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THE EXAMINATION EFFECT: A COMPARISON OF THE OUTCOME OF PATENT EXAMINATION IN THE US, EUROPE AND AUSTRALIA

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ABSTRACT

The article provides an answer to a question that, rather surprisingly, has not been addressed in the academic literature to date: What is the practical effect of patent examination? It does so by undertaking an empirical analysis of the examination of nearly 500 patent applications, filed in identical form, in three patent offices: the United States Patent and Trademark Office (USPTO), the European Patent Office (EPO), and the Australian Patent Office (APO). By comparing the form of claim 1 as granted with claim 1 in the patent application, we can identify whether there is any meaningful difference between the two and, if so, what is the type of difference. Any identifiable difference will show both the extent to which, and the way in which, the examination process within each office has a practical effect. Furthermore, by comparing the frequency with which each office effects meaningful change to claim 1, we can identify in which of the offices the process of examination has the greatest practical effect. We find that the routine effect of patent examination is to produce meaningful change, specifically a narrowing, to the definition of the invention contained in claim 1 of the patent. Importantly, this effect occurs more often in the USPTO than in the EPO, and more often in both of those offices than in the APO. Notably, our findings suggest that the quality of patents granted by the USPTO is higher than those granted by the other two offices despite its reputation for issuing many "bad quality" patents.

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I. INTRODUCTION

This article looks at a question that, rather surprisingly, has not been considered before in the academic literature: What is the practical effect of patent examination? Re-stated in an elaborated form, the unexplored issue that we investigate is the extent to which patent examination changes the legal scope of the patent in the form in which it is granted compared to the form in which it was applied.

This question is important because patent offices, in particular the United States Patent and Trademark Office ("USPTO"), increasingly have been criticized for the poor quality of their patent examination.[1] Although many patent scholars have asserted that the USPTO grants too many "bad" patents, and that these substandard patents unnecessarily stunt productive research and discourage innovation,[2] there is a notable absent of agreement as to what constitutes a "good" or a "good quality" patent.[3] Despite this lack of agreement on what constitutes patent

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[1] *See, e.g.*, Ronald J. Mann & Marian Underweiser, *A New Look at Patent Quality: Relating Patent Prosecution to Validity*, 9 J. EMPIRICAL LEGAL STUD. 1 (2012); James Bessen & Michael J. Meurer, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK (2008); Dan Burk and Mark Lemley, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT (2009).

[2] *See, e.g.*, R. Polk Wagner, *Understanding Patent Quality Mechanisms*, 157 U. PA. L. REV. 2135, 2138 (2009); Michael D. Frakes and Melissa F. Wasserman, Does the U.S Patent and Trademark Office Grant Too Many Bad Patents? Evidence from a Quasi-Experiment, 67 Stan. L. Rev. 613 (2015); Doug Lichtman & Mark A. Lemley, *Rethinking Patent Law's Presumption of Validity*, 60 STAN. L. REV. 45, 47 (2007); Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1495 (2001).

[3] Few scholars would dispute that a good quality patent should, at a minimum, satisfy the "statutory standards of patentability." *See* Wagner, *supra* note 2, at 2138. But there are differing opinions among scholars as to whether something more than just legal validity is required for a

quality, there is a general consensus that the relevant patent office, through its examination process, is primarily responsible for ensuring that quality patents are granted.

While much has been written over the past two decades on what changes could be made to USPTO practice to increase patent quality,[4] there is a dearth of understanding about what effect the USPTO's examination process has on the scope of the legal monopoly provided by the patents it grants and how this effect compares with that of other patent offices. To fill these knowledge gaps, we undertake an empirical analysis that compares, for approximately 500 granted patents, the form of the first claim ("claim 1") in the granted patent ("granted claim 1") with claim 1 in the patent application as filed for examination ("application claim 1"). By comparing the granted claim 1 with the application claim 1, we can identify whether there is any meaningful difference between the two and, therefore, the extent to which the examination process has a practical effect.[5]

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patent to qualify as a good quality patent. C. Guerrini, *Defining Patent Quality*, 82 FORDHAM L. REV. 3091, 3095 (2014). For example, some scholars believe that the "quality" of a patent should also be measured in terms of its commercial value, or technological and social utility. To do so they utilize simple indicators, such as the payment or non-payment of patent maintenance fees. Mark Shankerman & Ariel Pakes, *Estimates of the Value of Patent Rights in European Countries During the Post-1950 Period*, 96 ECONOMIC J. 1052 (1986). Another indicator used is the number of forward citations attributed to the patent. Rebecca Henderson, Adam B. Jaffe, & Manuel Trajtenberg, *Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965-1988*, 80 REV. ECON. AND STAT. 119-127 (1998).

[4] *See, e.g.*, Frakes & Wasserman, *supra* note 2, at 613 (stating that the fact that aggrieved applicants, once rejected, can continuously restart the examination process by filing repeat applications may create an incentive for an overwhelmed and underfunded USPTO to grant additional patents); Michael D. Frakes & Melissa F. Wasserman, *Does Agency Funding Affect Decisionmaking? An Empirical Assessment of the PTO's Granting Patterns*, 66 VAND. L. REV., 67, 80 (2013) (finding that the back-end fee structure of the USPTO biased a financially constrained PTO toward allowing patents); Jay P. Kesan, *Carrots and Sticks To Create a Better Patent System*, 17 BERKELEY TECH. L.J. 763, 784-86 (2002) (calling for mandatory technical methods of disclosure for software patents); Robert P. Merges, *As Many As Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent Reform*, 14 BERKELEY TECH. L.J. 577, 606-09 (1999) (arguing that the USPTO should raise the salaries of senior examiners to induce them to stay and increase the training of junior examiners).

[5] Claim 1 is taken as the most appropriate unit of analysis because it is typically the broadest claim in a given patent application and, therefore, is of most importance to the patent applicant and to third parties concerned with the scope of exclusive rights granted by the patent.

