientific community has become much closer connected on a global scale. Though face to face communication without doubt still has an advantage, it is today possible to collaborate with people in faraway places whom one has never met. But more importantly it has, thanks to social networking tools, become possible to find these people in the first place. The NSF reports that the share of worldwide articles in science and engineering that is coauthored increased from about 40% to 60% from 1988 to 2005, while international coauthorships alone increased from about 10% to 20% during the same period [1].

5. **Getting closer to the public**
   For better or for worse, science and scientists have gotten closer to the public. The maybe most impressive development is the open access movement through which

many scientific publications that formerly could be obtained only by costly journal subscriptions were made freely available online. Though these journals face the challenge of financing themselves by means other than subscription fees (most commonly author charges), meanwhile many are competing with established journals. Alongside this trend there has been the increasing use of Web2.0 tools, such as weblogs and online-forums, to communicate science on a popular level. Often written and maintained by active scientists themselves, this interaction with the public leaves out the journalist as the middleman. Most popular science magazines now offer additional content on the Internet with news and commentaries that are updated several times a day.

These technological developments have rapidly and significantly changed both the way science is done, as well as its communication to the broader public. The above identified changes need to be understood for knowledge discovery to function optimally. Fortunately, the very cause of these changes the rapid improvements in information technology also offer means to address these challenges. The issues to be considered can be divided into two categories: Those concerning the internal organization of scientific research, and those concerning its integration into the society. We will in the following focus our attention on the internal organization.

3 The Academic System

Though a lot of research occurs outside the academic system, we will here focus on the part of scientific research that is pursued in non-profit institutions which, next to research, have a mission to educate, either through teaching or public outreach. It is for this aspect of science the incorporation of knowledge into our societies and passing on insights to the next generation that a close understanding of the systemic properties, which we are concerned with here, is most crucial. In the following the term scientific community shell thus be used in this restricted sense. The question we will be asking is under which circumstances knowledge discovery works optimally, where optimally means with a most efficient use of human, financial and time resources.

Due to the changes we have identified in the previous section, the job of the scientists has acquired many new facets whose impact on the process of knowledge discovery is yet insufficiently understood and worse, also insufficiently studied. There are however noteworthy examples of case studies investigating these developments.

One aspect that has received a lot of attention in the last years, with the availability of open access journals, are traditional scientific publishing practices that have become subject of criticism. Ioannidis and Young [3] e.g. have examined the distortion of science through the process of publication. They argue that the necessity of a branding through getting published (preferably in high-impact journals) together with journals preferences for certain topics or criteria influences the presentation and performance of research results. The impact of the citation index and journal impact factor and their usage is an ongoing topic of discussion [4, 5], and Evans [6] examined whether electronic publishing has the effect to narrow scientists citation behavior. In a recent study Peters et al [7] investigated researchers interactions with the mass media, and Kempner [8] presented findings that provide evidence that political controversies can shape what scientists choose to study.

Though the first studies on scientific networks date back to the 1960s [9], with the increasing availability of data about scientists citations, collaborations, and coauthorships that by now date back into the beginning of the century, we have today the possibility to study in closer detail than ever before the process of knowledge discovery. With the rise of computational power, the field of scientometrics dedicated to the collection and classification of this data has become a tremendously useful source for studies of science itself. Redner [10] examines the distribution of the citation index, Chen [11] visualizes turning points and pivot points in cocitation networks. Newman [12] studies the starting advantage for early publications in new fields (the first mover effect) and the project Maps of Science[1] visualizes the relations between different fields of science, providing insights into interdisciplinary structures.

A central point to all these studies is the structure and dynamics of scientific networks, and the dissemination of knowledge and information through these networks. Missing however is an integrated attempt to connect these studies, and to practically implement the won insights in the organization of scientific research. What is needed is a systemic understanding. Much like economics aims to describe our economic system driven by actions of individuals engaging in production and trade of goods, we need to understand the basic principles of our academic system, driven by actions of individuals engaging in production of knowledge and trade of information.

4 We Have Only Ourselves to Judge Each Other

Systems with individuals who pursue interests and develop strategies that lead to emergent sociological dynamics can be found in many situations. For examples, see [13]. We will here focus on the academic system. The academic system too is constituted of individuals who pursue their own interests. The single researchers strategies on the micro-level should ideally lead to an optimal outcome. As in all other cases this requires the formulation of a primary goal, and that the system is set up appropriately such that developing individual strategies indeed lead to a desired trend. We will in the following discuss what the primary goal is, what the secondary criteria are, and whether the micro-macro link under the present circumstances leads to a desirable trend.

