

A Comparative Analysis of the Patent Scope of Major Additive Manufacturing Companies in the U.S. and Europe

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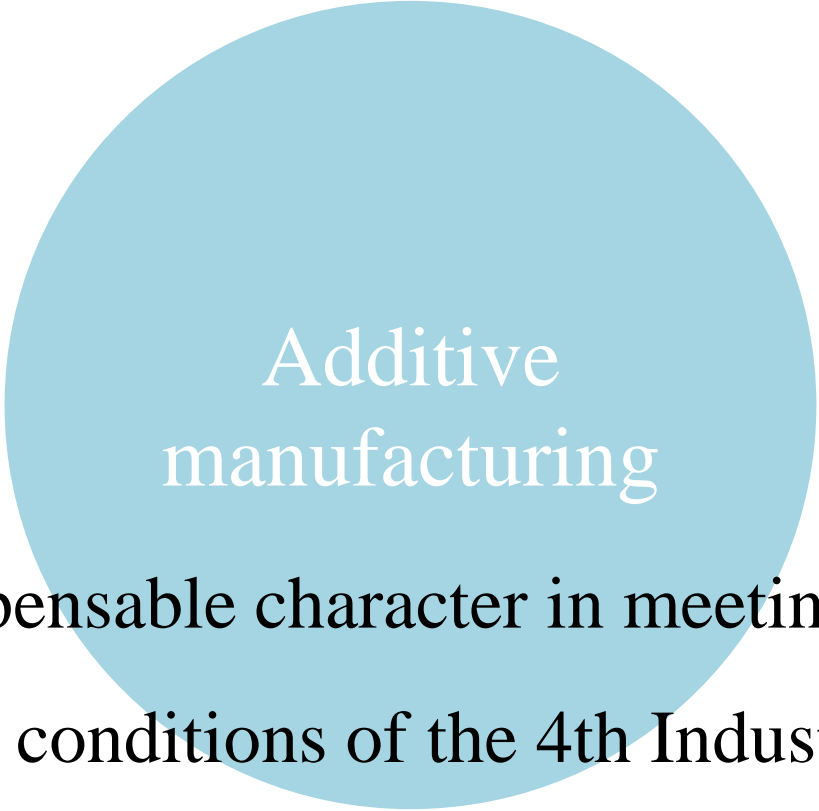
Outline

- I Introduction and Indicators of Claim Scope
- II Calculation Result and Analysis
- III Conclusion

Purpose and Motivation

Purpose

- Developing a new indicator to calculate the scope of the patent
- Observing the patent scope variation of the same invention between the USPTO and EPO



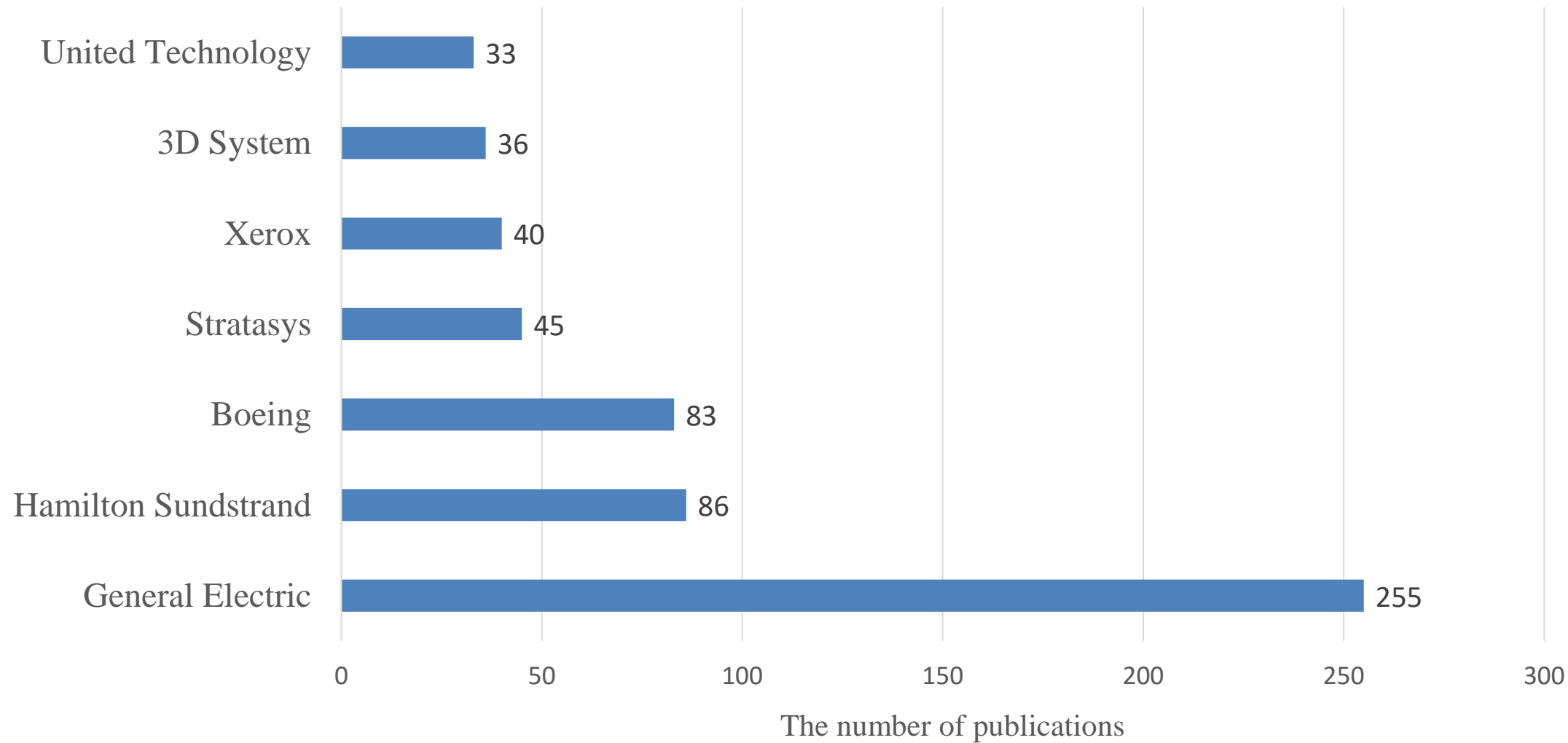
Additive manufacturing

- an indispensable character in meeting the essential conditions of the 4th Industrial Revolution
- including several categories, such as apparatus, process, materials, etc.; therefore, the coverage of the technology is wide.

- Top 15 US applicants of 3D printing technology who claimed US priority in the EPO,
- Publication date of the publications is between 2018 and 2022
- Only pre-grant publications are taken in.

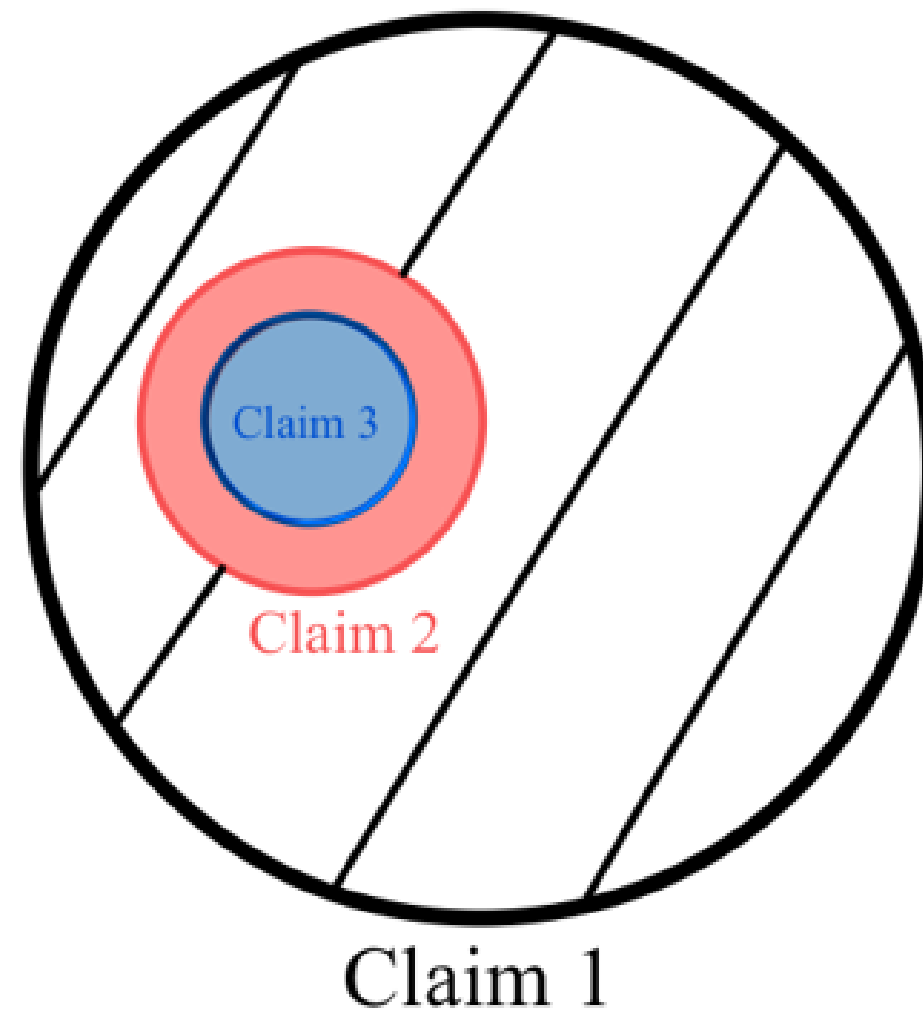
	EPO
Searching date	April.01, 2023
Query	(CPC = B33Y* OR IPC =B33Y*) AND (PUK = A1 OR A2) AND PUD >=20180101 AND PUD<=20221231 AND (APP = hewlett packard* OR APP = general electric* OR APP = xerox* OR APP = stratasys* OR APP = the boeing company* OR APP = united technologies corporation* OR APP = seiko epson corporation* OR APP = siemens* OR APP = kinpo electronics* OR APP = xyzprinting* OR APP= Hamilton Sundstrand* OR APP= Desktop Metal* OR APP= Carbon* OR APP= 3D Systems* OR APP= Align Technology*) AND PRN=US*
Amount	1199

After eliminating noises, publications with plural priorities, non-top 15 US applicants, and extremely complicated dependencies are excluded. Besides, companies with few publications (less than 35) are precluded, either. The final number of **available publications is 578 pieces**; the firms are United Technology, 3D System, Xerox, Stratasys, Boeing, Hamilton Sundstrand and General Electric.