We undertake this analysis separately for three patent offices: the USPTO, the European Patent Office ("EPO"),[6] and the Australian Patent Office ("APO").[7] Importantly, we assess how each office examines *identical* claims—that is, filed patent applications in which claim 1 is in precisely the same form in each of the three offices. By using identical claims, we are able to compare the effect of the examination process in each office against the effect in the other offices.

Our analysis focuses on three particular matters: (i) the *rates* at which the examination process produces meaningful change to claim 1; (ii) the *types* of meaningful change to claim 1 produced by the examination process; and (iii) the *factors* that are associated with the meaningful changes produced by examination. For all three matters, tests of statistical significance are conducted to determine which of the observed differences—both across and between offices—are statistically significant. As a result, we are able to draw detailed conclusions about the practical effects of the patent examination process in the offices, the differences between the offices in those effects, and the consequences of those differences.

II. METHOD

A. Sample Selection

Our quantitative evaluation of the patent examination process is based upon the collection and comparison of patent claims in a sample of patent families from the three offices. From a PATSTAT database dated September 2008, a large sample of patent families was identified using a search query. The search terms limited the identification of patent families to those that: (i) had at least one published patent application and one published grant from the USPTO with a filing date

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[6] The EPO was chosen as a comparator office because it and the USTPO are two of the three trilateral patent offices and the two that examine patent applications in English. The trilateral patent offices comprise, in addition to the USPTO and the EPO, the Japanese Patent Office. These offices established the Trilateral Co-operation in 1984. The objectives of the Trilateral Cooperation include improving the quality of examination processes and reducing the processing time of patent applications, harmonizing practices of the three offices, and exploiting the potential of work performed by the other Trilateral Offices in search, examination, documentation and electronic tools. *Objectives*, Trilateral, http://www.trilateral.net/about/objectives.html (last visited Aug. 23, 2016).

[7] The APO is formally known as IP Australia. The APO was included because it is the national office of the researcher's home country and the project was financially supported by the researchers' national research council, the Australian Research council, through its Linkage Project scheme as part of the project entitled: *The fingers of the powers above do tune the harmony of this peace": Australia and the Harmonisation of Patents* (Andrew Christie and Chris Dent, LP0882034). The Linkage Partners for the project were IP Australia and the Institute of Patent and Trade Mark Attorneys of Australia.

between 1 July 2003 and 31 December 2004;[8] (ii) had at least one published patent application and one published patent grant in English from the EPO; and (iii) had at least one published patent application and one published patent grant from the APO. The search strategy did not limit identification to patent families the applications for which had been filed in a particular manner. Thus, the search strategy identified applications filed through the Patent Cooperation Treaty ("PCT") process as well as applications filed directly in each office.

The objective of the research required that application claim 1 in each of the three offices was identical. The identity of application claim 1 was required to ensure that the nature of any change observed in granted claim 1 in one office could be compared with the nature of any change to the granted claim 1 in another office, by having the same reference point for determining the effect of those changes, namely, an identical application claim 1. To achieve this requirement of identity we excluded patent families in which the application claim 1 in the U.S. application did not match precisely the application claim 1 in either of the other two offices. As a result of such filtering, the number of matched patent applications that remained for analysis numbered 494.

B. Collection of Claims from Patent Application and Grants

The text of the application claim 1 and the granted claim 1 of each patent in the sample was collected using Internet-based resources. Specifications published by the USPTO were collected from Patent Full-Text Databases,[9] specifications published by the EPO were collected from the European Publication Server,[10] and PCT specifications published by the World Intellectual Property Office ("WIPO") were collected from Patentscope.[11] Specifications published by the APO were collected from Patent Lens,[12] rather than from IP Australia's AusPat database,[13] because the AusPat documents could not be digitally highlighted and copied (a process necessary for the comparison stage, discussed below). Each application claim 1 and each granted claim

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[8] These temporal limits were chosen to ensure that the vast majority of patent applications filed in the period would have been examined, and that the required documents were available for analysis from the USPTO website.

[9] *Patent Full-Text Databases*, UNITED STATES PATENT AND TRADEMARK OFFICE, http://patft.uspto.gov/ (last visited Aug. 23, 2016).

[10] *European Publication Server*, EUROPEAN PATENT OFFICE, http://data.epo.org/publication-server/?lg=en (last visited Aug. 23, 2016).

[11] *Patentscope,* WORLD INTELLECTUAL PROPERTY ORGANIZATION, http://www.wipo.int/pctdb/en/ (last visited Aug. 23, 2016).

[12] LENS: OPEN PUBLIC RESOURCE FOR INNOVATION CARTOGRAPHY, http://www.patentlens.net (last visited Aug. 23, 2016).

[13] *AusPat,* AUSTRALIAN GOVERNMENT: IP AUSTRALIA, http://pericles.ipaustralia.gov.au/ols/auspat/ (last visited Aug. 23, 2016).

1 was copied from the relevant websites and pasted into a word processing document for use during the comparison stage.

Occasionally the claims in the USPTO, the EPO and the WIPO published specifications would contain characters that were not present in the original paper version, due to transcription errors. These errors, which were readily recognized either when being pasted in the word processing document or when the automated comparison was undertaken, were corrected by reference to the online scanned version of the original. The claims in the APO publications collected from Patent Lens regularly contained transcription errors, making it necessary to compare every application claim 1 and granted claim 1 with the claim in the original scanned documents, and to correct the claims where necessary prior to insertion into the word processing document.

C. Comparison of Granted Claim 1 with Application Claim 1

The application claim 1 and the granted claim 1 for each patent family, in each jurisdiction, were compared in order to see the impact of the patent examination process. Figure 1 is a representation of the analysis undertaken. It is to be noted that the process of examination of the claims in each office was treated as a "black box" into which we did not peer. That is to say, we did not seek to ascertain how, or why, the examiners made the decisions they did—we simply sought to observe any changes made to application claim 1 that resulted from the examination process, whatever might be the reason for that change.