The essence of the scientific method is that in the end Nature judges on the success of a scientific research project. No matter what scientists liked or did not like, it is evidence that eventually decides which hypothesis is an accurate description of the world. And though this might be the case in the long run, in their daily lives researchers have to decide which approaches are worth being supported long before Nature had any chance to offer her judgment. The question scientists are thus facing is which ideas and which

[1] mapofscience.com

projects, both in theory and experiment, are worth being pursued and thus obtain the chance to mature sufficiently to be tested at all. We are here only concerned with the internal organization of science and thus asking how resources - time, human and financial - once allocated, can be used most efficiently. This most efficient use of resources is what we will consider the primary goal the system should be working towards. We will here not consider the allocation of these resources in the society.

The starting point that we will base our argument upon is that academic research is constituted of expert communities, and the only meaningful judgment on projects pursued within these communities can come from the experts themselves. It follows that any distortion of researchers interests that affects their objectivity works against the primary goal.

The most abundant distortions can be summarized as the following four sorts of pressure:

1. **Time pressure:**
   Time pressure has two aspects. For one, positions today are increasingly short-termed. Postdoctoral researchers and others in full-time nonfaculty positions constitute an increasing percentage of those doing research at academic institutions. In the USA, their share grew from 13% in 1973 to 27% in 2006, while the share of full-time faculty declined from 88% in the early 1970s to 72% in 2006, which shifts the weight towards scientists on short term contracts [1]. This creates incentives to work on topics that fit into these time-frames and to neglect more ambitious long-term projects.

   The second aspect is that scientists have many different responsibilities, and are expected to be all-rounders. They are not merely researchers and teachers, they are likewise managers, group-leaders, administrators, and frequent flyers. They write papers, organize conferences, give seminars, teach, sit through others seminars, couch students, write letters, referee manuscripts, write grant proposals and referee others proposals, maintain collaboration networks, fulfill various administrational duties, engage in public outreach, and somewhere at the end of the line, they have time to think. Time pressure is a common disease of our era, but especially for research which necessitates careful and coherent consideration this overload of diverse duties is highly disruptive and counterproductive.

2. **Peer pressure:**
   Especially in large communities with high competitive pressure, disagreeing with influential members in specialized fields can become an obstacle for the career. The increasing connectivity in the scientific community also supports a wider and faster spread of information and fads, and an amplification of trends through positive feedback. The people and topics everybody talks about are today much more streamlined than in a less connected network where information-exchange is stronger localized.

3. **Financial pressure:**
   Since financial incentives have become a common tool to influence peoples behavior,

it is of no surprise these tools are operating also on the academic system. The availability of financial resources directs interests through job opportunities and chances for grants. In many cases, successful application for grants has become a (written or unwritten) requirement for tenure, thereby exporting decisive power from hiring committees to funding agencies. Money is, without any doubt, very useful in influencing people. Its absence can set an end to research programs.

4. **Public pressure:**
   Public pressure too has two components. For one, scientists appreciate public recognition of their work. Public attention influences researchers decisions if they believe it to be relevant for future funding. Note that it is sufficient to influence priorities if scientists suspect it to be of relevance and act in response, not whether it is indeed relevant.

   Further, media coverage and popular science reporting affects the interests of the coming generation of scientists, about which researchers care. In both cases, the result of science getting closer to the public can thus lead researchers to report on their fields in an overly positive way.

How much these four pressures influence researchers decisions depends not only on the organization of academic research life which might vary from country to country, but also on the field.

5 Emerging Strategies

The four types of pressure form an environment that favors certain kinds of behavior and disfavors others. They present a selection mechanism in which some research strategies survive and others dont. Though these are not actually documented strategies, they are in practice passed on as well-meant advices from supervisors to students, among friends, and via online networks. These strategies are shared knowledge and familiar to most working in academic research. The problem is that this behavior beneficial for the individual in the short term does not automatically lead to a desirable outcome for science in the long run. In other words, we have a system set up such that the micro-interests do not result in a desired macro-behavior.

The most important favored strategies that can be identified are:

1. **Specialization:**
   Specialization into niches is a very general phenomenon one can observe also in ecological and economical systems. Similarly, social networks involved in knowledge discovery, such as scientific communities, typically self-organize into a cognitive division of labor, with divisions based on the deliberate exclusion of possibly relevant information, as Wilson points out [14]. Specialization is an advantageous strategy because it reduces competition. It is also a natural strategy in that the more knowledge there is, the earlier in ones specialization is necessary to contribute on the frontiers of current knowledge.