No. of claims	Sum	Changed	Does not changed
=20	352	257	95
>20	114	66	48
<20	72	52	20
<=15	40	6	34

1. A bicycle saddle comprising...
2. A bicycle saddle according to claim 1, it is made of leather.
3. A bicycle saddle according to claim 2, the leather is from animals.



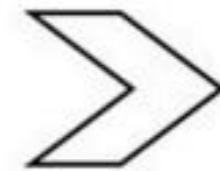
Wittfoth (2019) developed an indicator to calculate the scope of patents by dependency. Based on four assumptions, the approach is conducted.

1. A broad claim (like an independent claim) has an equal effect to n narrow claims (dependent claims), and **multiple dependent claims have the same impact as independent claims on the patent scope.**
2. Use issued patents to prevent from the claims being rewritten or amended during the filing procedures.
3. A dependent claim that holds a high dependency level (sub-claim first level) extends the patent scope bigger than a dependent claim with a lower dependency level (sub-claim fifth level).
4. Parallel dependencies expand the patent scope; serial dependencies lessen it.

Indicators of Claim Scope

Indicators of Claim Scope

1. A vehicle comprising...
2. A vehicle according to claim 1, being an electric vehicle...
3. A vehicle according to claim 1, being a fuel cell vehicle...



Independent (main) Claim	Sub Claim Level 1	Sub Claim Level 2
1		
	2	

$$depth = \frac{(nIndependent + nMultiple)*0 + nSubL1*1 + .. + nSubLn*Ln}{nClaims} \quad (1)$$

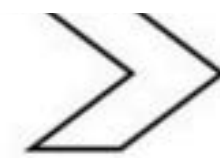
$$depth\ case1 = \frac{4*0 + 0*1 + 0*2 + 0*3}{4} = 0 \quad (3)$$

$$1*0 + 1*1 + 1*2 + 1*3 \quad (4)$$

$$arctan \left(\frac{(nIndependent + nMultiple) * 0 + nSubL1 * 1 + .. + nSubLn * Ln}{nClaims} \right) \quad (6)$$

$$patent\ scope = 1 - \frac{arctan \left(\frac{(nIndependent + nMultiple) * 0 + nSubL1 * 1 + .. + nSubLn * Ln}{nClaims} \right)}{\alpha Max} \quad (7)$$

1. A vehicle c...
2. A vehicle a claim 1, being an electric vehicle...
3. A vehicle according to claim 2, using a lithium-ion battery...



1		
	2	
		3
1	1	1

$$normalized\ depth\ case1 = \frac{0}{\alpha Max} = \frac{0}{26.565^\circ} = 0 \quad (9)$$

$$normalized\ depth\ case2 = \frac{\alpha Max}{\alpha Max} = \frac{26.565^\circ}{26.565^\circ} = 1 \quad (10)$$

$$scope\ case1 = 1 - normalized\ depth\ case1 = 1 - 0 = 1$$

$$scope\ case2 = 1 - normalized\ depth\ case2 = 1 - 1 = 0$$

Fig. 1. Example "Patent A" (above) and "Patent B" (below). Source: Author.

An Indicator to Measure the Patent Scope

The indicator of the study redefines how the scope of patents is measured; **it calculates the territory areas which the claims possess**. An independent claim and its dependent claims have their own territory; the independent claim defines the range of the territory, and the dependent claims further designate areas in the territory.

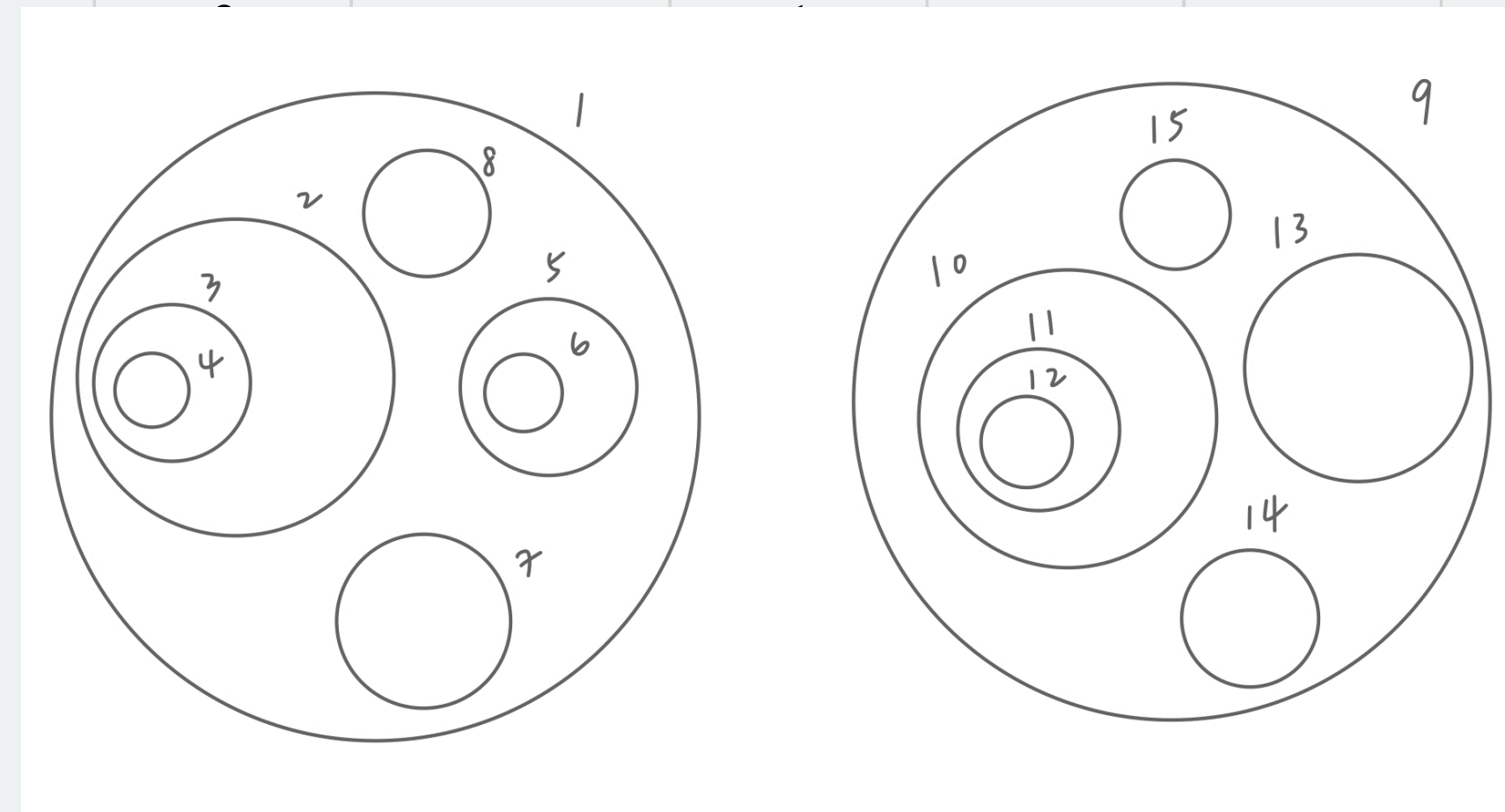
Limitation: the indicator is only based on the dependency of claims.

An Indicator to Measure the Patent Scope

EP 3450136 A1

1. A three-dimensional (3D) printing method for forming a 3D object layer by layer...
2. The 3D printing method as claimed in claim 1, wherein...
3. The 3D printing method as claimed in claim 2, wherein...
4. The 3D printing method as claimed in claim 3, further comprising...
5. The 3D printing method as claimed in claim 1, wherein...
6. The 3D printing method as claimed in claim 5, wherein...
7. The 3D printing method as claimed in claim 1, wherein...
8. The 3D printing method as claimed in claim 1, wherein...
9. A three-dimensional (3D) printing apparatus (100), comprising...
10. The 3D printing apparatus (100) as claimed in claim 9, wherein...
11. The 3D printing apparatus (100) as claimed in claim 10, wherein...
12. The 3D printing apparatus (100) as claimed in claim 11, further comprising...
13. The 3D printing apparatus (100) as claimed in claim 9, further comprising...
14. The 3D printing apparatus (100) as claimed in claim 9, wherein...
15. The 3D printing apparatus (100) as claimed in claim 9, wherein...

	independent	Lv1	Lv2	Lv3
1	1			



12				1
13		1		
14		1		
15		1		

An Indicator to Measure the Patent Scope

The method is based on the assumptions below:

1. The independent claim has a broader scope than dependent claims; an independent claim may have one or more than one dependent claim which refers to it. Accordingly, **the scopes of dependent claims are built on the territory of the independent claim to which the dependent claims refer.**
2. The largest scope of the sum of dependent claims with the same dependency level in the same territory is the total number of claims minus constant 1 divided by the total number of claims in the same territories. **There is always a blank area (constant 1/ the total number of claims) which does not be covered by the claims.**
3. Dependent claims with the same dependency level share the same territory (or area) of the claim that they depend on. **Every dependent claim with the same dependency level has the same effect on the scope of the claim to which they refer.**
4. Vertical dependency expands the patent scope less than parallel dependencies.