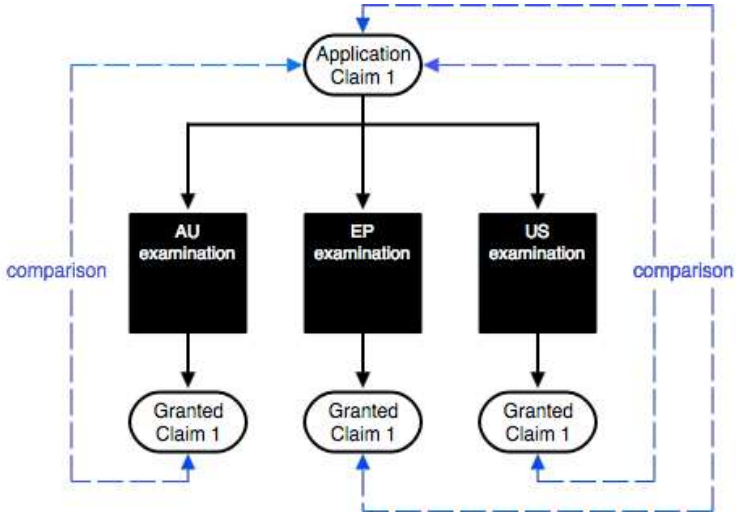

Figure 1: Comparison of granted claim 1 with application claim 1

The comparison of each granted claim 1 with its corresponding application claim 1 was made using the Microsoft Office 2003 Word "compare and merge document" function. This function created a new document, in which differences between the text of the two claims were presented in the form of "additions" and "deletions".[14] For our analysis, an "addition" was text contained in the granted claim 1 that was not in the application claim 1, and a "deletion" was text contained in the application claim 1 that was not in the granted claim 1.

D. Categorization of Differences between Granted Claim 1 and Application Claim 1

A key part of the method was the creation, and use, of a typology of difference between the granted claim 1 and the application claim 1. Differences observed between the claims were classified using a two-level typology of categories and sub-categories, as illustrated in Figure 2 below. The categories and sub-categories are mutually exclusive at each level.

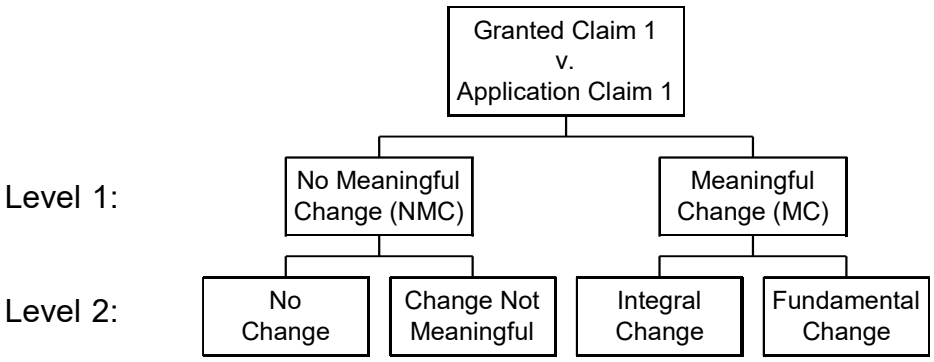

Figure 2: Categorization of differences between granted claim 1 and application claim 1

At the higher, more course-grained, level of analysis (Level 1), the outcome of the comparison of the claims is categorized as either "no meaningful change" or "meaningful change". An outcome is categorized as "no meaningful change" where it is not a "meaningful change". An outcome is categorized as a "meaningful change" where the *scope* of claim 1 has changed as a result of the patent examination process.

[14] Our analysis was concerned only with textual differences. Accordingly, any differences in the formatting of text were ignored.

That is to say, a change from application claim 1 to granted claim 1 is categorized as "meaningful change" where the effect of the change is to make the monopoly provided by the patent over the invention defined in granted claim 1 different to what it would have been had the application claim 1 been granted. The determination of the relative scope of a patent claim is a task that is routinely undertaken by experienced patent lawyers, and our research team included one.

At the lower, more fine-grained, level of analysis (Level 2), an outcome of "no meaningful change" is further categorized as either "no change" or "change not meaningful." An outcome is sub-categorized as "no change" where there was no difference at all between granted claim 1 and application claim 1. An outcome is sub-categorized as "change not meaningful" where there is a difference between the two claims, but the difference does not change the scope of the claim. Included within this sub-category are changes to the spelling of words, the inclusion or removal of numerical references to components of drawings in the specification, and any lexical, grammatical and syntactical changes that do not alter the scope of the invention as defined by the claim. At Level 2, an outcome of "meaningful change" is further categorized as either "integral change" or "fundamental change." An outcome is sub-categorized as "integral change" where the change adds to or alters the elements, or "integers,"[15] of the invention as defined in the claim. An example of integral change is including an additional integer of the form "wherein the X is made of Y." An outcome is sub-categorized as "fundamental change" where the change alters the fundamental form of the invention being claimed. An example of fundamental change is where the invention as claimed is changed from a product to a process, or *vice versa*.

III. RESULTS

A. Rates of Change

The outcome of our Level 1 comparisons of the granted claim 1 with the application claim 1, for each of the 494 patent families in our sample, is shown in Figure 3, below. It can be seen that meaningful change to claim 1 resulted from examination nearly four-fifths of the time in the USPTO, more than two-thirds of the time in the EPO, and just over one-half of the time in the APO.

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[15] Each claim of a patent is a definition of the invention, expressed in terms of the invention's essential elements or features. These individual elements or features are often referred to as "integers."