However, it has long been known that scientific breakthroughs often emerge from the connection of different areas (see Burt 2004 and references therein). Specialization further promotes the fragmentation of communities and renders communication increasingly difficult. Under such circumstances, the community enterprise of scientific research suffers from lacking integration of knowledge, and new insights can remain isolated in niches because their embedding into the larger context fails.

2. **Use of Shortcuts:**
   The adaptation of measures to judge on the value of a scientific idea fast and superficially, and to extend this judgment to its originator, can have damaging consequences. Time pressure and information overload favors the use of simplified criteria to assess peers and their work, both inside the community as also by funding agencies. This causes researchers to strive for secondary criteria used for such shortcuts. We will come back to this in 6.

3. **Marketing:**
   In our highly connected infotainment society, attention is a scarce resource, and scarcer even when under time pressure. This creates an incentive for researchers to adopt marketing tactics and advertise themselves and their work, both inside and outside the community. If left without attention, such behavior goes on the expenses of integrity, objectivity and honesty, much like in advertisements of consumer goods. Pointing out and discussing drawbacks and shortcomings is essential for the assessment of research projects, but if openness can result in a negative judgment of the researcher personally instead of a project, scientists risk their career with exactly that criticism (potentially self-criticism) essential for that vague primary goal "good science". In combination with large and specialized communities this can reinforce in in-group behavior [16] leading to lacking investigation of "known" problems.

These favored strategies endanger the ability of researchers to accurately judge on the promise of their area of research, which becomes problematic since this is in many cases the only judgment available. On the other hand, disfavored strategies are

1. **Broadness/Interdisciplinarity:**
   Obtaining a grant or being hired into a field of specialization requires often well documented prior knowledge in that same field. Though a qualification that lies at hand, its exclusiveness makes it very hard, if not impossible, for researchers to change fields or even subfields later in their career. They are in many cases judged not by their personal ability to do good research, but to have a good record in a very specific topic. This hinders scientists abilities to follow their interests and lowers successful cross-fertilization, which is an obstacle for free variation in the system. There is also little reward for communication and knowledge transfer between different areas, which is time not used for original research.

2. **Long-term and Risky Projects:**
   With the trend going towards short-term funding, long-term plans often have to

be abandoned to produce results within a given timeframe. This also lowers the tolerance of the scientific community for projects that potentially fail, or are not likely to produce results within the time period set by contracts or grants. The NSF acknowledged the need for such transformative research and defined it as research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies [17].

3. **Anything that does not fit in the Résumé:**
   And eventually, researchers have to pay attention to efficiency. That what cannot easily be accounted for and is of no obvious advantage for the next career-step often is abandoned. Peer review in journals is an example that currently suffers from the non-accountability of the referees effort. Public outreach and attending conferences outside the own field are also presently little acknowledged but important tasks.

It is an interesting question why these well known and often discussed obstacles to efficient knowledge discovery have not yet been addressed. One can identify several factors that hinder this correction:

1. **Survivor Bias:**
   Since the system has been operating in its present form for several decades, a large and increasing number of researchers are employed because they did well according to the applied selection criteria. They typically will have no reason to complain, and defend the system in its current form.

2. **Inertia:**
   It is hard to change habits. Any type of change needs effort, and especially when this means an effort to investigate matters that had not previously been considered necessary the attention, the desire to proceed without modifications weights strongly. This is even more so the case for systems with traditions, like academic research, that have gone a long time without a change in procedures.

3. **Social Values:**
   The academic system reflects more general trends from other areas of our lives. Media hypes, financial incentives, marketing tactics, information overload and time pressure have become so commonplace we might fail to question the damage they can cause in an area where objectivity and careful consideration is of central importance.

4. **Self-blockade:**
   Ironic as it sounds, the pressure to produce and to work efficiently according to suitable commonplace criteria renders contemplating questions how science works a waste of time and a disadvantage for the own success. In addition, specialization and fragmentation hinder communication with the sociology of science, the study of long-term trends, and an assessment of merits and drawbacks of presently used tactics.

6 The Measurement Problem

Scientists strive to promote our understanding of Nature, and to contribute to our societies the body of knowledge. They aim to do good research of high quality. Expressions like "good research" and "high quality" are idealistic and as such often elusive and not well-defined primary goals. Though such values may be considered as a drawback due to their vagueness, the advantage lies in their flexibility. The understanding of what procedures are necessary for and do constitute good science have changed over the centuries, and might further change, but the general aim to promote our understanding of the world we live in prevails.