An Indicator to Measure the Patent Scope

$$\text{scope of claims in Lv.1} = \frac{n \text{ Lv.1}}{N}$$

$$\text{scope of claims in Lv.2} = \frac{n \text{ Lv.2}}{N(N-1)}$$

$$\text{scope of claims in Lv.3} = \frac{n \text{ Lv.3}}{N(N-1)(N-2)}$$

$$\text{largest scope of claims in Lv.1} = \frac{N-1}{N}$$

$$\text{largest scope of claims in Lv.2} = \frac{N-1}{N} \times \frac{N-2}{N-1}$$

$$\text{sum scope} = 1 + \frac{n \text{ Lv.1}}{N \text{ claims}} + \frac{n \text{ Lv.2}}{N(N-1)} + \frac{n \text{ Lv.3}}{N(N-1)(N-2)} + \frac{n \text{ Lv.4}}{N(N-1)(N-2)(N-3)} + \dots$$

An Indicator to Measure the Patent Scope

	dependent	Lv1	Lv2	Lv3
1	1			
2		1		
3			1	
4				1
5		1		
6			1	
7		1		
8		1		
9	1			
10		1		
11			1	
12				1
13		1		
14		1		
15		1		

$$sum\ scope = 1 + \frac{n\ Lv.1}{N\ claims} + \frac{n\ Lv.2}{N(N-1)} + \frac{n\ Lv.3}{N(N-1)(N-2)} + \frac{n\ Lv.4}{N(N-1)(N-2)(N-3)} + \dots$$

Group of Claim 1 of **EP 3450136 A1**

$$1 + 4/8 + 2/(8*7) + 1/(8*7*6) = 1.539$$

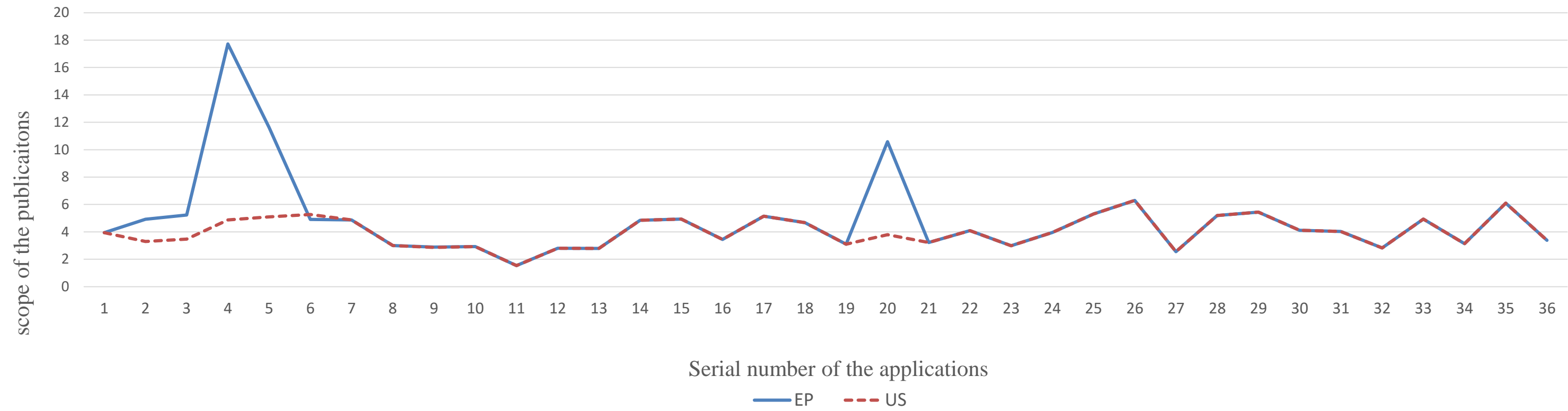
Group of Claim 9 of **EP 3450136 A1**

$$1 + 4/7 + 1/(7*6) + 1/(7*6*5) = 1.6$$

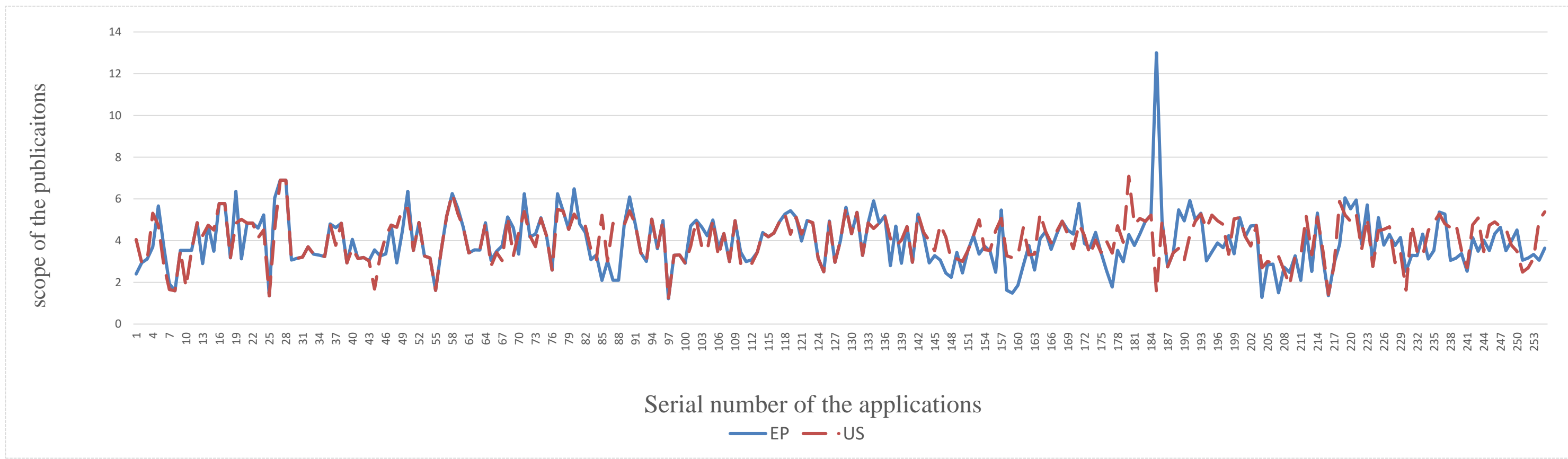
The scope of **EP 3450136 A1**

$$= 1.539 + 1.6$$

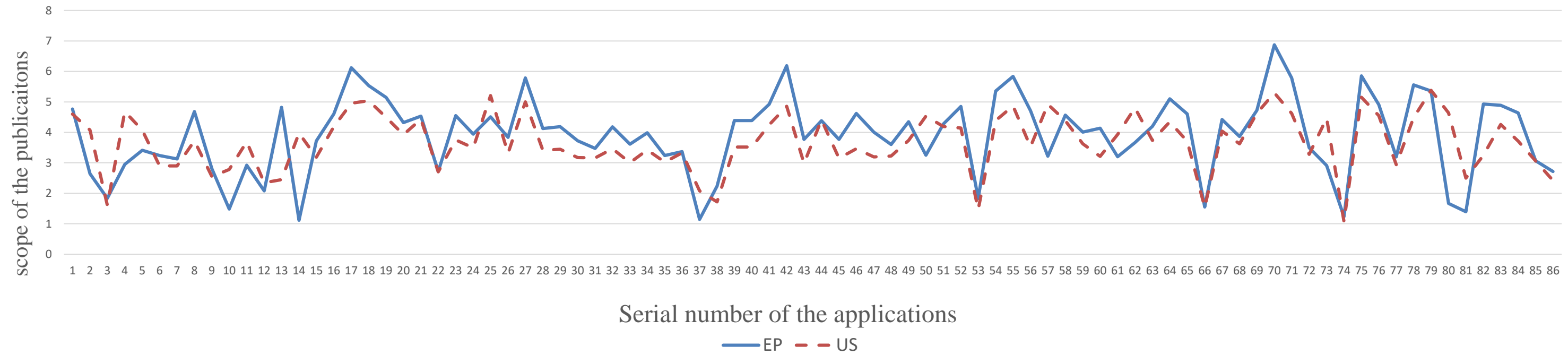
$$= \mathbf{3.139}$$



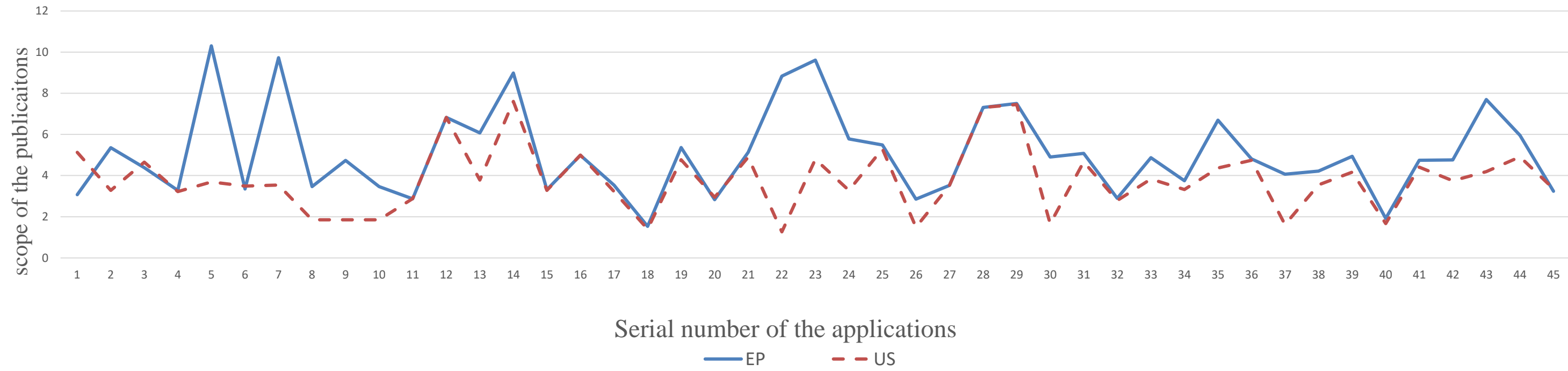
The scope variation of publications of 3D System



