# KNOWLEDGE PRODUCTION FUNCTION

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# HISTORY

- Introduced by Griliches (1979) to estimate the part of productivity (GDP), that can be attributed to research and development

- Jaffe (1989) uses the KPF to model spillovers from university research in the USA

- Luc Anselin, Attila Varga and Zoltan Acs (1997) broaden the database for 43 states (compared to 29 in Jaffe) and conducted alternative version of KPF at regional level (Metropolitan Statistical Area). They also repalced patents by count of innovations (from the U.S. Small Business Administration Innovation Database)

# SCOPUS TO EPO

- We idnentified academic patents in Europe based on similarity in between the academic paper and the patent application

- Name

- Location

- Time

- Cognitive proximity of technology and science

## KPF

- $$log\left(\frac{other\ patents}{other\ employees}\right) = log\left(\frac{other\ R\&D\ expenditures}{other\ employees}\right) + log\left(\frac{university\ patents}{university\ employees}\right) + cosine\ distance + \in$$

- Cosine distance – distance between the vectors of patent's occurences in IPC technological classes (A to H) of academic and other patents

- The goal is to identify set of predictors for the number of (other) patents in regions
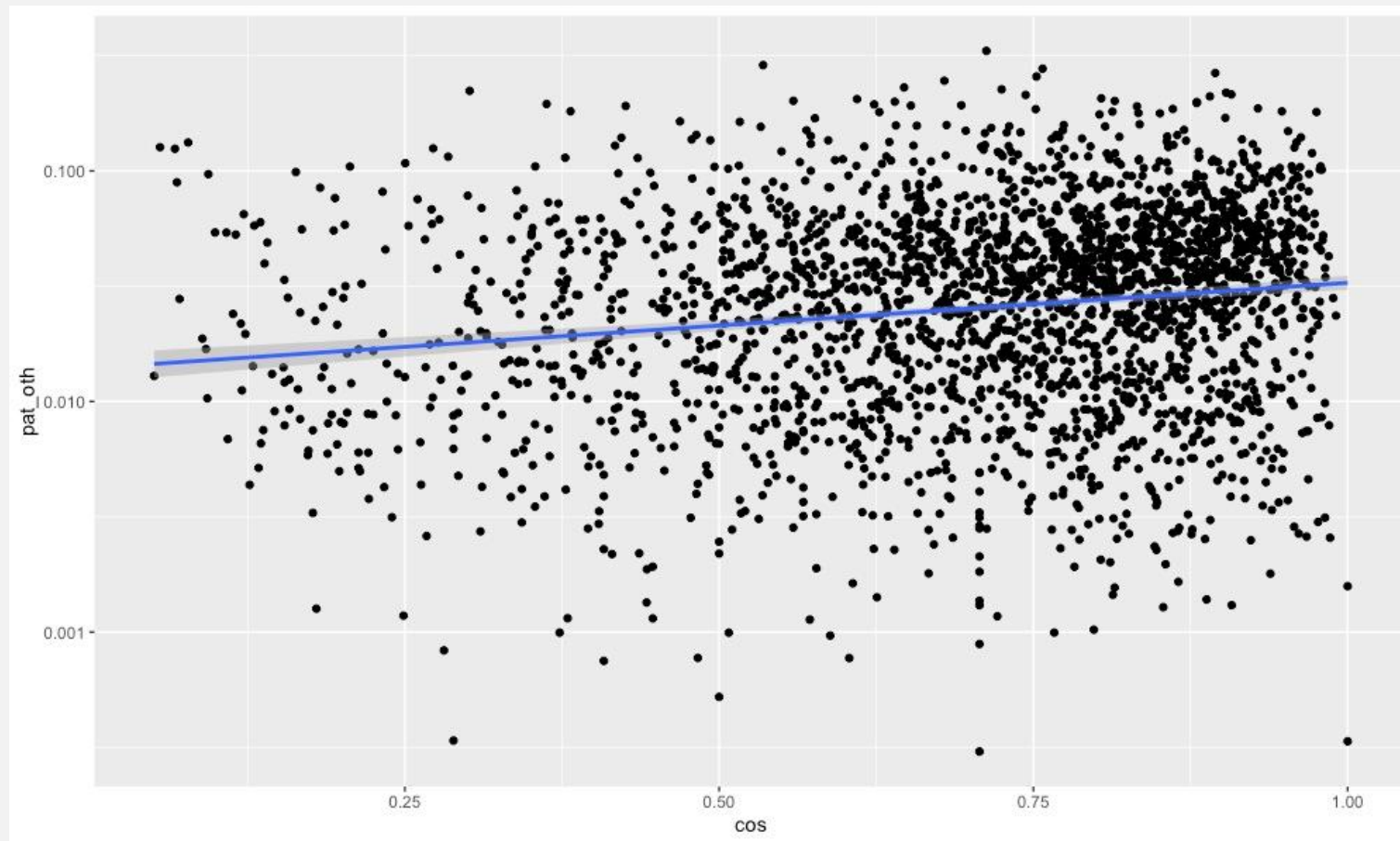
# EXPENDITURES
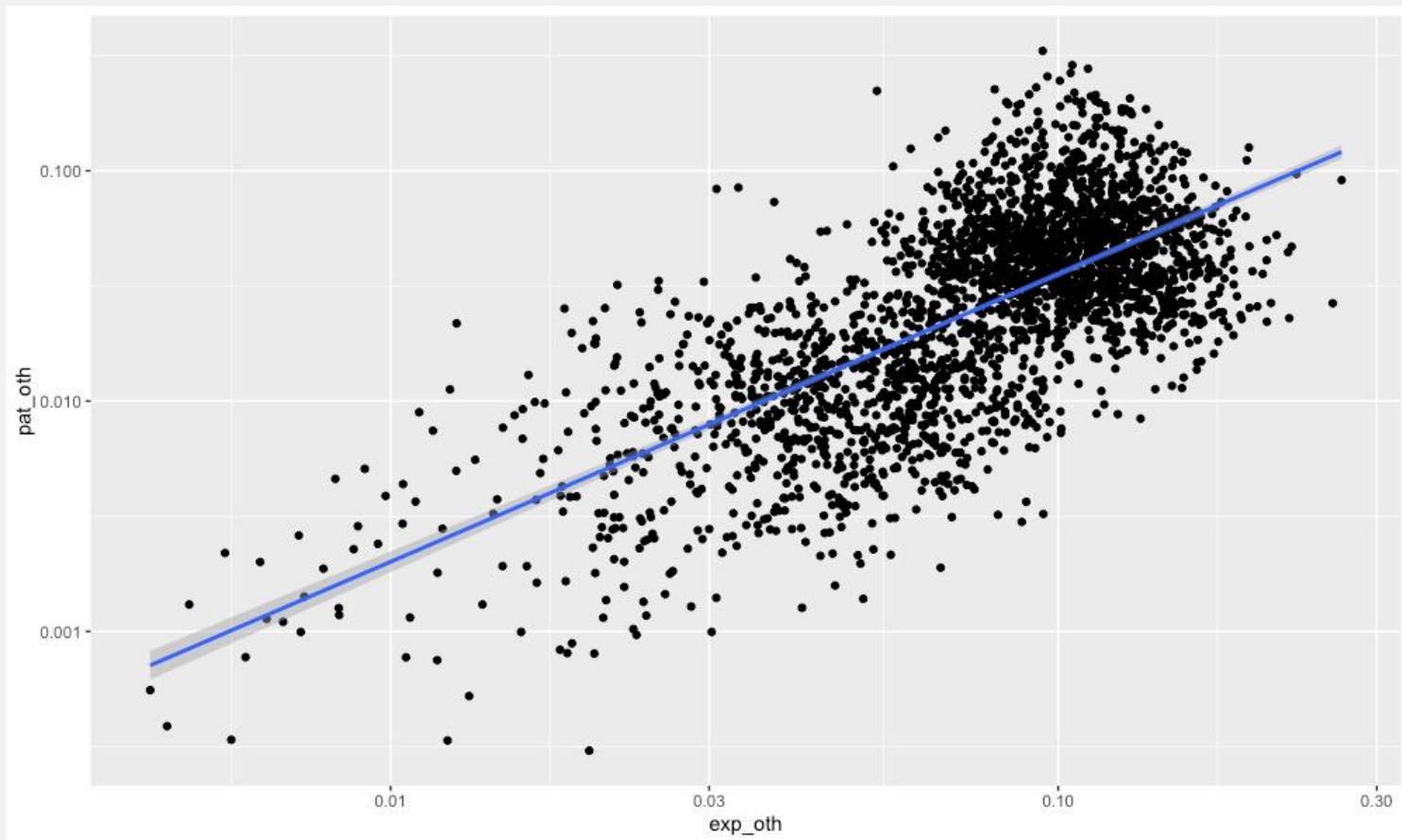
# UNIVERSITY PATENTS
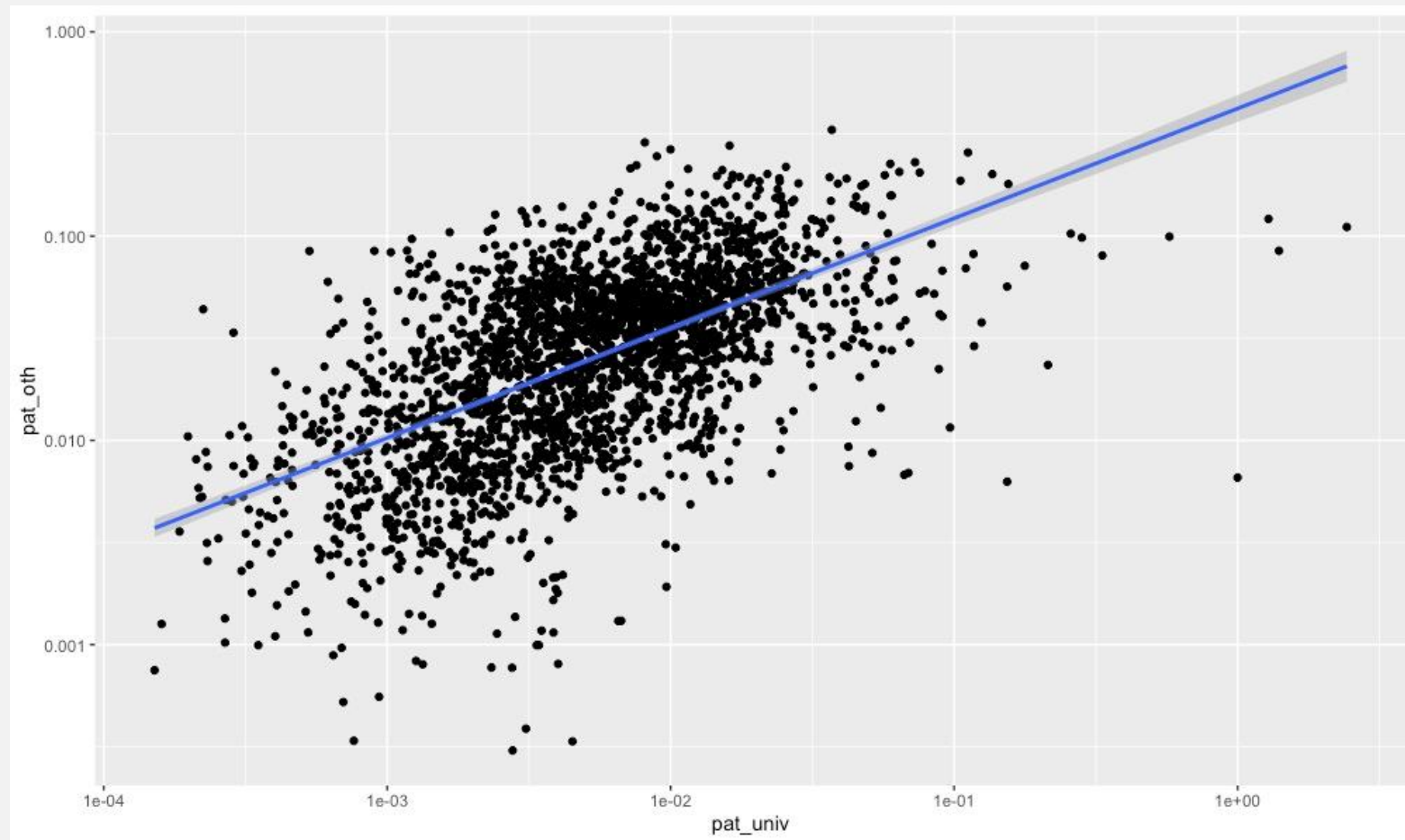
# COSINE DISTANCE