These primary goals however are not easy measures. In a time where everything is quantified, and we are used to rankings, counts and evaluations, what is instead often used for practical purposes are simplified shortcuts, and derived secondary criteria that emerge out of the scientific community because they have proven to be useful. Such secondary criteria might be the number of a scientists publications, a journals impact factor, a papers number of citations, a researchers count of prominent collaborators, a universitys ranking, or researchers affiliation with/connection to such highly ranked universities. All these are metascientific measures, used to quantify success. Their advantage lies in their objectivity but their drawback is their potential to alter goals for research despite the fact that such measures are recognizably no replacement for experts judgment.

The problem is that wide acceptance or even institutionalization of such metascientific measures inevitably backlashes on the scientific enterprise. These measures create incentives for researchers to aim for secondary instead of primary goals. Over the course of time, this renders the measure increasingly less useful, but it will often remain accepted nevertheless. A large part of the problem is that such measures originate bottom-up because they were considered useful indicators, but can become static secondary goals that researchers strive to fulfill for their own sake, and are typically hard to remove. The potential danger in measurement has been written about in [4, 5, 18, 19].

A lot of effort is being invested into making criteria more precise, such as a more appropriate replacement of the citation index by refining according to the research areas peculiarities, or by more accurate tracking of authors contributions to a publication. One can also think of credit points for engagement in public outreach, or administrational duties, open peer review with a simple ranking mechanism, or tracking the reliability of a scientists recommendations these and other ideas have been and are discussed (e.g. [20]).

But no matter what, no measure will ever, can ever, be exact. No matter how refined, no measure will be able to replace personal evaluation by peers an inevitably time-intensive process that is the very heart of scientific progress. There is no shortcut to this. The problem is not solved by imposing more precise metascientific measures, it can only be solved by giving researchers an environment free of distorting pressure and without the need to excel according to centralized quality assessment. Measures for scientific success are means to get an impression of a researchers productivity, but the means should not be an end to itself. Measures are useful but become problematic when abused beyond their usefulness, because then the process of optimization does no longer work towards the primary goal.

The use of such simplifying measures is a consequence of the changing demands on scientists. With the growing community and its connectivity, it is much easier today to find openings for grants, positions, or scholarships and apply worldwide. As a result, applicants can send many duplicates of their files without much effort, while selection committees in different places are faced with increasing piles of documents that are largely overlapping and have to be sorted out in a timely manner. To that end, they have to rely on shortcuts, such as other peoples judgments or quantifiable criteria. With more study, better ways to manage these changing demands could be found, instead of just hoping institutions will learn to cope and muddle through.

7 Recommendations

We have argued that in fields which require a high level of expertise the way to move forward is to leave judgment up to the experts themselves. But for this to work, external influence should be minimized and the system should allow researchers to fulfill this selective function as objectively as humanly possible. The experts judgment in the community is of highest relevance for the progress of science as a whole. Scientists have to live up to this responsibility, act accordingly, and their work environment has to encourage this.

It is then clear how to alleviate the problems discussed above. Researchers should be as free as possible to follow their interests, reflecting the experts knowledge about what is promising and what is not[2]. Recommendable is thus everything that reduces the four pressures discussed in 4.

A micro-macro link that has undesirable outcomes as the ones summarized above can be modified in two ways. One is through the top-down connection in which funding bodies use certain criteria and specifically targeted programs to direct research. These can also be used to alter incentives on the micro-level. On the other hand there is the bottom-up connection, since many decisions by funding agencies eventually go back to peer review and hiring committees make up their own rules, the communitys ability for self-reflection can change the selection procedure and thus the incentives.

Bottom-up one can improve the micro-macro link by raising awareness for what long-term effects can result from an acceptance of measures for quality or to give in to the four types of pressure. It is all too easy to blame funding agencies for mismanagement. The problem occurs only when measures are used not to obtain a rough first impression, but become incorporated by scientists themselves as something to strive for. This point can thus be addressed by making these consequences a more prominent topic of discussion and consideration. A further possibility would be to add a general introduction to the Sociology, History, and Philosophy of Science to the educational program for young scientists.

[2]One might object this could cause a situation in which fields presently in fashion are typically overpopulated and other worthwhile but less fashionable areas remain underpopulated. This neglects the fact however that an overpopulation leads to a diminished number of interesting research projects and lowers payoff in terms of appreciation.