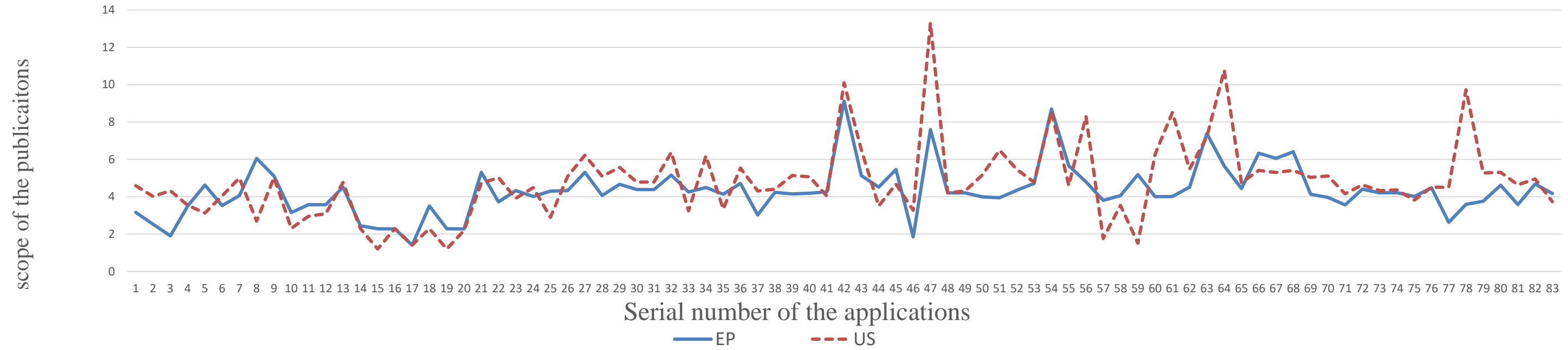
The scope variation of publications of General Electric



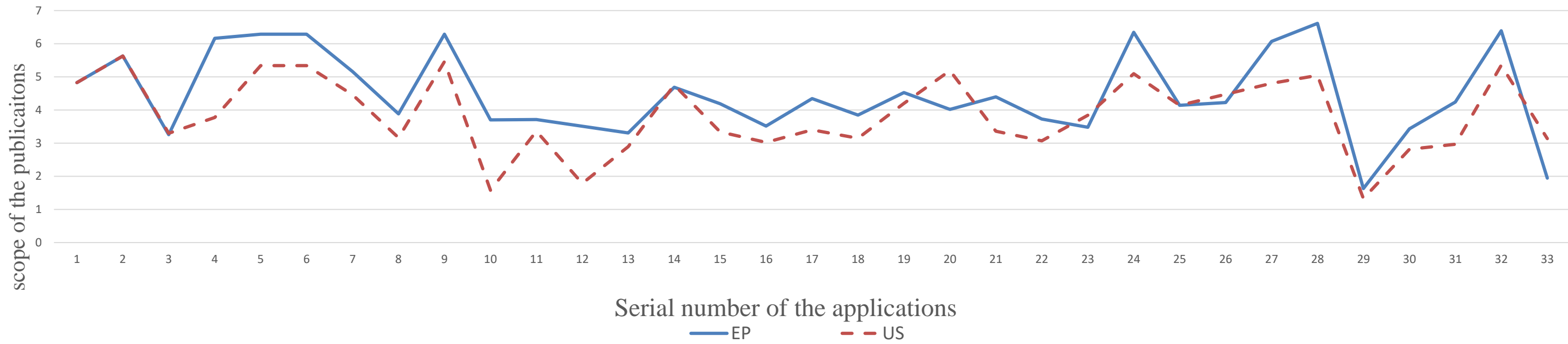
The scope variation of publications of Hamilton Sundstrand Corporation



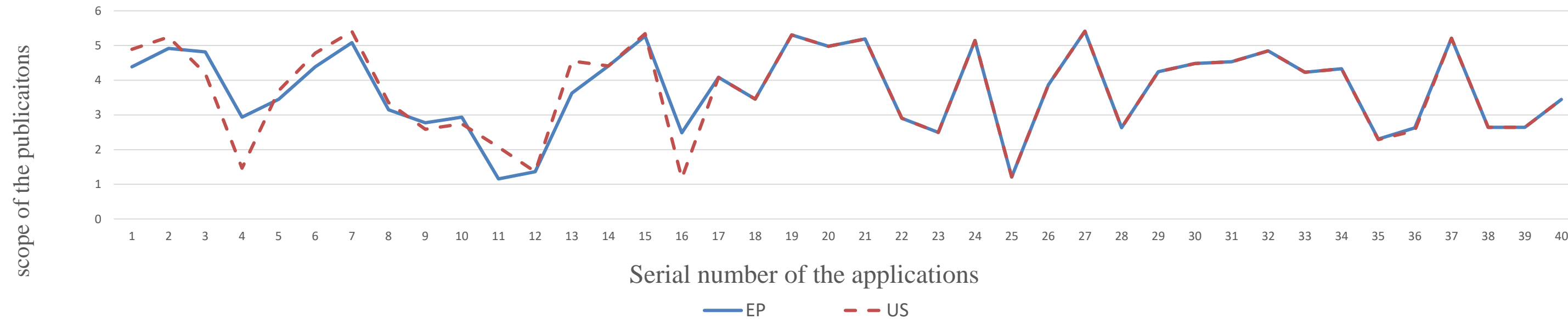
The scope variation of publications of Stratasys