| | Year | term | estimate | std.error | statistic | p.value |
|---|---|---|---|---|---|---|
| 1 | 1989 | (Intercept) | 11.4905408432122 | 3.82274505934828 | 3.00583498633077 | 0.0132112828373203 |
| 2 | 1989 | log(exp_oth) | 4.74993102839466 | 1.27510256638518 | 3.72513643499312 | 0.00394178899917954 |
| 3 | 1991 | log(pat_univ) | 0.296990402387588 | 0.0990376821971968 | 2.99876164101096 | 0.00576318097874384 |
| 4 | 1992 | log(pat_univ) | 0.334809374817612 | 0.127495090251884 | 2.62605700467484 | 0.0142849652005271 |
| 5 | 1993 | log(exp_oth) | 1.38055215735098 | 0.279690780279411 | 4.93599451498475 | 1.7188282450051e-05 |
| 6 | 1993 | log(pat_univ) | 0.23972392464333 | 0.0652209909435291 | 3.67556397373496 | 0.000748137004427644 |
| 7 | 1994 | log(exp_oth) | 0.962600099235808 | 0.4339764321399 | 2.21809302982033 | 0.0322903166300902 |
| 8 | 1995 | log(exp_oth) | 0.772267214828766 | 0.371089990691587 | 2.0810779977911 | 0.0407513157656667 |
| 9 | 1995 | log(pat_univ) | 0.315047155366278 | 0.0952508433207101 | 3.3075523993579 | 0.00143221818299517 |
| 10 | 1996 | log(exp_oth) | 0.759226402913787 | 0.328564759717084 | 2.31073595222911 | 0.0258281408456605 |
| 11 | 1996 | log(pat_univ) | 0.234864410998696 | 0.0754065165586413 | 3.11464342496247 | 0.00331318818812342 |
| 12 | 1996 | cos | -0.94040347680557 | 0.419134375588366 | -2.24368014550337 | 0.0301835083956333 |
| 13 | 1997 | log(pat_univ) | 0.473902580443228 | 0.101879576834068 | 4.65159549312885 | 1.51157510980036e-05 |
| 14 | 1998 | log(exp_oth) | 0.826347912900925 | 0.170826242660184 | 4.83735929581228 | 2.20374286125736e-05 |
| 15 | 1998 | log(pat_univ) | 0.172117253425809 | 0.0692537391834029 | 2.48531350733272 | 0.0174609247833622 |
| 16 | 1999 | (Intercept) | 3.34672564811462 | 0.66109435162849 | 5.06240242390598 | 4.95693553197425e-06 |
| 17 | 1999 | log(exp_oth) | 1.00559951618773 | 0.156690331434973 | 6.41775090382684 | 3.37686139616375e-08 |
| 18 | 1999 | log(pat_univ) | 0.582454461576387 | 0.0824588891837637 | 7.06357394990319 | 2.96768661705831e-09 |
| 19 | 1999 | cos | -1.41902654287103 | 0.473031171523824 | -2.99985842011168 | 0.00405270140143619 |
| 20 | 2000 | (Intercept) | 1.46699723980792 | 0.697064973238082 | 2.10453443528121 | 0.0390864753373025 |
| 21 | 2000 | log(exp_oth) | 0.973949421897479 | 0.141418681111752 | 6.88699268187802 | 2.41195895824782e-09 |
| 22 | 2000 | log(pat_univ) | 0.376888762173445 | 0.101221229407723 | 3.72341616851267 | 0.000405051286404885 |
| 23 | 2001 | log(exp_oth) | 1.02615666884359 | 0.109684593737108 | 9.3555223562489 | 4.076806153257e-13 |
| 24 | 2001 | log(pat_univ) | 0.432979842097618 | 0.0948045128423944 | 4.56708050193154 | 2.69226767128802e-05 |
| 25 | 2002 | log(exp_oth) | 1.09738553475624 | 0.116579669781526 | 9.41318101872118 | 6.09185486527988e-14 |
| 26 | 2002 | log(pat_univ) | 0.226710338431512 | 0.0771304682736388 | 2.93930976313022 | 0.00449002902738965 |
| 27 | 2003 | (Intercept) | 1.41644642182261 | 0.429701241066865 | 3.29635171242663 | 0.0012777917615066 |
| 28 | 2003 | log(exp_oth) | 1.09332910077649 | 0.121273458910985 | 9.01540296281141 | 3.00199863374115e-15 |
| 29 | 2003 | log(pat_univ) | 0.358551423526936 | 0.0706875073638162 | 5.07234498567809 | 1.39556611941027e-06 |
| 30 | 2004 | log(exp_oth) | 1.2507150540457 | 0.140932640823658 | 8.87455912793587 | 5.32600923428933e-14 |
| 31 | 2005 | (Intercept) | 1.39988187869362 | 0.443040535067723 | 3.15971512286035 | 0.00190591002482382 |
