

# Triple Helix: A Journal of University-Industry-Government Innovation and Entrepreneurship

## Organizing Product Innovation: Hierarchy, Market or Triple-Helix Networks?

--Manuscript Draft--

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<b>Full Title:</b>	Organizing Product Innovation: Hierarchy, Market or Triple-Helix Networks?
<b>Article Type:</b>	S.I. : Innovation's future
<b>Abstract:</b>	<p>TRHE-D-14-00005R1 Organizing Product Innovation: Hierarchy, Market or Triple-Helix Networks?</p> <p>Abstract</p> <p>This paper assesses the extent to which the organization of the innovation effort in firms - as well as the geographical scale at which this effort is pursued - affects the capacity to benefit from product innovations. Three alternative modes of organization are studied - hierarchy, market and triple-helix-type networks. Furthermore, we consider triple-helix networks at three geographical scales - local, national and international. These relationships are tested on a random sample of 763 firms located in five urban regions of Norway which reported having introduced new products or services during the preceding three years. The analysis shows that firms exploiting internal hierarchy or triple-helix networks with a wide range of partners managed to derive a significantly higher share of their income from new products, compared to those that mainly relied on outsourcing within the market. In addition, the analysis shows that the geographical scale of cooperation in networks, as well as the type of partner used, matters for the capacity of firms to benefit from product innovation. In particular, firms that collaborate in international triple-helix-type networks involving suppliers, customers and R&amp;D institutions extract a higher share of their income from product innovations, regardless of whether they organize the processes internally or through the network.</p> <p>TRHE-D-14-00005R1 Organizando la innovación en producto: ¿Jerarquía, mercado o redes de Triple Hélice?</p> <p>Resumen</p> <p>Este artículo valora en qué medida el esfuerzo realizado por las compañías para innovar, así como la escala geográfica a la que este esfuerzo se realiza, afecta a la capacidad de beneficiarse de la innovación en producto. Se estudian tres modalidades alternativas de organización: jerarquía, mercado y redes de tipo Triple Hélice. Además, las redes de Triple Hélice se examinan a tres escalas geográficas distintas: local, nacional e internacional. Dichas modalidades han sido analizadas a partir de una muestra aleatoria de 763 empresas, localizadas en cinco regiones urbanas distintas de Noruega, de las que se sabía que habían introducido nuevos productos o servicios en los tres años previos. El análisis muestra que las empresas que explotaron su jerarquía interna o las redes de Triple Hélice con diversos tipos de socios consiguieron obtener una cantidad significativamente mayor de ingresos a partir de sus productos en comparación con aquellas otras empresas que confiaron principalmente en la externalización dentro del mercado. A esto se suma que, como indica el análisis, la escala geográfica de cooperación de las redes, al igual que el tipo de socios implicados, es determinante a la hora de que las empresas se beneficien de la innovación en producto. En particular, las empresas que colaboraron con redes internacionales de tipo Triple Hélice involucrando a proveedores, clientes e instituciones de I+D consiguieron un porcentaje mayor de sus ingresos gracias la innovación en producto con independencia de si organizaron los procesos internamente o a través de la red.</p> <p>TRHE-D-14-00005R1</p> <p>Organiser l'innovation de produits: hiérarchie, marché ou réseaux Triple-Hélice?</p>

## Résumé

L'article définit dans quelle mesure l'organisation de l'effort d'innovation dans les entreprises --- ainsi que l'échelle géographique à laquelle cet effort est mené --- affecte la capacité à tirer bénéfice de l'innovation de produits. Trois modes d'organisation alternatifs sont étudiés --- par la hiérarchie, par le marché et par les réseaux de type triple-hélice. De plus, les auteurs considèrent les réseaux triple-hélice à trois niveaux géographiques --- local, national et international. Ces relations sont testées sur un échantillon aléatoire de 763 entreprises situées dans cinq régions urbaines de Norvège qui ont déclaré avoir introduit de nouveaux produits pendant les trois dernières années. L'analyse montre que les entreprises qui exploitent la hiérarchie interne ou les réseaux triple-hélice avec un nombre élevé de partenaires ont pu dériver une part plus importante de revenus issus de nouveaux produits, par comparaison à ceux qui se sont principalement appuyés sur les ressources externes du marché. De plus, l'étude montre que l'échelle géographique de coopération dans les réseaux, ainsi que le type de partenaires utilisé ont leur importance quant à la capacité des entreprises à tirer bénéfice de l'innovation de produits. En particulier, les entreprises qui collaborent à des réseaux de type triple-hélice qui regroupent des fournisseurs, des clients et des institutions R & D tirent une part plus importante de leurs revenus des innovations de produits, indépendamment de ce qu'elles organisent l'innovation en interne ou à travers le réseau.

TRHE-D-14-00005R1

组织产品创新：等级制度、市场还是三螺旋网络？

### 摘要：

本文评定在公司里的创新努力的组织方式——以及这个努力所进行的地理范围——在何种程度上影响公司从产品创新获益的能力。此项研究根据三种不同的组织方式来进行——即层级结构、市场和三螺旋型网络组织方式。此外，我们在地方、国家和国际三个地理层次上研究三螺旋网络。通过对位于挪威五个城区的据报道在过去三年中曾引入过新产品或新服务的763公司的随机抽样测试这些关系。分析表明，相比那些主要依靠在市场内外包的公司而言，利用内部层级结构或有广泛合作伙伴的三螺旋网络的公司，更易于由产品创新中获得明显较高的收入。进一步的分析表明：公司在网络内进行合作的地理范围，以及所采用的合作伙伴关系的类型，都与公司从产品创新获益的能力相关。特别是在涉及到供应商、客户和研发机构的国际三螺旋型网络中合作的公司，不管它们是通过内部组织还是通过网络组织这些过程的，都能从产品创新中得到更高的收入份额。

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Создание инновационного продукта: иерархия, рынок или сети Тройной спирали?

### Абстракт

В статье представлена оценка степени организации инновационных процессов в компаниях и географического масштаба этих усилий, а также извлечения максимальной пользы из продуктовой инновации. В статье рассмотрены три организационные модели: иерархия, рынок и сети Тройной спирали. Кроме того, мы рассматриваем сети Тройной спирали на трех географических уровнях – региональном, национальном и международном. Эти модели были протестированы на случайной выборке из 763 фирм в пяти городских районах Норвегии, которые выпустили на рынок новые продукты или услуги в течение предшествующих трех лет. Наш анализ показывает, что фирмы, эксплуатирующие внутреннюю иерархию или взаимодействие по типу Тройной спирали с широким кругом партнеров, получают значительно более высокую долю своих доходов от новых продуктов по сравнению с теми фирмами, которые в основном полагаются на аутсорсинг. Кроме того, наш анализ показывает, что географический масштаб сетевого сотрудничества, а также используемый тип партнера, имеет большое значение для способности фирм извлекать выгоду из продуктовой инновации. В частности, фирмы, которые сотрудничают в международных сетях Тройной спирали с участием поставщиков, клиентов и научно-исследовательских учреждений получают большую долю своих доходов от инновационных продуктов, независимо от того, организованы ли их процессы внутри фирмы или через сеть.

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تاكبش وأ قووسل تاكبش، يم رهلا لسلسل تاكبش: راكلبال تاكبش نم ميظنت اذ ةثالثل حوارملا تاكبش ؟

صخلم

يدم ي اىل ا قرولا هذه موقت ، راكلبالا يف يف فارغلا لماعلا رود اىل ا ةفاضلا اب نم ةدافتسالا اىل ا قردقلا اىل ا تاسسؤملا يف راكلبالا دوهجم ميظنت رثؤي :دوهجملا اذه ميظنت ةيفيكل قرط ةثالثل ةسارد تمت . لاجملا اذه يف تاكبش نملا امك . ةثالثل حوارملا تاكبش و قووسل تاكبش ، يم رهلا لسلسل تاكبش ينطولا اىل ا يوتسملا اىل ا ةثالثل حوارملا تاكبش ل ةسارد تمت 763 نم ةيئوشع ةقيرطب ةنوكم ةنيع اىل ا قاقالاعلا هذه رابتخا عقو . يلودلا و ا تاكبش نم دامتعاي تماق ، چيورنلا يف ةيرضح قيطانم ةسيمخ يف ةدوجوم ةسسؤم يف تاكبش نم اىل ا ليلحلا رهظي . ةريخال اثالثل تاووسل لال ا ةتييح تامدخ اىل ا ةثالثل حوارملا تاكبش ل اىل ا لسلسل تاكبش تلغستا ةصح اىل ا لوصحلا نم تنكمت اكرشلا نم ةعساو ةعومجم عم يلودلا يوتسملا يف تاكبش ل اىل ا كلبب ةنراقم ، ةثييحلا تاكبش نم ةيئاتم لخدلا نم ةعفترم ، كلذ اىل ا ةفاضلا اب . قووسل ل اىل ا ةفاضلا اىل ا ةساسا دمتعت تاكبش ل ل اىل ا فارغلا لماعلا رابتعا اىل ا نيعب ذخال اىل ا ليلحلا نيب نم ةدافتسالا اىل ا تاكبش ل اىل ا قردق نامضل ميم لماع دمتعا اىل ا كيرشلا ةيئون و اىل ا تنوعات يف تاكبش ل اىل ا صوصخلا اب ليلحلا نيب امك . راكلبالا تاكبش نم اىل ا لمتشت يف تاكبش ل اىل ا حوارملا تاكبش ل اىل ا يف لماعلا يوتسملا ةصح اىل ا لوصحلا نم تنكمت . ةيمنتلا و ثحبلا تاسسؤم و عمال اىل ا و نيذروملا ميظنت ناك اذ ام نع رظنلا ضغب ، راكلبالا تاكبش نم يف تاكبش ل اىل ا لخدلا نم ركب اىل ا قاقالاعلا ةكبش لال اىل ا نم و ا ةكرشلا ل اىل ا نم م تي راسملا اذه

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Organizing Product Innovation: Hierarchy, Market or Triple-Helix Networks?

Organizando a Inovação de Produto: Hierarquia, Mercado ou de uma hélice tripla Networks?