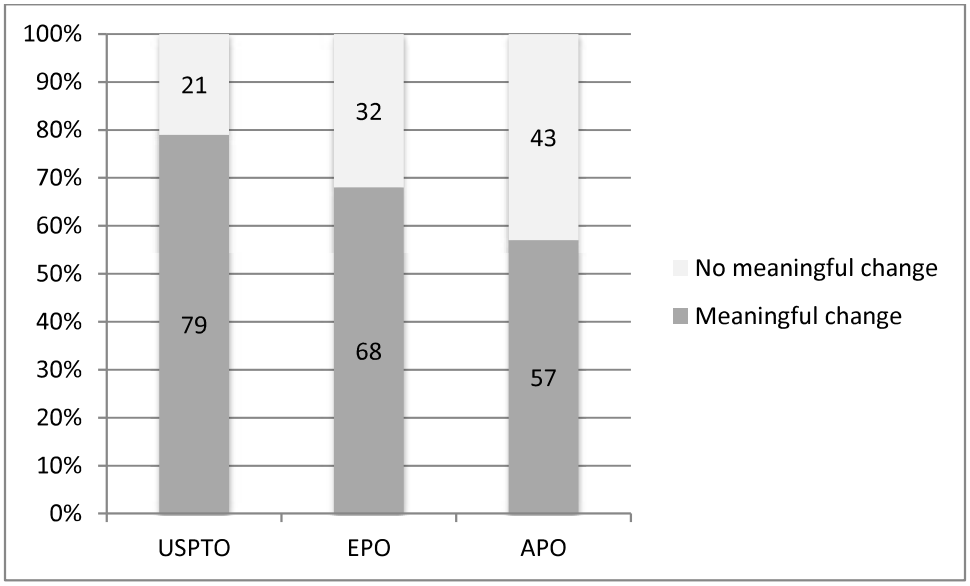

Figure 3: Rate of meaningful change to granted claim 1 over application claim 1

Our Level 1 comparisons were analyzed using a Generalized Linear Mixed Model (on Genstat version 10), using the fitting method described by Breslow and Clayton.[16] The results, shown in Table 1, are in the form of a pair-wise examination of the odds ratios across the offices.[17] It can be seen that the odds of meaningful change in the USPTO were nearly three-quarters higher than in the EPO, and one and three-quarters higher than in the APO, while the odds of meaningful change in the EPO were more than half higher than in the APO. All pairwise comparisons of the odds of meaningful change across the three offices were statistically significant.[18]

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[16] Norman E. Breslow & David G. Clayton, *Approximate Inference in Generalised Linear Mixed Models*, 88 J. AM. STAT. ASS'N. 421, 9 (1993), http://www.jstor.org/2290687.

[17] The model adopted is a generalized linear mixed model analysis that compares, in a pairwise manner, the estimated percentage of meaningful change in each office. The estimated percentage of meaningful change is divided by the estimated percentage of no meaningful change to give the odds of meaningful change in each office. The odds ratio is produced by dividing the odds of meaningful change in one office by the odds of meaningful change in the other office.

[18] We consider a difference with a p-value of less than 0.05 to have statistical significance.

Table 1: Odds ratios for meaningful change, comparing offices

Comparison of offices	Estimate	Odds ratio 95% CI	*p*-value
USPTO - EPO	1.73	1.39, 2.14	< 0.001
USPTO - APO	2.76	2.24, 3.41	<0.001
EPO - APO	1.60	1.32, 1.94	<0.001

B. Types of Change

The outcome of our Level 2 comparisons of the granted claim 1 with the application claim 1, for each of the 494 patent families in our sample, is shown in Figure 4.[19] It can be seen that where the examination resulted in meaningful change to claim 1, the vast bulk of that change in all three offices was "integral change." Where the examination resulted in no meaningful change to claim 1, the outcome in the three offices was more evenly split between "no change" and "change not meaningful."

[19] The percentages shown in the bars of the chart do not always sum to 100%, due to rounding to the nearest whole number.

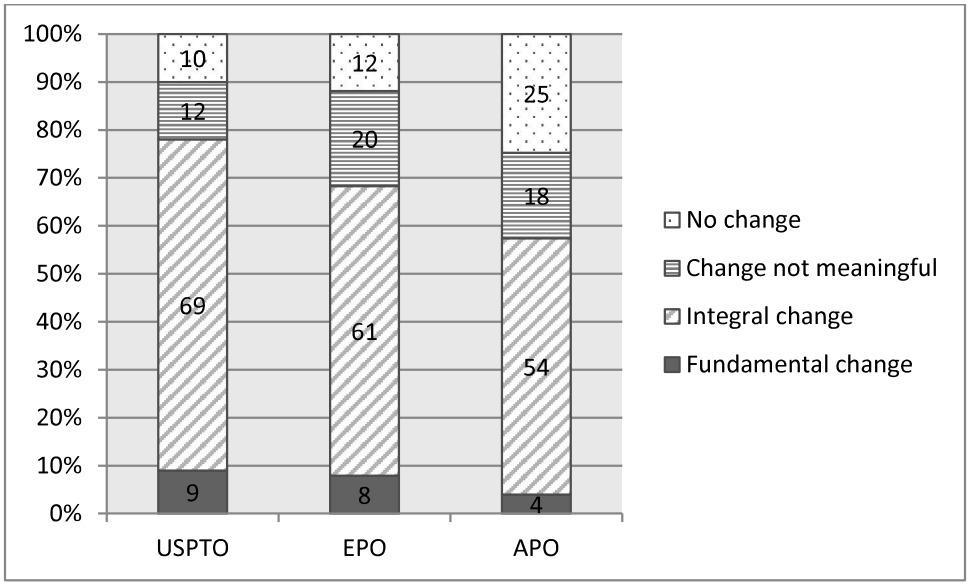

Figure 4: Proportion of different types of change to claim 1

Our Level 2 comparisons of the types of change were also analyzed using a Generalized Linear Mixed Model. It can be seen from the pair-wise comparisons in Table 2 that the following differences in the rate of the different types of changes are statistically significant: (i) the higher rate of fundamental change in both the USPTO and the EPO compared with the APO; (ii) the higher rate of integral change in the both the USPTO and the EPO compared with the APO, and in the USPTO compared with EPO; (iii) the lower rate of change not meaningful in the USPTO compared with both the EPO and the APO; and (iv) the lower rate of no change in both the USPTO and the EPO compared with the APO.