| 32 | 2005 | log(exp_oth) | 1.26572270935019 | 0.112406571455861 | 11.2602198693268 | 9.0536446057868e-22 |
| 33 | 2005 | log(pat_univ) | 0.273537709122078 | 0.0568045749092251 | 4.81541688427731 | 3.51803520636567e-06 |
| 34 | 2006 | log(exp_oth) | 0.993328155486099 | 0.112667557165029 | 8.81645240635798 | 1.98915599164199e-14 |
| 35 | 2006 | log(pat_univ) | 0.270126885008812 | 0.0587993280443673 | 4.59404714293651 | 1.16428793922128e-05 |
| 36 | 2007 | log(exp_oth) | 0.935009252489169 | 0.105222820725373 | 8.88599303880572 | 4.96678909127274e-16 |
| 37 | 2007 | log(pat_univ) | 0.334491646412301 | 0.0568788589423346 | 5.88077279734845 | 1.82119303029474e-08 |
| 38 | 2008 | log(exp_oth) | 0.93460399606378 | 0.131117277206291 | 7.12800033662486 | 6.45633194477583e-11 |
| 39 | 2008 | log(pat_univ) | 0.313777203223636 | 0.0697867492045974 | 4.49622896609955 | 1.5230666423902e-05 |
| 40 | 2009 | (Intercept) | 1.04853181841997 | 0.400986943355446 | 2.6148777056078 | 0.00965391844254195 |
| 41 | 2009 | log(exp_oth) | 0.835718039454463 | 0.122962252715221 | 6.79654138567202 | 1.39299016305405e-10 |
| 42 | 2009 | log(pat_univ) | 0.422090456639283 | 0.054573511395931 | 7.73434667923446 | 6.25032406456371e-13 |
| 43 | 2009 | cos | -0.56250633146526 | 0.258607400532687 | -2.17513625018693 | 0.0308748659010276 |
| 44 | 2010 | log(exp_oth) | 1.0052583468531 | 0.113214042318081 | 8.87927262617097 | 3.18763829768348e-15 |
| 45 | 2010 | log(pat_univ) | 0.245136169995713 | 0.0609531110997864 | 4.02171711291981 | 9.46933119558209e-05 |
| 46 | 2011 | log(exp_oth) | 0.873662171545063 | 0.112711063714004 | 7.75134350396973 | 4.50737659773155e-13 |
| 47 | 2011 | log(pat_univ) | 0.350985309055478 | 0.052635946348414 | 6.66816754337796 | 2.47298820646635e-10 |
| 48 | 2012 | log(exp_oth) | 0.902985148362266 | 0.0996820719187477 | 9.05865148046183 | 7.87397441164748e-16 |
| 49 | 2012 | log(pat_univ) | 0.265641808074587 | 0.0567297567371354 | 4.68258323943592 | 6.41792153985538e-06 |
| 50 | 2012 | cos | -0.579554654607309 | 0.256761084119962 | -2.2571748230216 | 0.0254811526291008 |
| 51 | 2013 | (Intercept) | 1.08882288070759 | 0.374307927130918 | 2.90889613012863 | 0.00409774426498431 |
| 52 | 2013 | log(exp_oth) | 0.986470966965894 | 0.0989594221262944 | 9.96843904066998 | 8.08215922785789e-19 |
| 53 | 2013 | log(pat_univ) | 0.349677880146615 | 0.0540271355583751 | 6.47226391946683 | 9.37535241005006e-10 |
| 54 | 2013 | cos | -0.757947541464307 | 0.267088971393599 | -2.83780920458654 | 0.00507931026242572 |
| 55 | 2014 | log(exp_oth) | 0.852881306757218 | 0.12020685947862 | 7.09511346071652 | 1.2051195105458e-10 |
| 56 | 2014 | log(pat_univ) | 0.227048906420753 | 0.0745977826982496 | 3.04364148917365 | 0.00290764001472524 |
| 57 | 2015 | (Intercept) | 0.88740924717527 | 0.38395759368731 | 2.31121681603715 | 0.0220071066371134 |
| 58 | 2015 | log(exp_oth) | 0.872678445397964 | 0.10130965662926 | 8.61397101158389 | 4.39519103080512e-15 |
| 59 | 2015 | log(pat_univ) | 0.401521863762752 | 0.0548732021401698 | 7.31726686438114 | 9.24592490534713e-12 |
| 60 | 2015 | cos | -0.574825508561291 | 0.243076884415346 | -2.36478886070913 | 0.019155011165705 |

# CONCLUSIONS

- Naturally, other expenditures are associated with the highest increase in other patenting 0.75 - 4.75

- University patenting coeff 0.17 – 0.58

- Increase in cosine similarity is associated with decrease in other patenting