Resumo

Este artigo avalia como a capacidade de uma empresa se beneficiar de inovações de produto pode ser afetada pela organização do seu esforço de inovação, bem como pela extensão geográfica que em esta ocorre. Três modos de organização alternativos são estudados: hierarquia, mercado e hélice tríplice. Além disso, nós consideramos a hélice tríplice em três escalas geográficas: local, nacional e internacional. Estes relacionamentos são testados em uma amostra aleatória de 763 empresas localizadas que havia informado a introdução de novos bens ou serviços durante os três anos precedentes em cinco regiões urbanas da Noruega. A análise mostra que as firmas que exploraram hierarquias internas ou redes hélice tríplice com a gestão de vários tipos de parceiros. A análise mostra que as empresas que exploraram redes de hierarquia ou hélice tríplice internas com uma ampla gama de parceiros conseguiram derivar uma parcela significativamente maior de sua renda a partir de novos produtos, em comparação com aqueles que se basearam essencialmente na terceirização. Além disso, a análise mostra que o alcance geográfico de cooperação em rede, bem como o tipo de parceiro utilizado, dificultam a capacidade das empresas de se beneficiarem da inovação de produtos. Em particular, empresas que colaboraram em redes internacionais tipo hélice tríplice envolvendo fornecedores, clientes e instituições de P&D obtiveram uma parcela maior de suas receitas da inovação de produtos, em detrimento daquelas que organizaram o processo internamente ou por meio de redes.

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<b>Author Comments:</b>	<p>Dear Professor Etzkowitz,</p> <p>Martin Gjelsvik, Andrés Rodríguez-Pose and I would like to express our gratitude for invitation to submit our paper "Organizing product innovation: hierarchy, market or triple-helix networks?" (please note the change in title) for consideration for the inaugural issue of the journal Triple Helix and, in particular, for the thorough and thoughtful feedback on the submitted version of the paper. Please also extend our gratitude to the three reviewers for their insightful comments on the first version of the paper. In this revised version, we have taken all of their comments on-board and find that the paper has become significantly stronger as a result. We hope that you will agree and will therefore find that the paper merits publication in the journal.</p> <p>Attached to this letter, you will find a detailed response to each point made by the three reviewers, including a description of how we have addressed them in the revised version of the manuscript.</p> <p>Thank you again for considering the paper, and we look forward to your decision on the revised paper.</p> <p>Yours sincerely,</p> <p>Rune Dahl Fitjar</p>
<b>Response to Reviewers:</b>	<p>Reviewer 1</p> <p>"I would have liked to see some more elaboration of the concept of networks and/or partnerships. Are all interactions between firms a sign of networks and how will this vary from sector to sector? Are the interactions/networks geographically or project motivated, or long term partnerships, and what is the role of the industry sector?"</p> <p>Response: Following the suggestion, we have elaborated on the distinction between simple interaction, collaboration or partnerships, networks, and triple-helix networks on page 6 of the revised manuscript. We have established mutually exclusive classifications in order to provide a clearer definition of the different concepts. The concepts of partnerships and networks are then returned to in the presentation of the empirical analysis. It must be noted that we measure networks through the number of stable collaborations of individual firms and that, although in a country like Norway it is likely that these networks would have a limited geographical scope, by introducing a distinction between local, national, and international partnerships, we allow for the possibility of firms belonging to networks not constrained by geographical proximity.</p> <p>"Two of the figures are a bit difficult to understand: Figure 1: should have had a better explanation and perhaps a clarifying text on the axes? Figure 3: Are the indications on(and above) the X-axis a count of how many firms that have the actual number of international partners?"</p> <p>Response: We have sought to clarify what these figures show by changing the title of Figure 1 to "Frequency distribution of innoshare" and by adding a note to Figure 3</p>

explaining that “The bars on the x-axis indicate the frequency of firms in each category of international partners”

"On page 18 the author states that the innovative firm used 2.36(+0.12) types of regional partners....

Does this refer to type of partners or to number of partners?"

Response: It refers to the number of different types of partners used among the seven types considered, so the terminology in the paper is correct. We don't have data on how many partners firms used of each type. Please note that, for the purpose of the paper, we are much more concerned with the types of different partners than with the absolute number of partners. If an innovative firm interacts only with a large number of suppliers and clients, it will likely be at the heart of the network, but it would be a network which is very different from what can be expected of a triple-helix network.

"How will the variation in size and industrial specialization for the city regions (Oslo, Bergen, Stavanger, Trondheim, Kristiansand) affect the results?"

Response: In order to address this question, we have tried to rerun the model with the city region in which the firm is located as an added control variable. None of the coefficients change significantly when the city region controls are included, and none of the region dummies are themselves significantly related to *innoshare*. Consequently, the location of firms in different city regions does not seem to matter much for the results, whether in terms of their values on the dependent variable or its relationship to any of the independent variables in the model. On this basis, it seems reasonable to assume that this is also the case for specific characteristics of these regions, such as their size and industrial specialization. We have run this analysis for all Models 1-5, finding that none of the results change significantly when the city region dummies are included.

Reviewer #2: Review statement

"Organizing innovation: Hierarchy, market, or triple helix networks This paper distinguishes three organizational forms for innovation of firms, namely, hierarchy, market and (triple-helix) network, and assesses which forms lead to more benefits for the firms from product innovation. Based on statistical analysis of a random sample of 763 firms, the study concludes that the returns to innovation are significant higher in either the hierarchy or network model. Regarding the firms participating in networks, the effect is only significant when the network is sufficient wide. In addition to testing a number of hypotheses raised by the author, this study also contributes to the knowledge pool by bringing the benefits from production innovation or the concept of "innoshare" into an empirical investigation and also the quantitative analysis is well developed.

However, my concern is about unclear definitions of the dependent variable (Innovation or economic returns from innovation) and independent variables (such as three forms of innovation effort). First, although in the survey it mainly measures "whether they had introduced any goods or services into the market during the past three years" (p.15), the concept innovation is not clearly defined by referring to key (Triple Helix) literature. For instance, in Etzkowitz's earlier work (1997, 2001) innovation was understood as both products (goods or services) and process (technological or organisational). Recently Etzkowitz's (2003, 2008) views innovation much broadly, which is "more than the development of new products in forms, it is also the creation of new arrangements among the institutional spheres that foster the conditions for innovation" (Etzkowitz, 2003, p. 299)."

Response: We agree that the concept of innovation can take on many different forms. However, in this paper, we focus on new product development as a specific form of innovation, and we are particularly interested in how these processes are organized. In light of this, we have made a number of revisions in the paper to clarify that our analysis is restricted to product innovation. Most notably, we have changed the title of the paper to "Organizing product innovation". Furthermore, we have clarified in the introduction to the paper that among the many different forms of innovation, we focus in this paper on new product development. We have also specified the type of innovation to which we refer at relevant points in the paper, including in the abstract ("the capacity of firms to benefit from product innovation"), the introduction ("firms

which reported product innovations" and "income from product innovations" , p. 4) and the conclusion ("organization mode does make a difference to the product innovation performance of firms" and "the returns to product innovation").

"Secondly, the three forms of innovation organisation distinguished by the author, namely hierarchy, market and network are micro level organizational arrangement where the firms are the central focus of the analysis. The author considers the network as Triple Helix model, but in the Triple Helix literature, the Triple Helix model at the macro level of the society. In the study's measurement, the "triple helix" network is actually about a firm's partnership with conglomerate, suppliers, customers, competitors, consultancies, competitors, consultancies, universities, and research institutes. In this regard, I see the "triple helix" network is not as same as the Triple Helix model, which is about the interrelations between university, industry and government. In general, it is unclear what is the relation between the three forms of organising innovation (market, hierarchy and network) and Triple Helix models (Overlapping model, laissez-faire model and statist model). To me, the three forms of organising innovation at the firm level can take place in either of the Triple Helix models. As this paper is submitted to the Triple Helix model, it is important to position it well to the Triple Helix literature.

I think the paper can be considered for publication after the author has clarified some key concepts like those mentioned above."

Response: Operationalising complex theoretical constructs, such as those of the triple-helix model, is always complicated and bound to underrepresent the wealth and complexity of the theory. In this case, we operationalise the emergence of triple-helix type networks following Ranga and Etzkowitz's (2013) conceptualisation of the triple helix system, which involves the establishment of partnerships with agents of a different nature. Please note that throughout the paper we are careful to always refer to triple-helix type networks and not to dwell on the triple-helix model, which is indeed, as you mention, derived from a macro approach. In addition, we have in the theoretical section carefully distinguished between partnerships and networks, and between networks and triple-helix type networks. Hopefully, this has helped to clarify the basic concepts used in the paper.

Reference:

Ranga, M. and Etzkowitz, H. 2013. Triple helix systems: An analytical framework for innovation policy and practice in the knowledge society. *Industry and Higher Education* 27(4): 237-262.

Reviewer #3:

1. Please explain what does the triple-helix-type networks mean in a beginning of the article. Provide a definition.

Response: A clear definition of what hierarchy, partnerships and outsourcing, networks, and triple helix type networks mean is now provided at the beginning of the theoretical section. Each of the categories is made mutually exclusive in order to facilitate their operationalisation in the empirical analysis.

2. Page 2. "On the other hand, the building and participation in triple-helix-type networks is often time-consuming and costly, while the knowledge generated within the networks is not always easy to process." Why? Explain. Provide specific examples.

Response: We have explained this sentence in greater detail on page 2 of the revised manuscript.

3. Page 4. "This relationship is explored for a random sample of 763 Norwegian urban firms which reported innovations." Where did you find these companies? What resources were involved in it?

Response: The firms are part of a larger survey in which 1600 firms were drawn at random from the Norwegian Registry of Business Enterprises according to pre-set quotas for different city regions. The 763 firms are those which responded affirmative to the question of whether they had any product innovations during the preceding three

years. These firms were then asked the follow-up question of how these innovations were developed. We have added a sentence explaining this on p. 4. This is also explained in greater detail in the "Methods, variable specifications and descriptive data" section on pp. 15-16.

4. Please make an introduction for section "H". Why will you have 5 of them (from H1a-H5b)?

Response: These are not sections, but hypotheses. We have changed the typeface from bold to normal to make this clearer. We have also changed the sentence leading up to the first hypothesis from "we expect that:" to "we hypothesize that:" in order to highlight the nature of these statements.

5. Page 5. "Ronald Coase (1937) conceived the firm as a governance structure, a provocative break with the then..." Please, provide reference.

Response: We have added a reference to Coase (1937).

6. Page 10. "Indeed, in the case of Norway, Strand and Leydesdorff (2013) find that foreign relations are characteristic of the regions with the most efficient triple-helix relations." Tell more about it. What industries are developing at these regions? Maybe it can explain why the triple-helix relations are efficient there?

Response: We have added information about the industry structures of these regions based on Strand and Leydesdorff's article.

7. In the article you are comparing companies by the size, location, type of industry, number of employees and etc. What is about financial data? Do you have information about it? Can you compare companies by its revenue and profits? A lot of companies what's to use their internal and external resources to be more innovative. However because of lack of financial means they mainly relied on outsourcing within the market. That is why it is important to analyze financial part of the companies.