Table 2: Odds ratios for various types of changes, pair-wise comparison of offices

		Odds ratio	
Comparison of offices	Estimate	95% CI	*p*-value
Fundamental change			
USPTO – EPO	1.23	0.78, 1.93	0.364
USPTO – APO	2.57	1.65, 3.98	< 0.001
EPO – APO	2.08	1.46, 2.98	< 0.001
Integral change			
USPTO – EPO	1.47	1.20, 1.79	< 0.001
USPTO – APO	1.96	1.61, 2.39	< 0.001
EPO – APO	1.34	1.10, 1.62	0.003
Change not meaningful			
USPTO – EPO	0.54	0.40, 0.73	< 0.001
USPTO – APO	0.61	0.45, 0.84	0.002
EPO – APO	1.14	0.86, 1.51	0.351
No change			
USPTO – EPO	0.79	0.56, 1.12	0.192
USPTO – APO	0.32	0.24, 0.44	< 0.001
EPO – APO	0.41	0.31, 0.55	< 0.001

C. Effect of Technology of Invention

We ascertained the rate of meaningful change to claim 1 (Level 1 analysis) in all three offices by the field of technology of the claimed invention, using the ISI-OST-INPI categories.[20] The results of that analysis are shown in Figure 5. We found that the differences in the rates of changes resulting from examination at the three offices were largely consistent across all fields of technology. This can be observed from the fact that the gaps between the three lines in Figure 5 remain largely the same regardless of the field of technology of the examined claim.

[20] *See* Ulrich Schmoch, *Concept of a Technology Classification for Country Comparisons*, WIPO, June 2008, <http://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_ipc_technology.pdf>.

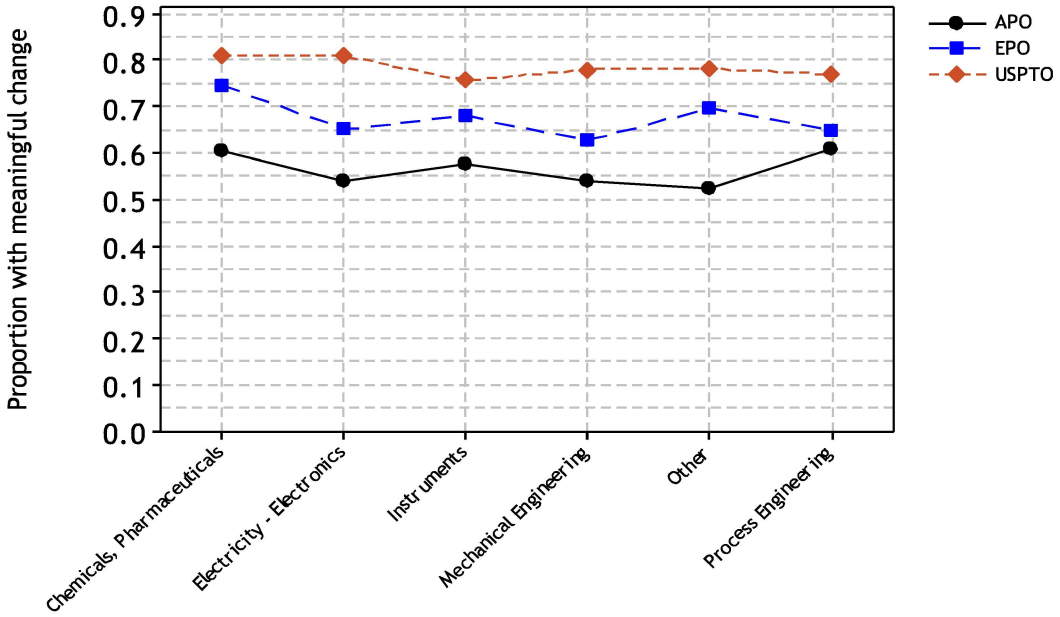

Figure 5: Proportion of meaningful change to claim 1, by field of technology

We then ascertained the effect of the patent office and the field of technology on the odds of meaningful change by fitting a model that allowed for the main effects of these variables and their possible interaction. The results of that analysis, shown in Table 3, indicate that the office of examination does have a statistically significant effect on the odds of meaningful change, but that the field of technology of the examined application does not. Further, the analysis shows that there is no statistically significant interaction between the office and the area of technology.[21] In other words, the odds of meaningful change vary significantly according to the patent office involved in the examination, but not according to the technology field of the claimed invention being examined.

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[21] For this analysis, "interaction exists where the relationship between two variables depends on the particular values of a third." George Argyrous, STATISTICS FOR SOCIAL AND HEALTH RESEARCH 470 (2000). That is to say, an interaction would exist if the relationship between the offices and the fields of technology depended on the rate of meaningful change.

Table 3: Overall tests of the effects of office and field of technology

	F	df	*p*-value
Interaction of Office and Technology	0.55	10,978	0.86
Main effect of Technology	0.57	5,493	0.72
Main effect of Office	45.16	2,988	<0.001

D. Effect of Country of Origin of Application

We further ascertained the rate of meaningful change in all three offices by country of origin of the patent application (as determined by the country of the address of the applicant). The results of that analysis, set out in Table 4, show the rates at which examination resulted in meaningful change to claim 1 of applications originating from the top 13 countries (being those countries from which ten or more applications in the sample originated).

Table 4: Rate of meaningful change to granted claim 1 over application claim 1, by country in which application originated

Country of origin	No. of applications	Rate of meaningful change		
		USPTO (%)	EPO (%)	APO (%)
Australia	11	91	91	55
Canada	17	64	59	47
Denmark	12	92	83	67
Finland	20	65	65	45
France	10	70	80	70
Germany	10	90	70	70
Great Britain	83	81	64	65
Italy	24	62	50	33
Japan	45	60	58	36
Netherlands	19	74	63	58
Norway	15	60	73	40
Sweden	24	75	50	38
United States	139	89	77	66

We then examined the effect of the patent office and the country of origin on the odds of meaningful change by fitting a model that allowed for the main effects of these variables and their possible interaction. The results, shown in Table 5, indicate that the odds of meaningful change depend on both the office and the country of origin. The results also indicate that there is little interaction between the variables—that is to say, the three offices do not deal with applications from the same country in a significantly different manner.