The scope variation of publications of the Boeing Company



The scope variation of publications of United Technologies Corporation

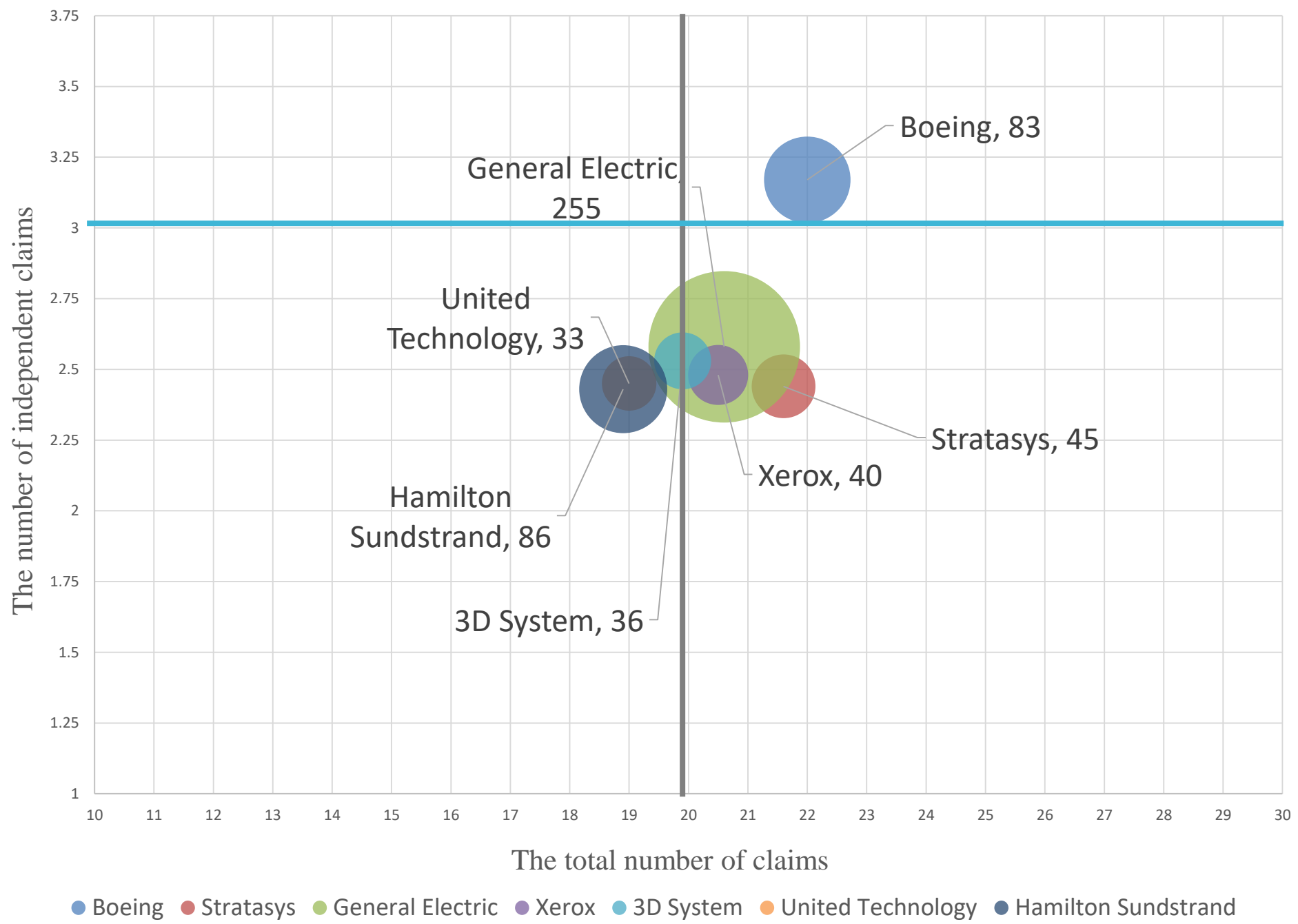
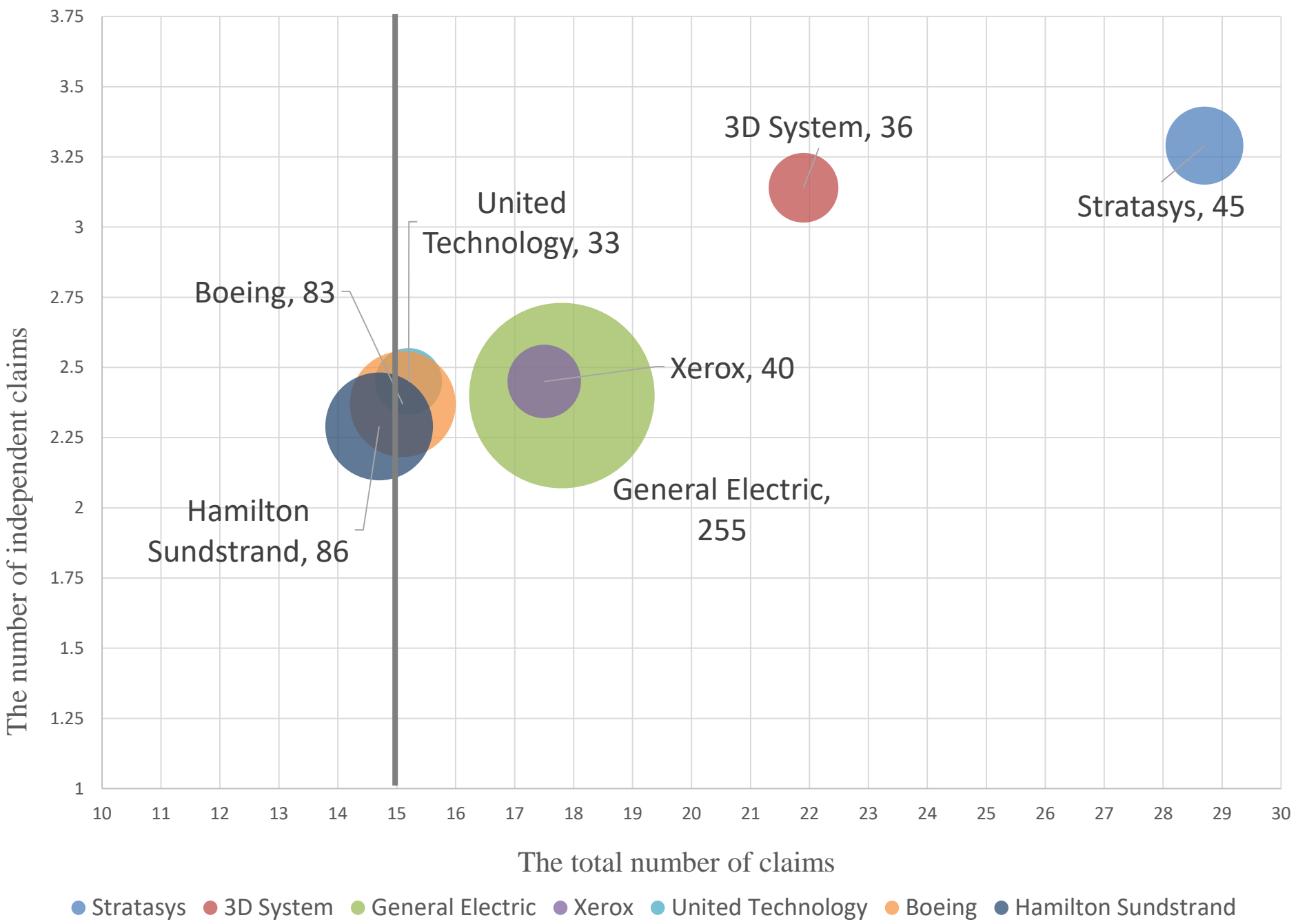


The scope variation of publications of Xerox Corporation

Overall, after entering EPO, the number and the dependency of the claims are rewritten, which makes the scope of the same invention change. Besides, EPO allows multiple dependent claims to refer to multiple dependent claims, which substantially expands the scope of the claims. Even though the total number of claims in Europe is five claims less than in the United States, the scope of the publications in Europe is still broader than in the United States of the same invention. The more and bigger territories the claims have, the broader scope they get.