Response: Unfortunately, we don't have any other information on the firms' finances than those which were provided in the survey and are already used in the model. Although it would certainly have been interesting to do so, we can therefore not analyse the firms further in terms of revenues or profits.

8. In conclusion please provide information about where results of the article can be used? What audience will be interested in the article? What will be the future research of this topic?

Response: We have added a paragraph in the conclusion about potential implications of the results for firms / firm managers. The final paragraph of the conclusion also points out some issues for future research to explore.

9. In your opinion, will these results be similar in the other countries or only in Norway?

Response: We have added this as a limitation of the study in the conclusion, noting some specific features of the Norwegian case that may have implications for the results.

10. My recommendation is to add information about practical application of the results of the analysis in an article that can be useful for entrepreneurs.

Response: We have added a paragraph in the conclusion where we discuss how firms can apply these results in decisions of how to organize their innovation processes.

## **Organizing product innovation: hierarchy, market or triple-helix networks?**

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## Organizing product innovation: hierarchy, market or triple-helix networks?

### **Abstract:**

This paper assesses the extent to which the organization of the innovation effort in firms – as well as the geographical scale at which this effort is pursued – affects the capacity to benefit from product innovations. Three alternative modes of organization are studied – hierarchy, market and triple-helix-type networks. Furthermore, we consider triple-helix networks at three geographical scales – local, national and international. These relationships are tested on a random sample of 763 firms located in five urban regions of Norway which reported having introduced new products or services during the preceding three years. The analysis shows that firms exploiting internal hierarchy or triple-helix networks with a wide range of partners managed to derive a significantly higher share of their income from new products, compared to those that mainly relied on outsourcing within the market. In addition, the analysis shows that the geographical scale of cooperation in networks, as well as the type of partner used, matters for the capacity of firms to benefit from product innovation. In particular, firms that collaborate in international triple-helix-type networks involving suppliers, customers and R&D institutions extract a higher share of their income from product innovations, regardless of whether they organize the processes internally or through the network.

**Keywords:** organization, markets, networks, triple-helix, outsourcing, firms, Norway

## Introduction

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3 Firm organization matters for innovation and for the returns that firms can extract  
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5 from generating and/or adopting innovation. Firms that innovate more are expected to  
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7 outcompete the market and earn a greater share of their revenues from the  
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9 introduction of new products and services. However, the exact mechanisms which  
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11 make a firm more or less innovative are still controversial. Firm-level innovation  
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13 depends to a great extent on how firms organize the innovative effort. In recent years,  
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15 many researchers have tended to highlight the importance of external links as a source  
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17 of knowledge and innovation. Firms which develop external links connecting them  
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19 with other firms, knowledge-creating centres, such as research centres and  
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21 universities, and government bodies often find themselves at the centre of complex  
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23 triple-helix networks which facilitate their capacity to innovate (Etzkowitz, 2008;  
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25 Leydesdorff, 2000).

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32 On the other hand, the building and participation in triple-helix-type networks is often  
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34 time-consuming and costly, while the knowledge generated within the networks is not  
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36 always easy to process (Laursen & Salter, 2006). By going beyond simple supply-  
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38 chain collaborations, firms have to engage with agents that function in different ways  
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40 and use different codes. As a result, and in contrast to the relatively straightforward  
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42 relationship with suppliers and customers in order to generate product innovation,  
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44 collaborations outside the supply chain may become more complicated, troublesome  
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46 or unstable and disputes may arise over the ownership of outcomes. Firms may have  
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48 to invest in absorptive capacity in order to access and transform external knowledge  
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50 for their own use. It may be necessary to recruit highly skilled employees in order to  
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52 communicate with universities, and government policies are not easily disentangled.  
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55 Moreover, network theory posits that even if firms choose to procure new products  
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1 externally, their relationship to suppliers is not necessarily best organized through  
2 arms-length market transactions (Powell, 1990; Uzzi, 1996). If production processes  
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4 have uncertain outcomes or require long-term commitment, the relationship between  
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6 actors needs to be based more on trust than on pure cost-benefit analyses and is  
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8 embedded in deeper social relations. This has advantages, but may also lead to more  
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10 uncertain outcomes in terms of innovation. As a consequence, rather than getting  
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12 involved in complex networks, firms may choose to simply rely on direct connections  
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14 within the market (dyadic collaborations or partnerships), outsourcing innovation to  
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16 suppliers or customers. Neo-classical economics holds that firms, being rational  
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18 actors, will use information and production inputs that are available in the market if  
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20 these are better or cheaper than what is available within the firm or in a network. This  
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22 general assumption is expected to apply also to innovation activities, implying that  
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24 firms that procure new product innovation from external suppliers may be able to  
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26 introduce more new products and hence derive a larger share of their income from  
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28 new innovations than those who fail to utilize this opportunity.  
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37 Outsourcing in the market is, nevertheless, again not without costs. Firms may thus  
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39 find it best, in order to reduce the transactions costs and risks of outsourcing  
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41 innovation to market agents or relying on triple-helix-networks, to organize  
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43 innovation activities internally. This may be particularly true of actions with uncertain  
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45 outcomes (Dodgson, 2014), asymmetric information or which require specific  
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47 investments, such as new product development. Under these circumstances, firms  
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49 may choose to organize their innovation activities in-house in order to economize on  
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51 transactions costs, limit risks and appropriate rents.  
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57 The geography of how the innovation effort is organized may also have an important  
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59 influence on innovation and economic outcomes. This is, however, a factor which has  
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1 been fundamentally overlooked by the literature. Triple-helix analyses about the  
2 formation of networks happen in what can be considered an ethereal space: complex  
3 networks can be developed in any sort of space, regardless of context and initial  
4 conditions (Etzkowitz, 2003). When space is considered, the assumption is that most  
5 interaction will happen in constrained geographical spaces. Etzkowitz (2008:8)  
6 indicates that “triple helix initiatives take place at the regional level, where specific  
7 contexts of individual clusters, academic development, and presence or lack of  
8 governing authority influence the development of the triple helix”. Theories on  
9 agglomeration forces (Glaeser, 2011), buzz (Storper and Venables, 2004) and clusters  
10 (Porter, 1998) assume that the benefits of knowledge diffusion are greatest when  
11 interaction takes place in close geographical proximity. A similar view has generally  
12 been taken in the triple-helix approach (Leydesdorff, Dolfsma, & van der Panne,  
13 2006; Leydesdorff & Fritsch, 2006), meaning that interaction at a distance may be  
14 detrimental for the capacity of a firm to innovate. This assumption has been  
15 nonetheless challenged by recent research (Fitjar & Rodríguez-Pose, 2013; Uzzi,  
16 1996) which has underlined the risks of lock-in in closely knit networks in  
17 constrained geographical spaces and, within the triple helix literature, by Leydesdorff,  
18 who indicates that “with globalization, one can expect the international–national  
19 dimension to be increasingly relevant” (2012: 32).

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47 The different forms of organization of innovation – and their geographies – may  
48 affect not only a firms’ capacity to innovate, but also how this innovation is translated  
49 into revenues and benefits. In this paper we analyse the extent to which the prevalence  
50 of different organizations of innovation in the firm – market, hierarchy and triple-  
51 helix-networks (Powell 1990; Williamson 1991) – and the scope of the triple-helix  
52 networks – in terms of geography (links at local, national and international level) or  
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1 types of partner (other firms, consultancies and R&D institutions) – affect the share of  
2 income a firm derives from new products developed during the past three years.  
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4 While innovation may take many different forms, the analysis focuses on innovation  
5 in the form of new product development and how this process is organized. This  
6 relationship is explored for a random sample of 763 Norwegian urban firms which  
7 reported product innovations as part of a larger survey of innovation in Norwegian  
8 city regions, which covered 1600 firms in total. We find that both hierarchical and  
9 triple-helix network organization of product development are associated with a  
10 significantly higher share of income from new products than a pure market  
11 organization. Furthermore, hierarchical organization is also associated with a  
12 significantly higher share of income from new products than network organization.  
13 For collaboration in triple-helix networks, we find that geography is important, but in  
14 ways which have tended to be eschewed by previous analyses. Our results show that  
15 the diversity and geographical location of partners matter. Notably, firms that  
16 collaborate with a diverse set of international partners, including universities and  
17 research institutions, tend to derive a significantly higher share of their income from  
18 product innovations. The share of income from innovation is also higher when the  
19 product is new to the market, indicating that first movers are able to capture an  
20 entrepreneurial rent (Schumpeter, 1934) that is not available to imitators.  
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## 50 **Markets, networks and firms**

51 Firms rely on three different forms of organizing innovation – markets, hierarchy, and  
52 networks (Powell, 1990; Williamson, 1991). At the firm level, these are three  
53 alternative modes of organization, the efficiency of which is determined by  
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1 characteristics of the transactions involved and the nature of the knowledge being  
2 transferred. At the macro or societal level, they represent three institutions in which  
3 the economy is organized. Hierarchy implies that innovation processes are organized  
4 internally within the boundaries of the firm. A market approach means that firms  
5 outsource their innovations to other market actors. The network mode denotes  
6 reciprocal and stable collaboration with other socioeconomic agents. The seed of  
7 networking in a system is interaction. We understand interaction as the reaction to the  
8 behaviour of another member within a system (Stogdill, 1959). Interaction can be, on  
9 the one hand, sporadic and have no economic purpose or, by contrast, can be repeated  
10 in time and have some economic goal. When this happens amongst economic agents  
11 in a system, repeated interaction can lead to collaboration or partnerships, which can  
12 be defined as a shared commitment of resources to the mutually agreed aims of  
13 partners. These aims include developing new markets, gaining access to production  
14 and distribution networks, and addressing issues related to research, technology, and  
15 innovation (Dodgson, 2014). Collaborations or partnerships tend to be dyadic, that is,  
16 they generally involve two firms or two agents within a system. As a consequence,  
17 these dyadic outsourcing partnerships can be considered as different from broadly  
18 defined networks, which entail a multiplicity of – at least, more than two – economic  
19 agents establishing regular multilateral ties for purposes of information and  
20 knowledge sharing, services exchange, and, ultimately, economic gain. When the  
21 networks involve economic agents from sectors which include firms, knowledge-  
22 generating centres and government, the network becomes a triple-helix network, with  
23 purpose-built chains which churn out new knowledge and innovation (Etzkowitz &  
24 Leydesdorff, 2000; Leydesdorff, 2000). As Etzkowitz (2008:50) posits: “Whereas the  
25 traditional firm, with strong boundaries, is a nexus of contracts [...] the triple helix  
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1 firm is part of a collaborative process that may include other firms and non-firm  
2 entities, such as university groups and government agencies”. These complex triple-  
3 helix networks involve a series of different purposes which range from simple  
4 collaboration – including collaborative leadership and conflict resolution – to  
5 substitution and technology transfer (Ranga and Etzkowitz, 2013).  
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12 Which of these three modes of organization of the innovation effort is more efficient  
13 in terms of the bottom line and, more specifically, of the share of the profits that  
14 accrue to the firm from product innovations, is still a matter of speculation. The  
15 characteristics of differentiated forms of innovation organization and of governing  
16 activities and transactions have been the focus of scholarly interest by institutional  
17 economists (Coase, 1937; Williamson, 1985, 1991), organizational sociologists  
18 (Granovetter, 1992; Powell, 1990), lawyers (Macneil, 1980) and strategic  
19 management theorists (Barney & Ouchi, 1986; Teece, 2000), among others. Ronald  
20 Coase conceived the firm as a governance structure, a provocative break with the then  
21 orthodox view of the firm as an uninteresting “black box” production function (Coase,  
22 1937). He observed that entrepreneurs and managers weighed up the benefits of  
23 internal organization and production against the costs and risks of using markets.  
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Transaction specific investments cannot be easily transferred to other purposes and include resources in the form of money, time and energy. Other drivers have also been