The top-down approach requires the formulation of recommendations and guidelines that can be used in practice. For this, the issues raised here need to be closer studied and analyzed. But following the here presented arguments, it is possible to state what needs to be aimed at in general: The system needs to allow for free variation, it must be able to adapt to changes over time, and dynamically balance different research styles. Most notably, these are balances between directed undirected research (where undirected means a free choice of topic), between collaboration and competition, between specialization and interdisciplinarity, and between transformative and conservative research. It is important to realize that there exists no fixed and right share for each of these. The necessity for one or the other depends not only on the field, but also on the available resources and the stage of the creative process.

Some recommendations for improvement by increasing the ability of the system to undergo free variation and optimization are: not tying researchers to topics or supervisor, support for appropriate time-periods, counteracting specialization by field, encouraging interdisciplinarity and broadness, discouraging advertisement, and avoiding the use of oversimplified measures.

For a better understanding and more concrete recommendations a data-based analysis of the situation in different field, a development of a systemic approach, and an implementation of the won insights is necessary. The solution to the here discussed problems thus lies within scientific research itself. The study of these issues lies at the intersection of the social, the natural, and the computer sciences. Their understanding, and the implementations of the so found knowledge are necessary to allow the organization of the academic system to remain able to learn and adapt to change.

Acknowledgements

This work has profited very much from fruitful discussions with Steve Fuller and Lee Smolin. Research at Perimeter Institute for Theoretical Physics is supported in part by the Government of Canada through NSERC and by the Province of Ontario through MRI.

References

[1] NSF Statistics. National Science Foundation. Retrieved July 11, 2008, from www.nsf.gov/statistics

[2] Eurostat. Retrieved July 11, 2008, from ec.europa.eu/eurostat/

[3] Young N. S., Ioannidis J. P. A. & Al-Ubaydli O. (2008). *Why Current Publication Practices May Distort Science.* PLoS Medicine Vol. 5, No. 10, e201.

[4] Campbell ,P. (2008). *Escape from the Impact Factor.* ESEP 8:p1.

[5] Lawrence P. (2008b). *Lost in publication: how measurement harms science.* ESEP 8:p9-11.

[6] Evans J. A. (2008). *Electronic Publication and the Narrowing of Science and Scholarship.* Science, Vol. 321, 5887, pp. 395 - 399 (2008).

[7] Peters H. P., Brossard D., De Cheveign S., Dunwoody S., Kallfass M., Miller S. & Tsuchida S. (2008). *Interactions with the Mass Media.* Science, Vol. 321, 5886, pp. 204 - 205.

[8] Kempner J. (2008). *The Chilling Effect: How Do Researchers React to Controversy?* PLoS Med 5(11): e222.

[9] Price D. J. de S. (1965). *Networks of scientific papers.* Science 149, 510515.

[10] Redner S. (1998). *How popular is your paper? An empirical study of the citation distribution.* Eur. Phys. J. B 4, 131134.

[11] Chen, C. (2004). *Searching for intellectual turning points: Progressive knowledge domain visualization.* Proceedings of the National Academy of Sciences, vol. 101, Suppl 1, pp. 5303-5310

[12] Newman, M. E. J. (2008). *The first-mover advantage in scientific publication.* arXiv: 0809.0522v1 [physics.soc-ph].

[13] Sawyer, R. K. (2005). *Social Emergence: Societies As Complex Systems.* Cambridge University Press.

[14] Wilson P. (1995). *Unused relevant information in research and development.* Journal of the American Society for Information Science, 45(2), 192203.

[15] Burt, R. S. (2004). *Structural holes and good ideas.* American Journal of Sociology, 110(2), 349399 and references therein.

[16] Stryker S. & Burke P. J. (2000). *The Past, Present, and Future of an Identity Theory.* Social Psychology Quarterly, Vol. 63, No. 4, pp. 284-297.

[17] National Science Foundation (2007). *National Science Board Approves NSF Plan to Emphasize Transformative Research.* Press Release. Retrieved October 12, 2008, from http://www.nsf.gov/news/news_summ.jsp?cntn_id=109853

[18] Lawrence, P. (2008a). *The mismeasurement of Science.* Science Focus 3, 1-4.

[19] Smolin L. (2006). *The Trouble With Physics.* Houghton Mifflin.

[20] Radicchi F., Fortunato S. & Castellano C. (2008). *Universality of citation distributions: towards an objective measure of scientific impact.* C. Proc. Natl Acad. Sci. USA, arXiv: 0806.0974.