Table 5: Overall tests of the effects of office and country of origin

	F	df	*p*-value
Interaction of Office and Technology	1.01	24,833	0.46
Main effect of Technology	3.00	12,409	<0.001
Main effect of Office	39.96	2,857	<0.001

Finally, we analyzed the effect of examination across the three offices on the applications from each of the top 13 countries, to determine from which countries the applications that underwent more or less meaningful change originated. To undertake a pair-wise analysis, one country must be used as the reference country against which the rate of meaningful change to applications originating in each of the other countries is compared. The United States was used as the reference country because it was the country from which the largest number of applications in the sample originated at 139. Again, the odds ratios were compared, and a statistical test of the significance of observed differences was undertaken. As can be seen from Table 6, examination of applications originating from six countries (Canada, Finland, Italy, Japan, Norway, Sweden) resulted in meaningful change at significantly lower rates than the rates of meaningful change resulting to applications originating from the other countries.

Table 6: Odds ratios for meaningful change, comparing countries of origin

		Odds ratio	
Comparison of Countries	Estimate	95% CI	*p*-value
Italy – USA	0.26	0.12, 0.55	< 0.001
Japan – USA	0.29	0.16, 0.52	< 0.001
Sweden – USA	0.33	0.16, 0.69	0.004
Canada – USA	0.37	0.16, 0.88	0.024
Norway – USA	0.38	0.15, 0.96	0.040
Finland – USA	0.39	0.18, 0.88	0.023
Netherlands – USA	0.53	0.23, 1.21	0.130
United Kingdom – USA	0.67	0.41, 1.08	0.097
France – USA	0.79	0.26, 2.47	0.691
Germany – USA	0.95	0.30, 3.02	0.937
Australia – USA	1.08	0.36, 3.30	0.888
Denmark – USA	1.21	0.41, 3.58	0.727

IV. DISCUSSION

A. Findings Common Across the Offices

We found that the typical effect of examination is to produce change in claim 1 of a patent application. This change is meaningful, in the sense that it changes the scope of the monopoly provided by the patent over the claimed invention, and it occurs by way of adding integers to the claim. While there is no difference in the rate of meaningful change made to inventions in one technical field as compared to another, there is a difference in the rate of meaningful change made to applications originating from certain countries.

1. Rate of Meaningful Change

The rate at which examination produces change in the scope of the granted monopoly is noteworthy. Across the three offices under consideration, examination resulted in meaningful change much more often than not. The purpose of patent

examination is to determine whether the claimed invention satisfies the requirements for grant of a patent.[22] Where, as a result of examination, the patent office concludes that one or more of the requirements for grant are not satisfied, the applicant usually has the opportunity to amend the claims in an attempt to overcome the office's objection—that is, to change the claims to satisfy the requirements. Thus, it should not be surprising that the typical effect of patent examination is to produce meaningful change to the claims.

2. Type of Meaningful Change

The type of meaningful change to claim 1 that commonly results from examination is also noteworthy. Across the three offices analyzed in this study, almost all of the meaningful change to claim 1 that results from examination is integral change (i.e., change that adds to or alters the integers of the claim). This is significant, because it suggests that where meaningful change to application claim 1 occurs, it is almost always due to one or both of two particular requirements for the grant of a valid patent: novelty, and non-obviousness (or inventive step).[23] The reason that this must be so is explained below.

The requirements for the grant of a valid patent are of three basic types: (i) requirements that are concerned with the form and content of the patent specification—namely, that the invention is adequately described,[24] and that only one invention is claimed;[25] (ii) requirements that are concerned with the inherent nature of the claimed invention—namely, that the invention is inherently patentable subject matter,[26] and that the invention is useful;[27] and (iii) requirements that are concerned with the size of the advance of the claimed invention over the prior art—namely, that the invention exhibits novelty[28] and non-obviousness.[29]

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[22] For elaboration of these requirements, see the discussion immediately below on the types of meaningful changes observed.

[23] The equivalent of the U.S. patent law requirement that an invention be non-obvious compared to the prior art is, under the European Patent Convention ("EPC") and the Australian Patents Act 1990 (Cth) ("APA"), the requirement that the invention involves an "inventive step." Hereafter, the phrase "non-obviousness" includes "inventive step."

[24] 35 U.S.C. § 112; EPC art. 83; APA s. 40(2)(a).

[25] 35 U.S.C. § 121; EPC art. 82; APA s. 40(4).

[26] 35 U.S.C. § 101; EPC art. 52; APA s. 18(1)(a).

[27] 35 U.S.C. § 101; EPC art. 57 (which requires "industrial application"—being a requirement that is equated with usefulness/utility by footnote 5 of the TRIPS Agreement); APA s. 18(1)(c).

[28] 35 U.S.C. § 102; EPC art. 54; APA s. 18(1)(b)(i).

[29] 35 U.S.C. § 103; EPC art. 56; APA s. 18(1)(b)(ii).

The first type of requirement tends to be binary in its effect: the specification either does or does not contain an adequate description of the invention, and either does or does not claim only one invention. An objection that the specification does not contain an adequate description cannot, typically, be overcome by making a meaningful change to the application claim 1. Rather, it will be necessary to enhance the description of the invention contained in the specification. An objection that the specification claims more than one invention can be overcome only by deleting the claims to the additional invention (with these claims possibly being included in a separate application).[30] Deleting claims will only have an effect on application claim 1 where the claims that are deleted include application claim 1. In that situation, there will be a fundamental change to application claim 1.[31]

The second type of requirement for grant of a valid patent also tends to be binary in its effect—an invention either is or is not patentable subject matter, and so either all or none of the claims to that invention will be found to satisfy this requirement. Typically, an objection to grant taken by the patent office under this requirement either will not be able to be overcome by amendment to the application claim 1, or it will be overcome only by fundamentally changing the nature of the invention claimed. Thus, where the objection is overcome, it will have occurred by making a fundamental change to application claim 1.