1 observed: the desire to increase incentive alignment through integrated ownership  
2 (Grossman & Hart, 1986), the need for superior monitoring or measurement that can  
3 be done in-house (Barzel, 1981), the inability to educate outside suppliers (Langlois,  
4 1992), the potential to capitalize on the firm's comparative or competitive advantages  
5 (Argyres, 1996; Gulati, Lawrence, & Puranam, 2005), and fostering knowledge  
6 sharing and coordination (Conner & Prahalad, 1996; Kogut & Zander, 1996).  
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15 On the other hand, exchanges that are easy to define, standardized, with no specific  
16 investments needed to the particular transactions, will take place in the market.  
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18 Market-based exchanges are characterized as discrete contracts, often short-term,  
19 between autonomous buyers and sellers. These transactions are “sharp in”; indicating  
20 that they are accompanied by a clear-cut, complete and monetized agreement. They  
21 are also “sharp out” in the sense that the provider's obligation of performance and the  
22 buyer's expected payment are unambiguous.  
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33 This academic discourse has developed in parallel with managerial practice. In recent  
34 decades a trend for outsourcing has emerged. It is based on the assumption that a  
35 competitive advantage could be gained and sustained if external suppliers were  
36 contracted to carry out so-called non-core processes more efficiently. Several drivers  
37 for outsourcing have been reported: (i) *economic* – outsourcing allows economies of  
38 scale and the longevity of demand for the activity; (ii) *quality* – access to skills, the  
39 competency and specialization of potential suppliers and geographical coverage is  
40 increased; and (iii) *innovation* – improvements in quality through innovation, and the  
41 development of new services (Kakabadse & Kakabadse, 2000). Outsourcing provides  
42 companies with greater capacity for flexibility, especially in access to rapidly  
43 emerging new technologies or the myriad of components in product development. In  
44 addition, outsourcing may have a potential to reduce the product design cycle time if  
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1 multiple best-in-class suppliers who work simultaneously on individual components  
2 of the process, are used (Quinn & Hilmer, 1994).  
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5 Knowledge-based approaches have also been advanced to configure the optimal  
6 governance structure of activities. These contributions often emerge from the resource  
7 based literature on the strategy of firms (Barney, 1991; Conner, 1991; Peteraf &  
8 Helfat, 2003), which might be seen as an alternative or a complement to transaction  
9 cost theory. Transaction cost theory conceptualizes the firm as a contractual entity  
10 with a strong focus on property rights, incentives and contracts. These issues are  
11 crucial when it comes to the appropriation of the benefits and rents of an innovation.  
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13 When innovation processes are organized mainly within the boundaries of a firm, the  
14 property rights are unambiguous and the incentives more aligned. On the other hand,  
15 the knowledge or resource based perspective conceptualizes the firm as a repository  
16 of distinct productive knowledge, including the ability to learn and grow on the basis  
17 of that knowledge (Dosi & Kogut, 1992; Foss, 1996; Nickerson & Zenger, 2004) and  
18 their related dynamic capabilities (Teece, 2007; Teece, Pisano, & Shuen, 1997). As  
19 the raw material for innovations is new combinations of knowledge and learning, this  
20 perspective is also important in studies of innovation processes. On this basis, we  
21 hypothesize that:  
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45 H1: Firms that develop new innovations within the company will be more innovative  
46 than those who source innovations in the market.  
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51 A third way of organizing innovation is through networks, an approach which has  
52 become more prevalent in recent years. Historically, the market and the vertically-  
53 integrated firm (hierarchy) were seen as a dichotomy. Exchanges could be arrayed  
54 along a continuum with discrete market transactions at one end and the integrated  
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1 firm at the other. This continuum appears to have less and less explanatory power as  
2 firms are increasingly blurring their established boundaries to engage in neither the  
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4 familiar alternative of arms' length market contracting, nor in the former ideal of  
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6 vertical integration (Powell, 1990). Powell argues that "by sticking to the twin pillars  
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8 of markets and hierarchies, our attention is deflected from a diversity of  
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10 organizational designs that are neither fish nor fowl, nor some mongrel hybrid, but a  
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12 distinctly different form" (Powell 1990: 299). Some exchanges are dependent on  
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14 relationships, mutual interests and reputation, and less guided by a formal structure of  
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16 authority, but rather by networks and relational contracts (Macneil, 1980).  
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22 Networks adopt many forms and shapes, but the exchange of information and  
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24 knowledge tends to be maximized in dense triple-helix relationships involving firms  
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26 with other knowledge-generating agents, such as governments, universities and  
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28 research centres (Baum & Oliver, 1991; Leydesdorff, 2000). In these rich ecologies  
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30 (Leydesdorff & Mayer, 2006), repeated interaction within the network helps to  
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32 disseminate knowledge, making firms involved in the network more dynamic and  
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34 innovative than those outside it.  
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40 Triple-helix networks have been increasingly regarded as a superior form of  
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42 innovation organization than markets or hierarchy. Polanyi (1944) classically noted  
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44 that relations between economic actors are socially constructed and embedded in  
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46 broader social structures. Building on this, Granovetter (1985) emphasized personal  
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48 relations and networks of such relations as essential mechanisms for producing  
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50 sufficient trust for market transactions to take place. He criticizes Williamson and  
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52 other institutional economists for treating hierarchy as the solution to opportunism,  
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54 noting that hierarchical structures do not produce trust between actors, and for  
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56 ignoring the social relations in which firms and other economic actors are embedded.  
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1 Organizing transactions in such networks of social relations “are superior to pure  
2 authority relations in discouraging malfeasance” (Granovetter, 1985). Embedded – or  
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4 networked – triple-helix relations thus provide a range of benefits to firms. They  
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6 allow transfer of tacit and proprietary knowledge, enable joint and continuous  
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8 problem-solving, and provide allocative efficiency (Uzzi, 1996). As knowledge is  
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10 increasingly distributed across a wide range of individuals and organizations, it has  
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12 become important for firms to be able to mobilize both internal and external  
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14 knowledge resources in pursuit of innovation (Chesbrough, 2003; Foss, Laursen, &  
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16 Pedersen, 2011; Tapscott & Williams, 2006; Von Hippel, 1988). Studies indicate that  
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18 entrepreneurial opportunities emerge in the interplay between firm-specific  
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20 capabilities and external knowledge (Audretsch & Keilbach, 2007; Roper, Du, &  
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22 Love, 2008).  
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29 On this background, we expect that:  
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33 H2a: Firms involved in triple-helix networks for the development of innovations will  
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35 be more innovative than those who source innovations in the market or rely on  
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37 internal, vertically integrated, hierarchies.  
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41 However, in order for the network approach to promote innovation, partners – in a  
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43 pure triple-helix logic – should be sufficiently differentiated to provide missing  
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45 technologies or new or complementary capabilities (Osborn & Hagedoorn, 1997).  
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47 Being part of a diversified network (or several) will increase the number of ideas to  
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49 select from. These advantages are further advanced if a firm is positioned in between  
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51 differentiated networks, in the so-called structural holes (Burt, 1992, 2004). For this  
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53 reason, we extend on the question of whether or not a network mode is used by also  
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55 considering the scope of the network. Firms collaborating with many different types  
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1 of partners – including other firms as well as research institutions – in a triple-helix  
2 network will have a greater chance of occupying structural holes or encountering  
3 novel information. Furthermore, we consider the impact of collaborating with each  
4 type of partner – other firms in the supply-chain, competitors, consultancies, and  
5 research institutions – on firms’ level of innovation.  
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12 H2b: Firms involved in triple-helix networks with a broad scope will be more  
13 innovative than those who involved in networks with a more limited scope.  
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### 21 ***Geography and the organization of innovation***

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24 A related debate, often neglected in the innovation literature, concerns the  
25 geographical scope of networks. Although some arguments advocate that networking  
26 can happen “at national, regional, or increasingly also at international levels”  
27 (Etzkowitz and Leydesdorff, 2000: 118), the majority of the literature has argued for  
28 the superiority of local or regional networks. Local and regional networks are  
29 perceived as superior because, as much of the knowledge is diffused through face-to-  
30 face contact (Gordon & McCann, 2000; Porter, 1990; Storper & Venables, 2004), the  
31 effort and costs required to make tacit knowledge circulate over large geographical  
32 distances makes triple-helix networking at arm’s length much less likely to be  
33 effective (Leydesdorff and Fritsch, 2006). The conditions under which transactions  
34 are best conducted locally include situations of complex information, rapid changes or  
35 low volumes (Duranton & Puga, 2004; Leamer & Storper, 2001), all of which are  
36 usually present in new product development processes.  
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56 However, others have pointed to the dangers of lock-in and over-embeddedness  
57 associated with local interactions with the same partners over an extended period of  
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1 time (Fitjar & Rodríguez-Pose, 2011; Gertler, 2003; Moodysson, 2008; Uzzi, 1996),  
2 advocating instead the use of partners outside the comfort zone of local interaction  
3 through the development of global pipelines (Bathelt, Malmberg, & Maskell, 2004;  
4 Morrison, Rabellotti, & Zirulia, 2013). Similarly, from within the triple-helix  
5 perspective, Leydesdorff (2012) has argued that triple-helix approaches overcome one  
6 of the traditional limitations of regional innovation systems approaches in that they  
7 may extend beyond regional (or national) boundaries, making innovation systemic,  
8 rather than dependent on a priori defined boundaries. Indeed, in the case of Norway,  
9 Strand and Leydesdorff (2013) find that foreign relations are characteristic of the  
10 regions with the most efficient triple-helix relations. This is closely related to the  
11 industrial composition of these regions with strong petroleum and maritime sectors.  
12 Interacting with partners in different geographical contexts increases the chances of  
13 occupying structural holes (Burt, 1992) and of bridging diverse cognitive frameworks.  
14 The need for face-to-face contact can be maintained through temporary proximity  
15 (Maskell, Bathelt, & Malmberg, 2006; Torre, 2008) and international business travel  
16 (Beaverstock, Derudder, Faulconbridge, & Witlox, 2009), and knowledge can also be  
17 transferred through virtual interaction over the internet, reducing the need for  
18 permanent co-location (Bathelt & Turi, 2011). On this basis, we present two  
19 alternative hypotheses:  
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46 H3a: Firms that cooperate with a wide range of regional partners will be more  
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49 H3b: Firms that cooperate with a wide range of international partners will be more  
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### ***From knowledge to innovation and commercial success***