Excess fee 500~3500 EUR

Excess fee 100~200 USD

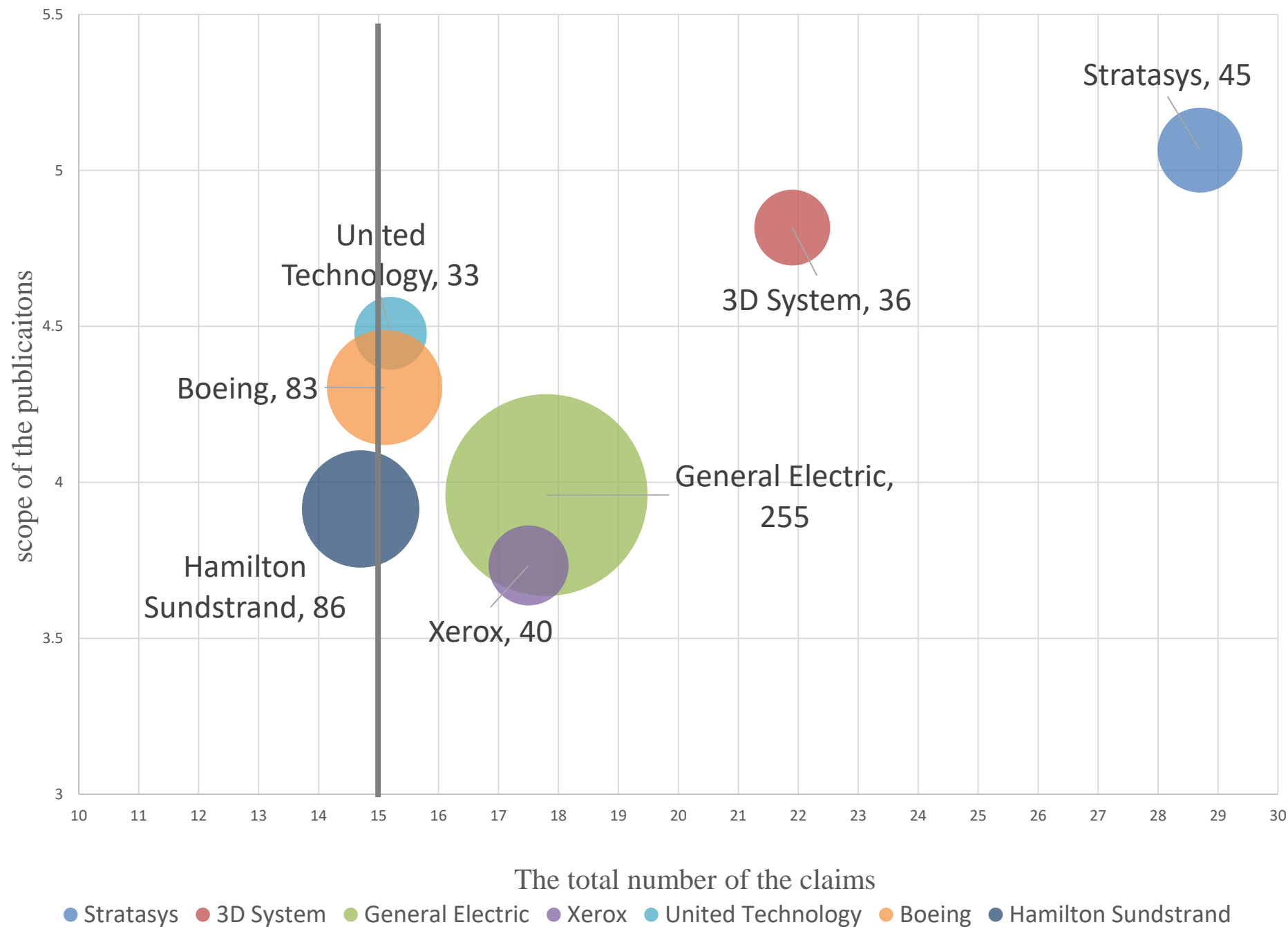


Patent publications in the EPO

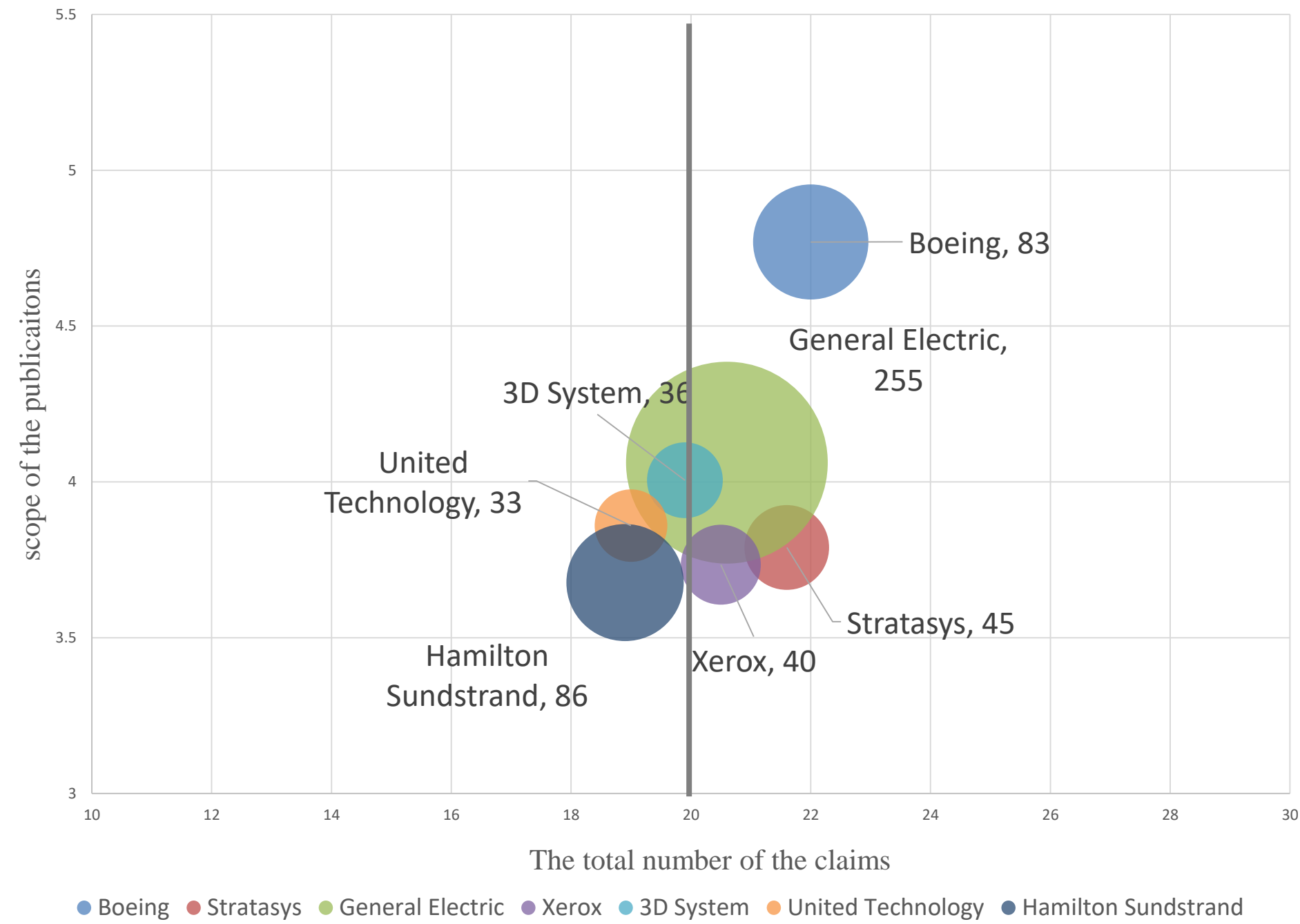
Patent publications in the USPTO

Calculation Result and Analysis

Result of the Analysis

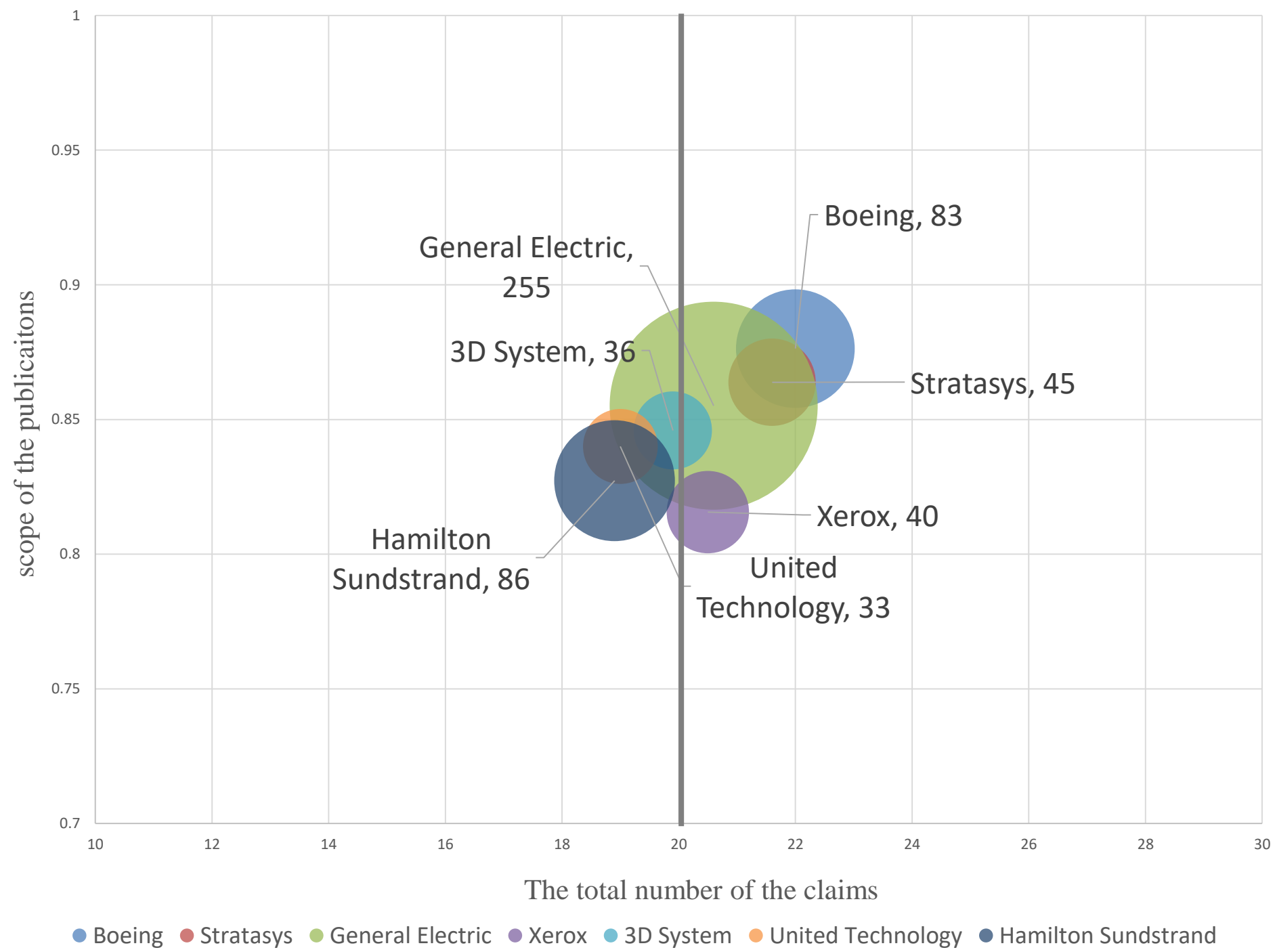
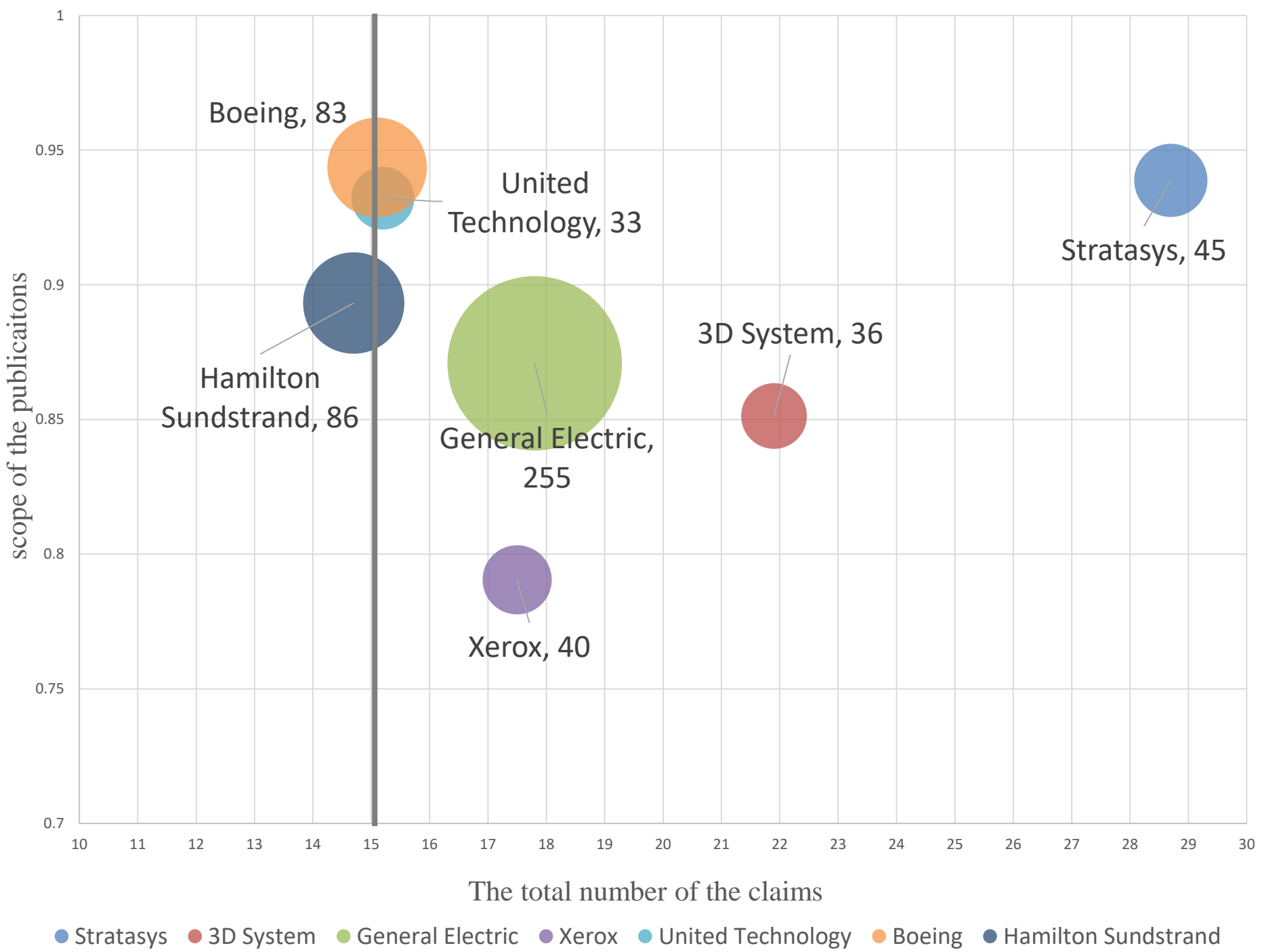