The third type of requirement for the grant of a valid patent tends to be non-binary in its effect. An objection that the claimed invention does not exhibit novelty or non-obviousness over the prior art typically can be overcome by narrowing the claim (i.e., adding an additional feature, or integer, to the claim, to distinguish it from the prior art). Thus, where a prior art-based objection is overcome during examination, it will have occurred by making an integral change to application claim 1.

Because the type of meaningful change that results from examination is almost always integral change, and because integral change generally only occurs as a result of a novelty and/or a non-obviousness objection, it follows that our study suggests almost all the meaningful change that occurs as a result of examination is due to the requirements of novelty and/or non-obviousness.

3. Technology of Invention

It is further noteworthy that the rate of meaningful change to claim 1 that results from examination does *not* vary significantly across the different fields of

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[30] 35 U.S.C. § 121; EPC art. 76; APA s. 79B (for the possibility of including such deleted claims in a "divisional application").

[31] The change will be fundamental because the remaining claims, and hence the new claim 1, will be defining a (fundamentally) different invention.

technology. This finding may be considered surprising. One previous study has suggested that the application of the legal requirements for a valid patent by the *courts,* during a revocation action, varies depending on the field of technology of the invention.[32] Our finding suggests that this is not the case when the legal requirements are being applied by any one of the three *patent offices,* during examination. Assuming both studies to be correct, it appears that there may be an inconsistency in approach between the courts and the patent offices on the application of the requirements for grant of a valid patent—the courts adopt a technology-specific approach whereas the offices do not. The reason for such a difference in approach, if it exists, is not obvious to us. Furthermore, it is not clear to us which of these two approaches should be considered preferable.

A different previous study has found that the proportion of applications that result in a granted patent varies according to the field of technology of the invention.[33] Our finding is not inconsistent with that previous study, since our sample was selected on the basis that a patent grant resulted from the patent application. Nevertheless, our finding does show that in those cases where a patent does issue, the field of technology of the invention does not impact on the likelihood that the granted claim 1 will be meaningfully different from the application claim 1.

4. Country of Origin of Application

Claim 1 in U.S.-originating applications underwent more meaningful change during examination than claim 1 in applications originating from many other countries (being five of the ten other most common sources of applications in our data set). This suggests that U.S.- originating applications are drafted more broadly than those from other countries. This finding seems consistent with the finding of an earlier study that U.S. applications in the USPTO "spent significantly longer in prosecution than foreign patents."[34] In other words, a more broadly-drafted

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[32] *See* Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1205 (2002) (finding that the legal rules on validity are applied differently by the U.S. courts to software inventions compared with biotechnology inventions).

[33] *See* Paul H. Jensen, Alfons Palangkaraya & Elizabeth M. Webster, *Disharmony in International Patent Office Decisions*, 15 FED. CIR. B.J. 679, 680 (2006). While Katznelson demonstrated problems with Jensen analysis of the relative grant rate of the trilateral offices, his criticism did not extend to their analysis of grant rate by technology area as this was limited to filings in a single office. Ron D. Katznelson, *Bad Science in Search of "Bad" Patents*, 17 FED. CIR. B.J. 1 (2008).

[34] John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 VAND. L. REV. 2099, 2134 (2000). Allison and Lemley's analysis compared the time a patent application spent under examination in the USPTO by the country of origin of the application. Only applications from nine countries could be included in that phase of their

application is likely to require more meaningful change to claim 1 during examination, and more time under examination, than is a less broadly-drafted application.[35]

Making the assumption that a patent application is likely to be drafted by a patent professional in the country from which the application originates, our finding suggests that U.S. patent professionals tend to draft an application claim 1 more broadly than one drafted by patent professionals in other countries. We do not know why this is so. It could be that U.S. patent professionals are generally less aware of the relevant prior art than are patent professionals in other countries, and so are less likely to draft a narrow claim in an attempt to avoid the known prior art. However, the fact that U.S. patent law, unlike the European Patent Convention and the Australian patent legislation, imposes an obligation on the applicant to disclose known relevant prior art suggests this is unlikely to be the case. More likely, it could be a matter of different countries having a different "drafting culture" within their patent profession. Relevant here may be the fact that the USPTO cannot, in practice, issue a final rejection to a patent application. Because of this, aggrieved applicants are able to continuously restart the examination process by filing continuation applications.[36] This may encourage U.S. patent drafters to draft application claim 1 more broadly, knowing that the applicant will have "multiple bites at the cherry" of narrowing the claims to an acceptable form.

B. Findings of Differences Between the Offices

We found that there is a statistically significant difference between the three offices in the frequency with which their examination results in meaningful change to claim 1. This difference is driven primarily by a variation in the rates at which integral change occurs to claim 1—each office's rate of integral change is significantly different from the rates of integral change in the other two offices.

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analysis. Of the six countries from which applications in our study underwent a significantly lower rate of meaningful change than did applications from the U.S., Allison and Lemley had applications from three of the countries being dealt with more quickly than U.S.-originating applications (Italy, Japan and Sweden), and applications from one country taking longer than U.S.-originating applications (Canada, but only by 22 days). The other countries (Norway and Finland) did not feature in Allison and Lemley's analysis.

[35] It should be noted that, as our country of origin analysis considered the differences in rates of meaningful change across all three offices, it is not possible to consider the results in terms of any bias for, or against, applications from the country in which the office is sited. Our analysis, therefore, cannot show whether patent prosecution in the EPO and the APO echoes the nationalist bias in the USPTO that was asserted in Kimberly Moore, *Xenophobia in American Courts*, 97 NW. U. L. REV. 1497, 1497 (2003).

[36] *See, e.g.*, Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U.L. REV. 63, 64 (2004).