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3 As this discussion suggests, the conditions which favour networks – in particular  
4 regional ones – and internal organization are similar. In both cases, they involve  
5 uncertainty, frequent or repeated interaction, and unique investments of money, time  
6 or knowledge. The choice between networks and internal organization under such  
7 circumstances is not straightforward. Access to external knowledge indicates an  
8 advantage for networks compared to firm-organizing. When the ideas are easy to  
9 transform and market to your own customers, and knowledge travels easily from its  
10 origin to the focal firm, the triple-helix network form may be the preferred  
11 organizational mode. An interorganizational partnership may also have developed  
12 what Kogut and Zander (1992) call “higher order organizing principles”, such as  
13 shared goals and cultures, common identities and languages. A long term partnership  
14 may also enable exchange of tacit knowledge, especially if the relations are built on  
15 physical, social or cognitive proximity (Boschma, 2005). To borrow a concept from  
16 evolutionary theory (Burgelman, 2002), the variation may be greater in a network  
17 than within the boundaries of the focal firm. However, there is more to an innovation  
18 process than creativity and ideas.

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42 A successful innovation ends up in a commercial product or service, and the  
43 organization of this part of the innovation process is best understood by applying  
44 concepts from the contractual approach. In this line of reasoning, the fundamental  
45 reason why resources and assets are brought under common ownership in a firm is  
46 due to incentive problems that may arise in situations of high asset specificity and a  
47 proclivity to opportunism (Williamson, 1985). Interconnected or co-specialized  
48 resources produce rents that may be appropriated by opportunistic input-owners, even  
49 in a partnership. Furthermore, when the outcome is uncertain – which is often the case  
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1 in innovation processes – it may be costly to agree on contracts or negotiate ex post.

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Uncertainties typically also evolve during the innovation process where some ideas are discarded and novel ideas are further explored. In that case, an internal employment contract is more flexible than an incomplete contract between separate firms. Teece (1982) has detailed how considerations of appropriability of rent-yielding knowledge resources influence the way in which innovative activities are organized.

To sum up: there is no straightforward prediction about which type of the three organizations considered will deliver greater innovation and commercial success. Being embedded in triple-helix networks may facilitate the circulation of new ideas, increased variation, and may provide complementary assets and knowledge. These complementarities may speed up the innovation process. On the other hand, especially if specific investments are needed to this particular innovation process, contractual issues may evolve. These hard topics may intensify when the outcome of the process is highly uncertain (especially if the upside is potentially huge) and give rise to appropriability issues. In that case in-house developments are preferred. In this study we use the share of income that results from innovations (over the last three years) as the measure of innovation performance. Highly innovative firms (as measured by a high share) are dependent on income from new products and services. Based on the discussion above, we present two competing hypotheses:

H4a: Firms that develop new innovations within the company will be more innovative than firms that cooperate with other companies or organizations in the development of innovations.

1 H4b: Firms that cooperate with other companies or organizations in the development  
2 of innovations will be more innovative than firms that develop new innovations  
3 within the company.  
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11 ***First-mover advantages versus imitation***  
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13 A final controversial issue in innovation strategy relates to the degree of novelty (Tidd  
14 & Bessant, 2009). To capture the degree of novelty, we distinguish between products  
15 and services being new to the market and new to the firm. The latter is an imitation or  
16 adaptation of something already known, and may, as such, represent an incremental  
17 innovation. The literature on firm strategy offers two competing perspectives on this  
18 issue. On the one hand, imitations and incremental innovations are less imbued with  
19 risk and uncertainty than new products and services. The technologies and knowledge  
20 are proven, the size of the market is fairly well known, and so are customer tastes and  
21 preferences. In a more established market, an accepted market prize is also well  
22 documented. Imitators can learn from the mistakes of others and often free ride on the  
23 investments of the original innovators. Furthermore, as communication and  
24 transportation have advanced, opportunities for imitation have burgeoned. The  
25 globalizing economy and technological advances have expanded the ranks of  
26 imitators, and have made imitation and incremental adaptations more feasible, more  
27 cost effective and much faster (Shenkar, 2010).  
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51 A competing view is that the introduction of genuinely new products into the market  
52 offers first-mover advantages (Lieberman & Montgomery, 1988) that allow firms to  
53 appropriate an entrepreneurial rent (Schumpeter, 1934). Since imitated products and  
54 services have already been in the market, there are no first mover advantages. The  
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entrepreneurial rent has already been appropriated by other firms in the market. According to Lieberman and Montgomery (1988), the first-mover advantages include superior positions in geographical space (prime physical locations), technology space (e.g. patents) or customer perceptual space. New entrants may be able to expand and defend their position by blocking the market with a broader product line. Pioneers may also develop a superior reputation related to their products and services. Furthermore, customers may incur perceived or real switching costs as they accumulate experience with the pioneer's product or service, and network externalities may establish the pioneer's product as a standard in the market (Lieberman & Montgomery, 1998). First-movers may also gain a head start in developing a set of dynamic capabilities (Teece, 2009) that are key to the product or service in question. These capabilities are often referred to as learning or experience curve advantages, and are typically more important than patents (Cohen, Nelson, & Walsh, 1997).

Early movers also stand a better chance to dominate the market and earn substantial profits. Such profits fade away, however, as imitators enter the same market. The sustainability of first-mover advantages depends on the initial resources captured by the pioneer, and the resources and capabilities subsequently developed, relative to the quality of those held or developed by imitators (Lieberman & Montgomery, 1998).

Based on the discussion above, we once more present two competing hypotheses:

H5a: Firms that introduce new products into the market will earn a higher share of their income from innovations than firms that introduce products which are similar to existing products.

1 H5b: Firms that introduce new products which are similar to existing products will  
2 earn a higher share of their income from innovations than firms that introduce new  
3 products into the market.  
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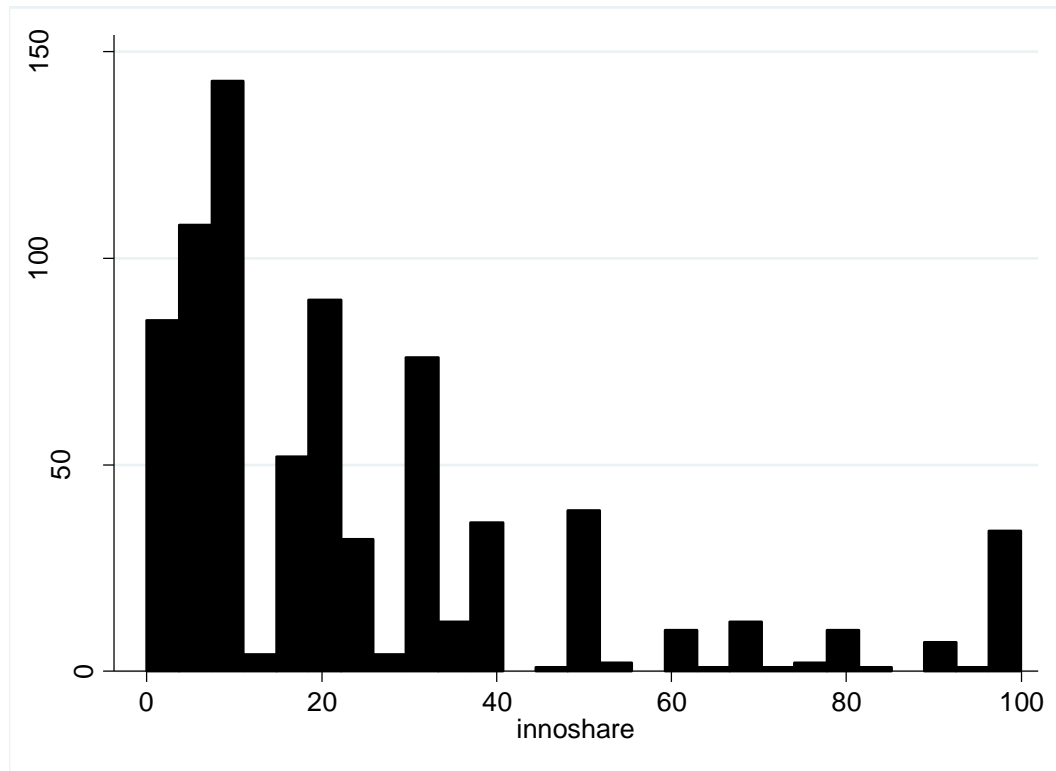
## 10 **Method, variable specifications and descriptive data**

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12 The analysis is based on data from a survey of 1604 firms located in Norway's five  
13 largest city regions: Oslo, Bergen, Stavanger, Trondheim, and Kristiansand. It may be  
14 argued that Norway represents a well-suited case to study the issues raised in this  
15 paper, including the impact of triple helix. Generally, universities are publicly owned,  
16 and government has taken substantial ownership of firms in important sectors  
17 (banking, energy, telecom, etc). The survey was conducted in 2010 through telephone  
18 interviews with the CEO of each firm. As the vast majority of firms are small or  
19 medium, we expect the top manager of the firm to be most informed of the  
20 innovations in their companies. The median size is 27 employees and three out of four  
21 firms in the sample have 60 employees or less. Firms were drawn randomly from the  
22 Norwegian Register of Business Enterprise, where all firms are required by law to  
23 register. Survey respondents were sampled among all firms with more than ten  
24 employees located in municipalities in which ten per cent or more of the population  
25 commuted into the core urban municipality/-ies of the city region in 2009 (Leknes,  
26 2010). We imposed a quota of 400 firms for each of the three largest city regions, 300  
27 for Trondheim, and 100 for Kristiansand. The sampling and interviews were  
28 conducted by Synovate (now Ipsos), a professional market research firm. A total of  
29 5887 firms were approached, with a response rate of 27.2 per cent.  
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### ***Dependent variable***