The scope of the publications calculated by the indicator of the study in the EPO



The scope of the publications calculated by the indicator of the study in the USPTO

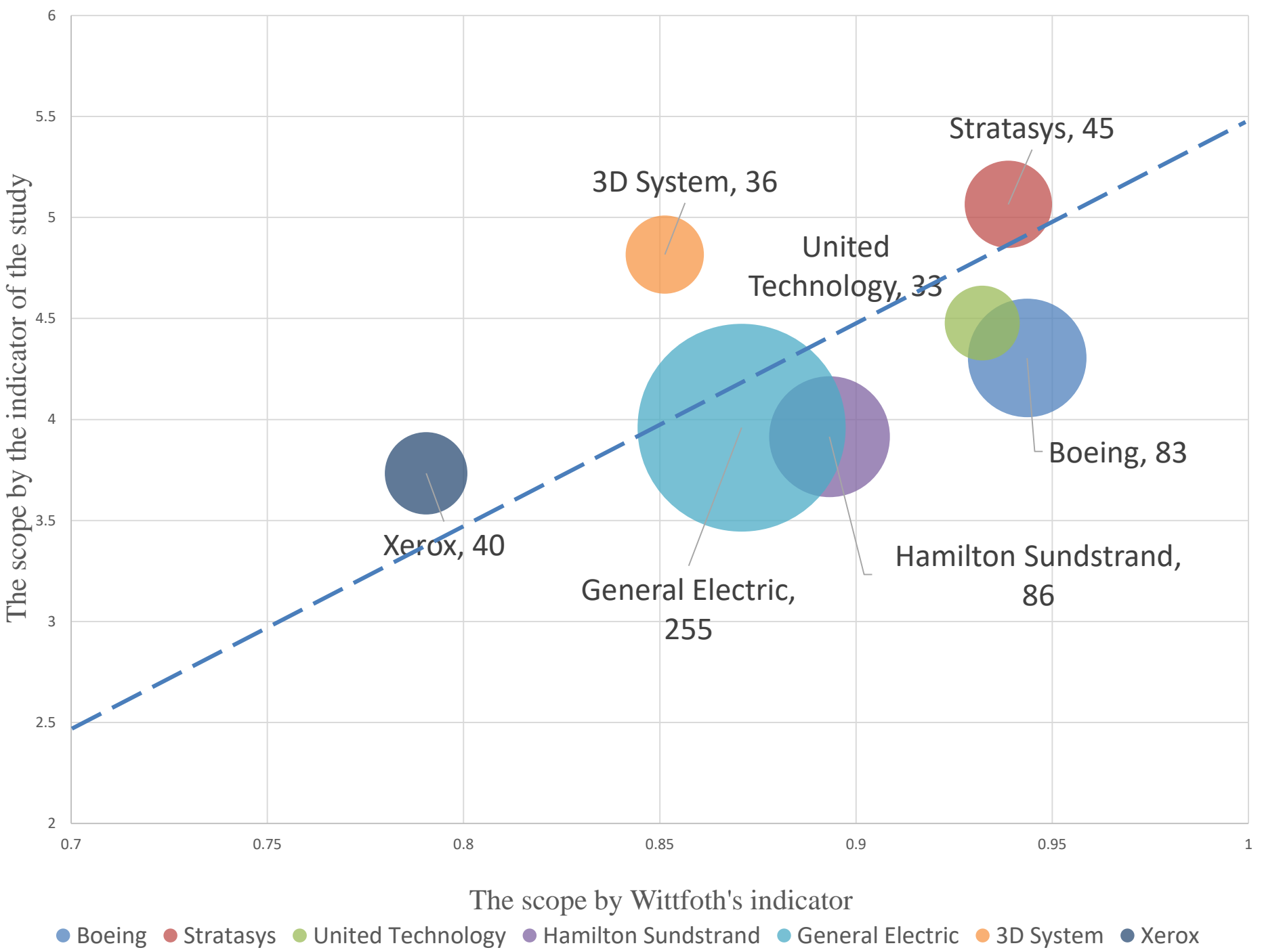
After entering EPO, the number of claims and independent claims of General Electric and Xerox is similar.



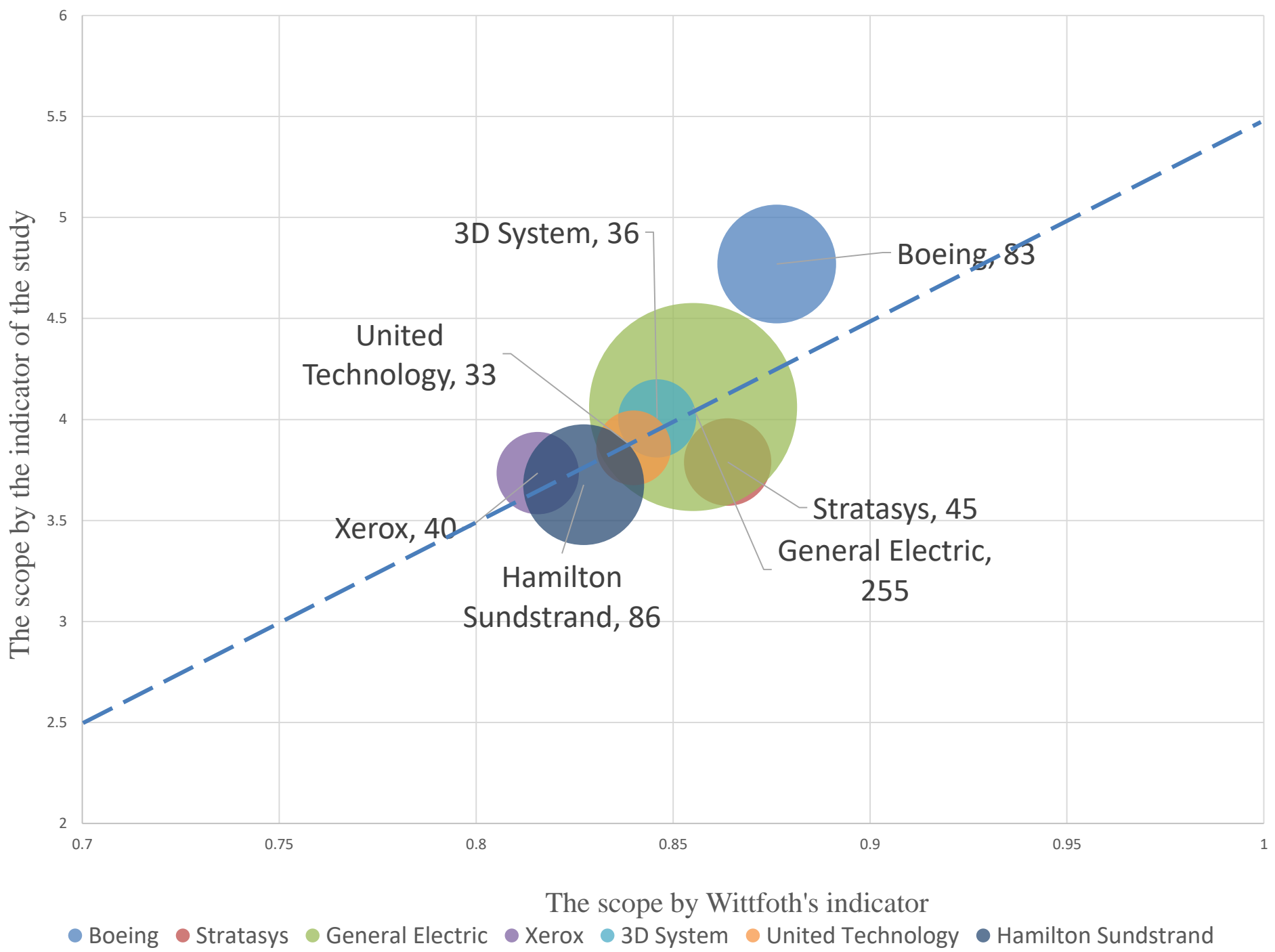
The scope of the publications calculated by Wittfoth's indicator of the study in the EPO

The scope of the publications calculated by Wittfoth's indicator of the study in the USPTO

The two indicators are positive correlations.