1. Rate of Meaningful Change

That the rates of meaningful change are significantly different in each of the three offices under consideration, and that it occurs most in the USPTO and least in the APO, is highly noteworthy. It is a fundamental principle of patent law that the effect of any changes made to a claim during examination cannot be to widen the scope of the claim.[37] Thus, where a meaningful change occurs as a result of an integral change (which is the usual case), the effect of that change is to narrow the scope of the claim.[38] Assuming that the frequency of claim narrowing is a measure of the effectiveness of the examination process, our finding indicates that the examination process in the USPTO is *more* effective than in the EPO and the APO. This finding is contrary to numerous assertions, both express and implied, in the previous literature.[39]

Given that each application claim 1 entering examination in the three offices is identical, the only part of the patent system that could impact on the form of the granted claim 1 is the process that is illustrated by the "black box" in Figure 1—namely, the examination process in the respective patent office. If the examination process in each office was the same, then it would be expected that the rate at which it produced meaningful change to application claim 1 would be the same. Given that we found that this was not the case, it follows that there must be a significant difference in the examination process that is adopted by each of the three offices.

Logic suggests that any difference between two offices in the examination process adopted by them must be one or both of two types: (i) a difference in the requirements for the grant of a valid patent that are applied by the office (that is, a difference in the law being applied during examination); and (ii) a difference in the manner in which those requirements are applied by the office (that is, a difference in the practice of applying the law during examination). The latter difference has at least two aspects. First, the difference could be in a *function* undertaken by the office, such as the way in which a prior art search is conducted. Secondly, the difference could be in the *rigor* of the application of a legal standard, such as in the determination of

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[37] 35 U.S.C. § 314(a); EPC art. 123(3); APA s. 102

[38] This comment does not apply where the meaningful change is as a result of a fundamental change. For example, where application claim 1 is to a product and granted claim 1 is to a process. In such a situation, the concept of widening or narrowing the scope of the claim does not apply, as the invention being claimed in the application claim1 is fundamentally different from that in granted claim1.

[39] *See* Lemley, *Rational Ignorance at the Patent Office*, *supra* note 2; *see also supra* note 1 and accompanying text; Malwina Mejer & Bruno Van Pottelsberghe de la Potterie, *Patent Backlogs at USPTO and EPO: Systemic Failure vs. Deliberate Delays*, 33 WORLD PAT. INFO 122, 124 (2011) (discussing the USPTO as providing "a low quality of examination process characterized by relatively cheap and easy procedures to have a patent granted").

the required "height of the bar" that an invention must pass to be considered non-obvious. While our study is not able to determine whether it is a difference in the law, the practice, or both that produces the significantly different rates of meaningful change resulting from patent examination in the three offices, it is able to shed some light on which type of requirement is the source of the significant differences that we observed in examination outcome, as discussed below.

2. Type of Meaningful Change

Given that the most usual type of meaningful change made in all three offices is integral change, and that the rate of this type of change in each of the three offices is significantly different, it follows that the most substantive difference in the examination process adopted by the three offices is in respect of the requirements that typically give rise to integral change, namely, the prior art-based requirements of novelty and non-obviousness. Thus, whether the difference in approach is due to a difference in the law, the practice, or both, it is clear that the difference is *about* the requirements of novelty and/or non-obviousness.

C. Limitations of Study

We recognize some limitations in our study's methodology. First, while our study looked at the form in which application claim 1 entered examination in the three offices (it had to be in identical form), it did not look at the manner by which it entered examination. That is to say, we did not differentiate between applications that entered examination in the three offices by direct filing or by filing under the PCT. Unlike a direct filing in a national patent office, a filing in the World Intellectual Property Organization under the PCT undergoes examination in the "international phase" before it enters national examination, which produces preliminary reports on relevant prior art and on patentability.[40] For a number of the applications considered in our study, entry into national examination in the three offices may have occurred by different routes. It could be that the route into national examination affects the process of examination and its outcome (e.g., because entry under the PCT brings with it access to preliminary examination reports). Our study was not able to determine if this was so.

Secondly, while our study looked at the rate of meaningful change in the three offices, it did not look at the magnitude of that change. Thus, while we are able to say in which office examination results in meaningful change most often—the USPTO—we are unable to say in which office a meaningful change results in the greatest

[40] PCT arts 18 and 35, respectively.

narrowing of the scope of claim 1. It could be, therefore, that examination in the USTPO not only results in meaningful change to claim 1 more often, but also results in a narrower claim 1 in the situation where the claim was meaningfully changed in more than just the USPTO. However, our analysis does not allow us to say whether this is so.

Finally, while our study looked at the *effect* of examination in the three offices on the form of claim 1, it did not look at the *reasons* that examination produced meaningful change to claim 1. That is to say, we treated the examination procedure as a "black box" into which we did not peer. Thus, while we know that there is a significant difference between the offices on the rate of meaningful change, and that this difference has to do with the offices' approach to examination of the prior art requirements (novelty and/or non-obviousness), we do not know if the difference is due to the law, the practice of those requirements, or both.

V. CONCLUSION

Our findings show that the answer to the question posed in the introduction—What is the practical effect of patent examination?—is that examination more often than not results in a meaningful change to the definition of the invention contained in claim 1 of the patent. Thus, we concur with Lemley and Sampat, albeit for different reasons, that the role of the patent offices is not just that of a "rubberstamp."[41] Instead, patent office's regularly narrow, over that which was sought in the application, the scope of the legal monopoly provided by the patents that they grant. Importantly, this effect of examination does not occur at the same rate in the different patent offices. Rather, the effect occurs significantly more often in the USPTO than in the EPO, and significantly more often in both of those offices than in the APO.

Taken together, our findings can be seen to add to the debate on "patent quality." While the literature in this area does not offer a unanimous definition of what is a quality patent, a common feature in most understandings is that a quality patent is one that meets the "statutory standards of patentability."[42] That patent examination in all three offices generally results in a narrowing of claim 1, shows that the statutory standards for patentability are impacting on the scope of the claims contained in granted patents. That the USPTO narrows claim 1 more often than either of the other two offices suggests that the quality of granted U.S. patents is higher than that of granted European and Australian patents—since the concern to date has been that granted patents are too wide, not too narrow.

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[41] Mark A. Lemley & Bhaven N. Sampat, *Is the Patent Office a Rubber Stamp?*, 58 EMORY L.J. 101, 123 (2008).

[42] Wagner, *supra* note 2, at 2138 (2009).