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3 In order to obtain data on the relationship between organization mode and innovation  
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5 performance, we first asked all firms whether they had introduced any goods or  
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7 services into the market during the past three years that were new to the company or  
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9 significantly improved compared to their existing products. Of the 1604 firms  
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11 included in the survey, 857 firms, or 53.4 percent, answered affirmatively and were  
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13 classified as innovative firms. These firms were subsequently asked to estimate which  
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15 percentage share of their income derives from products that were developed within  
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17 the last three years (*innoshare*). We elicited 763 responses to this question. The  
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19 average share of income from new products and services was 24.4, with a standard  
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21 deviation of 24.9. Figure 1 shows the distribution of the share of income deriving  
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23 from new products and services across all 763 firms. Because the distribution on the  
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25 variable is skewed, which could cause problems of heteroscedasticity and non-  
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27 linearity, we apply a log transformation when fitting the OLS regression model. This  
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29 is done by adding 1 to the value of *innoshare* (in order to avoid taking the log of 0)  
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31 and then calculating the natural logarithm. The logged variable has mean 2.74,  
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33 median 2.77, and skewness -0.49.  
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**Figure 1: Frequency distribution of *innoshare***



***Independent variables***

The analysis includes three vectors of independent variables. First, *Innomode* is a categorical variable measuring how firms organized the innovation processes that resulted in the introduction of new products. Managers of innovative firms were asked if their new products were developed mainly by their own company (*Internal mode*), mainly by other companies or organizations (*External mode*), or whether, in a triple-helix way, they cooperated with other companies or organizations in developing them (*Cooperation mode*). *External mode* is treated as the baseline, with dummy variables for *Internal* and *Cooperation* modes included in the regression model. In total, 47.3 percent of firms mainly used the *Internal mode*, 36.5 percent the *Cooperation mode*, and 14.8 percent the *External mode*, while 1.4 percent did not know and were excluded from further analysis.

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Second, *New-to-market* is a dichotomous variable measuring whether the new product or service was new to the market or only new to the firm. Managers were asked whether any of their new products were new to the market, or whether they were only new to their company and very similar to a product that already existed in the market. In total, 57.2 percent answered that the product innovations were new to the market. Again, we include a dummy variable for *New-to-market* innovations against a baseline of new-to-firm innovations.

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Third, *Partners* is a vector of three indices measuring the innovative firm's established partnerships with other companies and organizations. As argued above, it is not only the number of partners that may be important. The crucial point may be the number of different partners (Osborn & Hagedoorn, 1997). Following our definition of networks, the greater the number of bilateral partnerships, the larger the scope of the network. If these partnerships link firms to socioeconomic agents which are different in the nature (such as research centres, universities, and government offices or agencies), the network becomes a triple-helix network. This argument is picked up in our analysis by counting the number of partnerships involving different partner types. Managers were therefore asked whether their firm had cooperated with any of seven different types of partners (other companies within the conglomerate, suppliers, customers, competitors, consultancies, universities, and research institutes) in the last three years. We expect that the relationship is rather long-lasting and purposely established to gain access to complementary assets. Note that in our conceptualization, networks emerge from firms establishing collaborations with types of partners of a different nature. Therefore, if a firm only establishes partnerships within the supply chain, that would be considered as outsourcing in the market within our framework. If, by contrast, partnerships go beyond the supply chain and involve

1 competitors, consultancies and/or research institutions and this is repeated by multiple  
2 agents, a network emerges. We assume that a large number of different types of  
3 partners represents evidence of a firm's embeddedness in triple-helix-type networks.  
4 For each type of partner, managers were also asked whether the partner(s) were  
5 located within their own region, elsewhere in the country, and/or abroad. Based on  
6 their responses to these questions, we created three indices measuring the firm's  
7 network within the region (*Regional partners*), nationally outside of the region  
8 (*National partners*), and abroad (*International partners*). Each index is simply a count  
9 of the number of different types of partners used at each geographical scale. The  
10 average innovative firm used 2.36 ( $\pm 0.12$ ) types of regional partners, 1.59 ( $\pm 0.11$ )  
11 types of national partners, and 1.23 ( $\pm 0.10$ ) types of international partners.  
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27 In order to assess further the role of networks, we also run a separate analysis in  
28 which we measure the impact of collaborating with different types of partners, by re-  
29 specifying *Partners* according to the type of partner(s) with whom firms collaborate,  
30 rather than the geographical location of these partners. We examine four different  
31 basic types of partners, each coded as dummy variables, which take the value 1 if the  
32 firm has collaborated with any of its suppliers and/or customers (*Supply-chain*  
33 *partners*), its competitors (*Competitor partners*), with consultancy firms (*Consultancy*  
34 *partners*), or with universities and/or research institutes (*R&D partners*).  
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## 51 Controls

52 The analysis controls for a set of factors that could be expected to affect both firms'  
53 share of income from new products and services and their values on the independent  
54 variables. First, *Company size* is measured as the natural logarithm of the number of  
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1 employees in the company. Larger firms are usually older and more established and  
2 could be expected to procure comparatively more of their income from existing  
3 products. They also have a higher capacity for internal development of innovations  
4 and possibly for networking with partners. The average innovative firm in the survey  
5 has 80 ( $\pm 14$ ) employees, while the median is 27 employees. 75 percent of firms have  
6 60 employees or less. Second, *Foreign ownership* is measured as the proportion of  
7 shares held by non-Norwegian owners. Foreign-owned firms could be expected to  
8 have a larger international network and to introduce products and services developed  
9 by sister or mother companies elsewhere. In total, 79.6 percent of the innovative firms  
10 are completely Norwegian owned, while 15.3 percent are completely owned by  
11 foreigners. The remaining 5.1 percent are partly owned by foreigners (50 percent or  
12 less in 3.7 percent of cases). Third, *Industry* will affect the pace of innovation and  
13 therefore the proportion of income emanating from new products. There are also  
14 different traditions and cultures for networking and cooperation, and for secrecy about  
15 new product development, across industries. We include dummy variables for nine  
16 different industries based on the firm's official listing in the Norwegian Register of  
17 Business Enterprise by NACE codes. The categories used were mining and quarrying  
18 (1.6 percent of innovative firms); manufacturing (22.2 percent); construction (8.5  
19 percent); electricity, gas and water supplies (0.5 percent); wholesale and retail trade  
20 (19.6 percent); food and accommodation services (6.7 percent); transportation,  
21 storage, information and communication (7.4 percent); financial and insurance  
22 activities (3.6 percent); and other services (29.9 percent). We included dummy  
23 variables for each category, with *Other services* as the baseline.  
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## Analysis

Including the variables described above in the model, we fit the following regression models to the data:

$$\text{Log}_e(\text{innoshare}_i + 1) = \alpha + \beta_1 \text{Innomode}_i + \beta_2 \text{New-to-market}_i + \beta_3 \text{Controls}_i + \varepsilon_i \quad (1)$$

$$\text{Log}_e(\text{innoshare}_i + 1) = \alpha + \beta_1 \text{Innomode}_i + \beta_2 \text{New-to-market}_i + \beta_3 \text{Partners}_i + \beta_4 \text{Controls}_i + \varepsilon_i \quad (2)$$

where  $\alpha$  is a constant and  $\varepsilon$  is an idiosyncratic error with random normal distribution.

Table 1 shows the results of the analysis for model 1 and model 2. A full set of diagnostic tests have been performed on the analyses, including for non-linearity, multicollinearity, heteroscedasticity and significant outliers. As the latter test revealed some significant outliers, the models were also analysed using a robust regression model. The results from this analysis are shown in the last two columns of Table 1 and produce broadly the same findings as in the OLS model. The Breusch-Pagan test also showed significant heteroscedasticity ( $p=0.04$  for both models). The model is therefore fitted with robust standard errors.



**Table 1: OLS and robust regression estimations of the empirical models**

Outcome: Log(Innoshare+1)	Model 1	Model 2	Model 1 Robust	Model 2 Robust
Internal	0.59*** (0.12)	0.55*** (0.12)	0.59*** (0.12)	0.54*** (0.12)
Cooperation	0.23* (0.12)	0.20 (0.12)	0.22* (0.12)	0.19 (0.12)
New-to-market	0.24*** (0.08)	0.19** (0.08)	0.19** (0.08)	0.15* (0.08)
Regional partners		-0.00 (0.02)		-0.01 (0.02)
National partners		0.03 (0.03)		0.02 (0.03)
International partners		0.10*** (0.03)		0.10*** (0.03)
Company size	-0.18*** (0.04)	-0.21*** (0.04)	-0.18*** (0.04)	-0.20*** (0.04)
Foreign ownership	0.05 (0.10)	-0.07 (0.11)	-0.01 (0.11)	-0.14 (0.11)
Mining	0.42 (0.31)	0.38 (0.31)	0.40 (0.32)	0.30 (0.31)
Manufacturing	-0.29*** (0.10)	-0.27*** (0.10)	-0.30*** (0.10)	-0.30*** (0.10)
El., gas and water supplies	-0.15 (0.21)	-0.16 (0.29)	-0.23 (0.74)	-0.24 (0.73)
Construction	-0.15 (0.16)	-0.08 (0.16)	-0.25 (0.15)	-0.18 (0.15)
Wholesale and retail trade	-0.27** (0.11)	-0.25** (0.11)	-0.29** (0.11)	-0.28** (0.12)
Hotels and restaurants	-0.39** (0.16)	-0.31* (0.17)	-0.44** (0.18)	-0.36** (0.17)
Transport and communications	-0.13 (0.17)	-0.10 (0.16)	-0.09 (0.16)	-0.07 (0.16)
Financial services	-0.76*** (0.24)	-0.77*** (0.24)	-0.69*** (0.21)	-0.70*** (0.21)
Constant	3.06*** (0.18)	3.03*** (0.20)	3.15*** (0.18)	3.15*** (0.18)
N	752	752	752	752
R <sup>2</sup>	0.12	0.14		