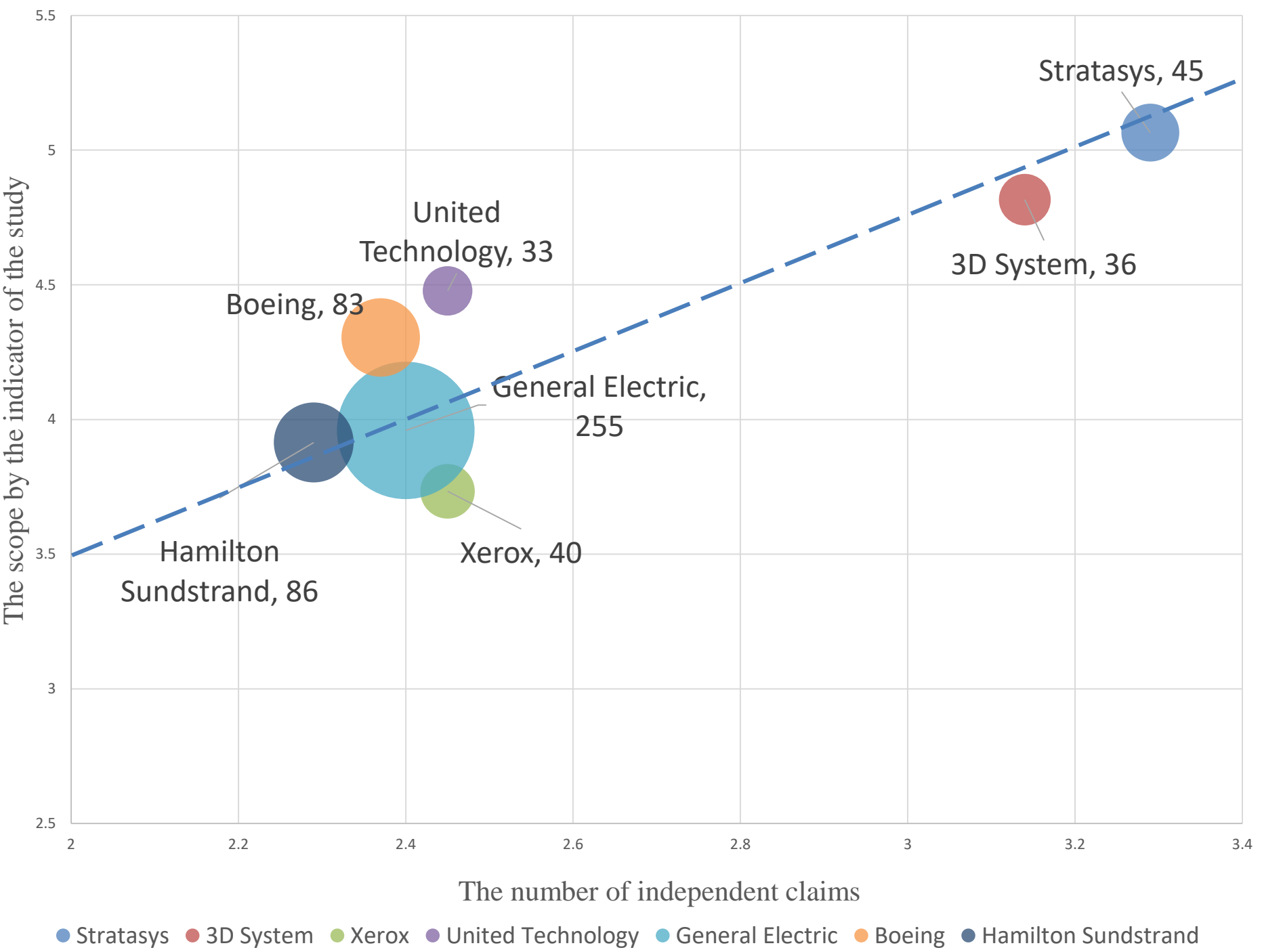


The comparison of the scope in the EPO

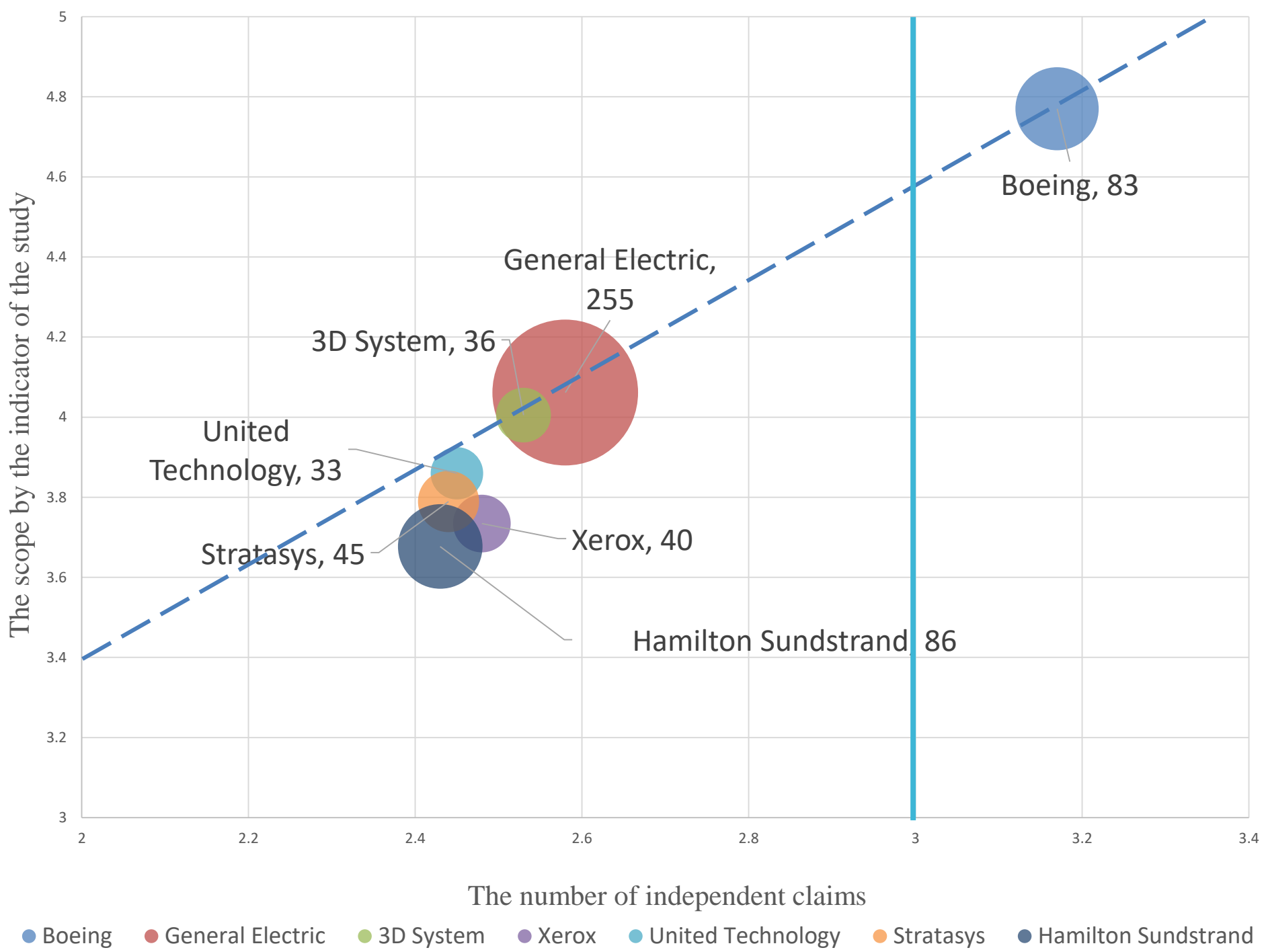


The comparison of the scope in the USPTO

The layouts of dependent claims of United Technology and Boeing are rigorous. (EP publication)



The scope of the publication compared with the ICC in EPO



The scope of the publication compared with the ICC in USPTO

Findings of the Study and Suggestion

- The indicator of the study has a more detailed calculation of the scope according to dependencies and the number of claims to which the multiple dependent claims refers. **After calculation and comparison, the indicator is verified by another two indicators in works of literature.**
- Except for the patent claims which are not revised, **most of the publications acquire broader scope after entering EPO.**
- Most of the companies have US publications with the number of claims in the limitation of the regulations. On the contrary, **their corresponding EP publications have to pay expensive excess fees.**

Findings of the Study and Suggestion

- **3D System**
redrafting claims while entering the EPO and making good use of multiple dependent claims in order to decrease excess fees
- **General Electric**
properly utilizing multiple dependent claims in their EP applications so as to expand the patent scope; do not waste the opportunity.
- **Hamilton Sundstrand Corporation**
increasing the number of claims for better and greater scope
- **Stratasys**
ensuring the necessity of the claims of the EP publications and avoiding being charged exorbitant fees without owning reasonable patent scope

Findings of the Study and Suggestion

- **The Boeing Company**
finding out the reason why the scope of EP publications which include multiple dependent claims is not wider except for the number of independent claims
- **United Technology**
keeping current claim drafting strategy and taking advantage of increasing valuable claims to expand the scope
- **Xerox Corporation**
utilizing multiple dependent claims while claim drafting EP applications

**Thanks for
your concentration.**