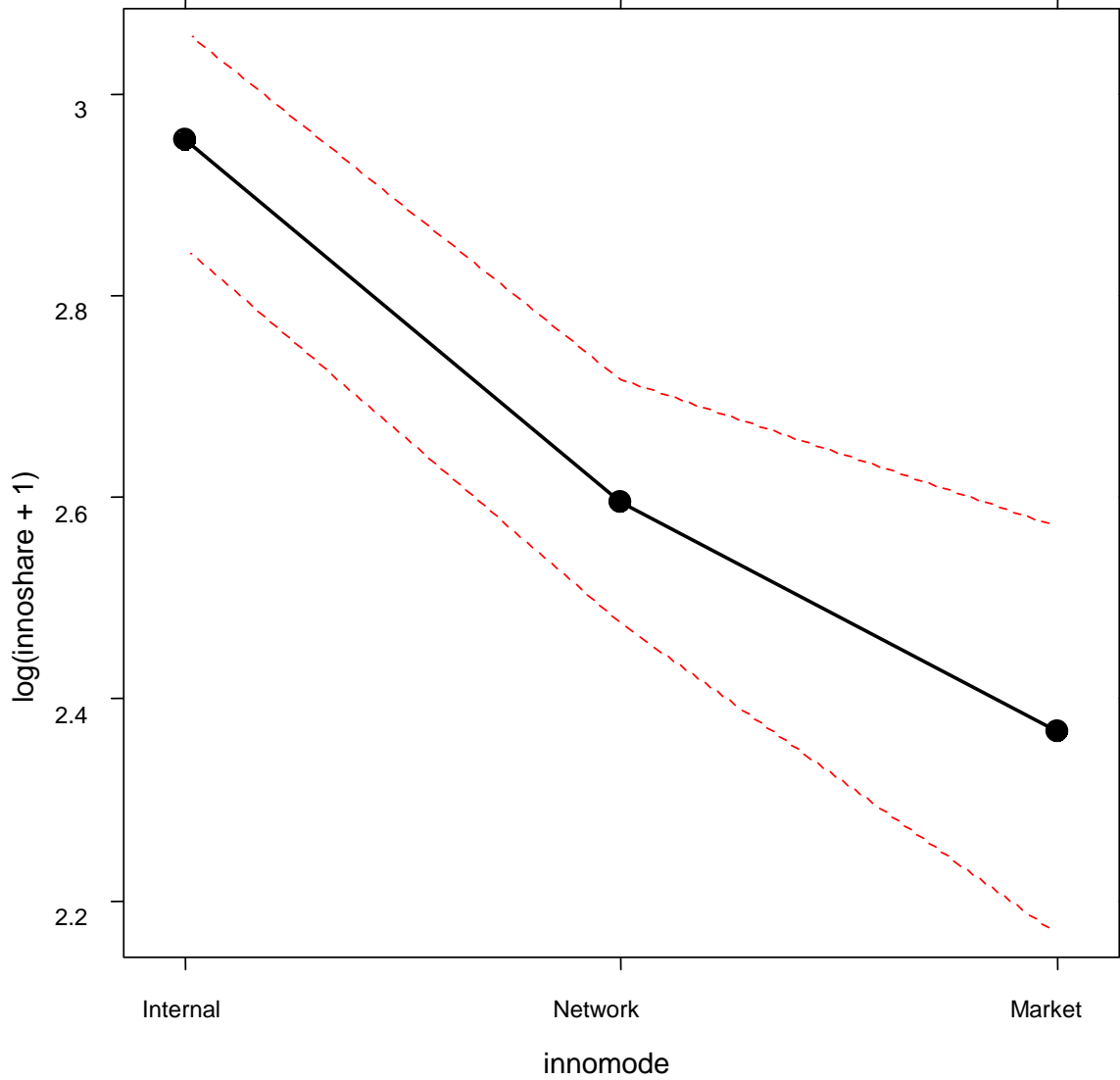
Note: \* = P<0.10, \*\* = P<0.05, \*\*\* = P<0.01.

Table shows regression coefficients, with robust standard errors listed below in parentheses.

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In line with hypothesis 1 and hypothesis 4a, firms that develop new products and services internally earn a significantly higher share of their income from innovations than do firms that procure new product development in the market or in cooperation with other companies or organizations. Firms that are active in networks are also significantly more innovative than those who procure innovation by simple bilateral, commercial interaction in the market, supporting hypothesis 2. The log share of income from innovation in the group that develops new products internally is 0.59 higher than among firms who hire external companies or organizations to develop new products for them (market mode), and 0.36 higher than among firms who cooperate with others (triple-helix network mode). Furthermore, the log share of income among firms using the network mode is 0.23 higher than among firms using the market mode. This difference is significant at the 90 percent level. However, when we control for *Partners*, the difference between the latter two groups falls to 0.20 and is no longer statistically significant, suggesting that the impact of collaborating with partners depends crucially on how many types of partners the firm collaborates with, as well as where these are located. The difference between internal organization and the two other modes also falls slightly – to 0.55 and 0.35 compared to market organization and networks, respectively – but it remains significant. Figure 2 shows the expected values of  $\log(\text{Innosshare}+1)$  for firms in the three groups, controlling all other variables at their means. The dotted lines represent 95 percent confidence intervals of the estimates. The expected share of income for new products or services for an average firm that develops innovations internally is  $e^{2.95} - 1 = 18.2$  percent. For a firm that uses a network mode, it is  $e^{2.60} - 1 = 12.4$  percent, and for a firm that hires other companies or organizations to develop its innovation, the predicted share is  $e^{2.37} - 1 = 9.7$  percent.

Figure 2: Effect of innovation mode on income share from innovations



Firms that develop products which are new to the market also earn a significantly higher share of their income from new products than firms who are early adopters and introduce products which are only new to the firm, supporting hypothesis 5a, rather than 5b. The log share of income from new products is 0.24 higher for firms that introduce products that are new to the market. For an average firm with an early adoption strategy, the fitted value of *Innoshare* is  $e^{2.60} - 1 = 12.4$ , whereas it is  $e^{2.83} -$

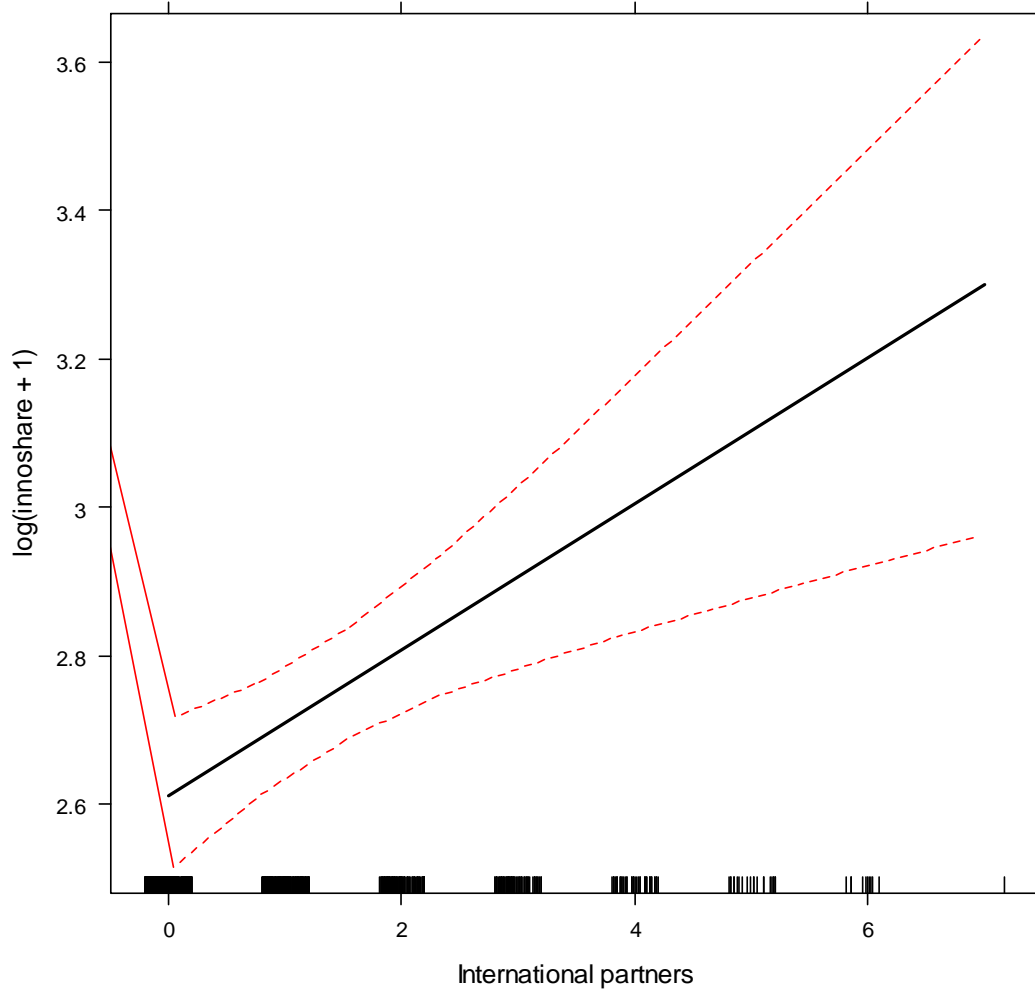
1 = 16.0 for a first mover. The effect of introducing original products is somewhat weaker when some influential outliers are weighted down in the robust regression analysis, but it is still positive and significant.

Model 2 introduces a third independent variable – *Partners*. This reduces the effect of each of the other independent variables and makes the difference between the network mode and the market mode no longer statistically significant. As for the effect of partnerships, neither regional nor national partners make a difference for the firms' share of innovation income. Hypothesis 3a is therefore not supported. However, collaborating with a wide range of international partners has a strong and significant positive effect on innovation income, supporting hypothesis 3b. For each additional type of international partner with which the firm collaborates, its log share of income from new products increases by 0.10. Contrary to expectations in much of the literature, the development of local triple-helix networks yields much lower returns than engaging in wider geographical networks, at least in the case of Norway. International network development delivers greater innovation and firm-level income and profits than networking at close quarters in what are relatively small local and national markets. As Leydesdorff (2012) suggests, the sources of innovation at firm level in Norway may have become systemic rather than constrained by local or national boundaries.

Figure 3 plots the fitted values of  $\log(\text{Innosshare}+1)$  at different levels of *International partners*, controlling all other variables at their means. The dotted lines represent 95 percent confidence intervals of the estimates. The expected share of income from innovation increases from  $e^{2.61} - 1 = 12.6$  for a firm that does not cooperate with any foreign partners to  $e^{3.30} - 1 = 26.1$  for the rare case of a firm which is completely embedded in international triple-helix-type networks and cooperates with all seven

types of foreign partners. Introducing this additional variable into the model also increases the explained variance from 0.12 to 0.14.

**Figure 3: Effect of international partners on income share from innovations**



Note: The bars on the x-axis indicate the frequency of firms in each category of *international partners*.

Among the control variables, company size has a significant negative effect on innovation income. As expected, larger firms earn more of their income from established products.

Unlike foreign partnerships, foreign ownership does not affect the share of income from new products. Controlling for the other variables in the model, Norwegian and

1 foreign-owned firms earn a similar proportion of their income from new products. In  
2 terms of industry, firms in “other services” (these are mostly knowledge-intensive  
3 services, e.g. real-estate, legal services, accountancy, consultancy, marketing) tend to  
4 earn a comparatively higher share of their income from new products and services.  
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6 Only mining has a – non-significant – positive coefficient compared to the baseline,  
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8 whereas four industries have significantly less income from innovation than “other  
9 services”: Wholesale and retail trade, manufacturing, hotels and restaurants, and  
10 financial services. The share of income from new products is by far the lowest in the  
11 latter group, with a log share that is 0.77 lower than among firms in ‘other services’.  
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22 In table 2, we specify two new models that represent different specifications of the  
23 regression equations presented in model 2. Model 3 is identical to model 2 with the  
24 exception that the vector *Partners* is now a measure of the types of partners, rather  
25 than their geographical location, as detailed in the section on independent variables.  
26  
27 For the variables *Innomode* and *New-to-market*, as well as for the controls, the results  
28 are consistent with model 2, with only minor changes in the coefficients. The  
29 coefficients of interest in this case are those associated with the dummy variables for  
30 different types of partners. In model 3, we simply include the four different indicators  
31 and examine if interaction with any of the four types of partners has an impact on the  
32 innovation levels of the firm. The analysis shows that two of the four variables –  
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*Supply-chain partners* and *R&D partners* – have a positive and significant effect on  
*Innoshare*. The average firm that does not collaborate with supply-chain partners has  
a predicted value of *Innoshare* of  $e^{2.44} - 1 = 10.5$  percent, compared to  $e^{2.76} - 1 = 14.8$   
percent for firms that do. Firms that do not collaborate with R&D partners have a  
predicted value of  $e^{2.67} - 1 = 13.4$  percent, while the predicted value for those that do

is  $e^{2.84} - 1 = 16.1$  percent. For the other two types of partners – competitors and consultancies – the effect is negative, but not significant.

**Table 2: OLS regression estimations, testing for type of partner**

Outcome: Log(Innoshare+1)	Model 3	Model 4
Internal	0.56*** (0.13)	0.57*** (0.13)
Cooperation	0.20 (0.13)	0.21 (0.13)
New-to-market	0.21*** (0.08)	0.21*** (0.08)
Supply-chain partners (only)	0.31* (0.17)	0.37* (0.19)
Competitor partners	-0.06 (0.08)	-0.06 (0.08)
Consultancy partners	-0.03 (0.08)	-0.03 (0.08)
R&D partners (only)	0.17** (0.08)	0.49 (0.43)
Supply-chain and R&D partners		0.53*** (0.19)
Company size	-0.20*** (0.04)	-0.20*** (0.04)
Foreign ownership	0.04 (0.10)	0.04 (0.10)
Industry fixed effects	Yes	Yes
Constant	2.82*** (0.25)	2.77*** (0.27)
N	752	752
R <sup>2</sup>	0.13	0.13

Note: \* = P<0.10, \*\* = P<0.05, \*\*\* = P<0.01.

Table shows regression coefficients, with robust standard errors listed below in parentheses.

In model 4, we further include an interaction between the two key types of triple-helix partners that were found to have a significant impact on *Innoshare* in model 3. This analysis examines the interaction between collaboration within the supply-chain and with research institutions by specifying three dummy variables – one for firms that collaborate with supply-chain partners only, one for firms that collaborate with R&D

1 partners only, and one for firms that collaborate with both supply-chain and R&D  
2 partners. These three variables are compared against a baseline of firms that  
3 collaborate with neither supply-chain nor R&D partners. The results show that  
4 collaborating with both supply-chain and R&D partners is associated with the highest  
5 share of income from new products,  $e^{2.85} - 1 = 16.3$  percent. Interaction with supply-  
6 chain partners only also has a significant positive effect, while the effect of interaction  
7 with R&D partners is positive, but not statistically significant. The predicted value of  
8 *InnoShare* is  $e^{2.69} - 1 = 14.7$  percent for firms that collaborate with supply-chain  
9 partners only, and  $e^{2.82} - 1 = 15.8$  percent for firms that collaborate with R&D  
10 partners only. The lowest levels of innovation are found among firms that collaborate  
11 with neither supply-chain nor R&D partners, where the expected value is  $e^{2.32} - 1 =$   
12 9.2 percent. While the analysis show that the most innovative firms collaborate with  
13 both supply-chain and R&D partners, they do not show a positive interaction between  
14 the two types of collaboration, as the sum of the coefficients for supply-chain partners  
15 only and R&D partners only is larger than the coefficient for collaborating with both  
16 ( $0.37 + 0.49 > 0.53$ ). However, this difference is not statistically significant. The other  
17 coefficients in the model change very little from model 3.

18 Table 3 shows an analysis of the interaction between the mode of innovation –  
19 hierarchy, triple-helix network or market – and whether or not firms have established  
20 partnerships with any of the critical innovation partners – other firms in the supply-  
21 chain and/or R&D institutions. The analysis shows that there is very little difference  
22 between the three modes of innovation when the firm does not cooperate with other  
23 firms in its supply-chain or with R&D institutions. However, when such partners are  
24 present, the hierarchy and network modes become much more efficient than the  
25 market mode. In particular, three constellations stand out as being associated with



1 significantly higher shares of income from new products compared to the baseline.

2 The highest level of innovation can be found among firms in the network mode that  
3 cooperate with R&D institutions. Firms that organize their innovation processes  
4 internally, but also have strong links within the supply-chain, are also significantly  
5 more innovative, in particular if they also collaborate with R&D institutions.  
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**Table 3: OLS regression estimations, interacting *Innomode* with type of partner**

Outcome: Log(Innoshare+1)	Model 5
Internal with no supply-chain or R&D partners	Baseline
Internal + R&D partners	0.50 (0.77)
Internal + supply-chain partners	0.54** (0.25)
Internal + supply-chain + R&D partners	0.75*** (0.25)
Cooperation with no supply-chain or R&D partners	-0.04 (0.40)
Cooperation + R&D partners	0.85*** (0.25)
Cooperation + supply-chain partners	0.21 (0.25)
Cooperation + supply-chain + R&D partners	0.28 (0.26)
External with no supply-chain or R&D partners	-0.01 (0.56)
External + R&D partners	0.18 (0.39)
External + supply-chain partners	-0.03 (0.28)
External + supply-chain + R&D partners	0.05 (0.31)
New-to-market	0.21*** (0.08)
Company size	-0.20*** (0.04)
Foreign ownership	0.04 (0.10)
Industry fixed effects	Yes
Constant	3.11*** (0.29)
N	752
R <sup>2</sup>	0.14

Note: \* = P<0.10, \*\* = P<0.05, \*\*\* = P<0.01.

Table shows regression coefficients, with robust standard errors listed below in parentheses.

## Conclusion

Our analysis has highlighted that the organization of the innovation effort in firms, as well as its geographical dimension, make a difference to the product innovation performance of firms. If innovation processes are organized in contrasting ways, the returns to product innovation may be significantly greater. On the one hand, companies that develop product and service innovations based on internal hierarchy seem to derive a significantly higher share of their income from innovation, compared to those relying on simple dyadic partnerships for sourcing innovation from the market. However, the apparent superiority of internal hierarchy for product innovation is challenged when more complex external networks are considered. The participation in broad-based networks, involving different types of socioeconomic agents – as advocated in the triple-helix approach – in the development of new products and services is also associated with earning a higher share of income from innovation compared to conducting product development through market mechanisms. In the latter case, a crucial point is that the network needs to be sufficiently wide to avoid lock-in and overembeddedness. If networks include a broad scope of different partners, both in terms of their geography and the type of partner, their impact on innovation may be very large indeed. If the network is too narrow and constrained, it might have no impact at all.

Our analysis highlights that innovation and the rewards from innovation can be achieved by different forms of organization within the firm, ranging from pure internal sourcing to multiple cooperations with partners of diverse origin. These findings have implications for firms deciding how to organize their product innovation processes. In light of the increasing tendency for firms to split up their value chains and outsource parts of the production and innovation process to external

1 actors, it is noteworthy that those firms which organize the development of new  
2 products internally tend to reap greater returns. This might prompt some firms to  
3 reconsider how they organize new product development. However, the findings also  
4 suggest a different route that may provide even greater rewards: Developing new  
5 products together with external partners that are sufficiently diverse – in terms of  
6 geographical location and function, including partners from the supply-chain and  
7 from R&D communities – can produce significant returns. Hence, if firms choose to  
8 outsource parts of the innovation process, the greatest returns may stem from working  
9 in close cooperation with their partners rather than at arms-length, and from involving  
10 a sufficiently wide network of partners in the way proposed by the triple-helix  
11 approach.  
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27 Having said that, it has to be borne in mind that the study has several shortcomings.  
28 First, we have only differentiated between truly novel and imitated innovations. A  
29 finer distinction between innovations, for instance the degree of tacit knowledge and  
30 other knowledge modes, the scope of uncertainties and the longevity of the  
31 partnerships could facilitate more precise predictions. Furthermore, by linking the  
32 different strands of theory to evolutionary perspectives on innovation processes, we  
33 could have detailed the innovation process and discussed where in that process the  
34 different organization modes may be more efficient. For instance, as documented  
35 above, the number of different international partners facilitates more product and  
36 service innovation than fewer and more local partners. Is that effect primarily linked  
37 to the early phases of the process by offering more ideas, or does it also include the  
38 appropriation phase? Finally, the study is limited to firms in Norway, which is a high-  
39 trust society where network organization may be more effective, and which therefore  
40 has a long tradition of inter-firm cooperation in innovation processes. It is also a small  
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country with a relatively limited market in many areas, reducing the potential for outsourcing parts of the innovation process. While all of these questions merit further research, the study has shown that involvement in purpose-built triple-helix-type international networks are more important for Norwegian firms than local interaction for the generation of innovation and economic dynamism. This contributes to the triple-helix approach in underlining that triple-helix networks must be of sufficient scope – in terms of geography as well as type of partner – in order to deliver the expected benefits.

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