Technological Innovation Index

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Chapter 4

Towards an Improved Measurement Method

4.1 Introduction

In this section, we set the preliminary assumptions for the "discrimination concept" of the second generation patent citations that we employed. We will then expand on the empirical dynamic algorithm for the second generation lambda factor, following with the integration of the dynamic forward and backward factors into the new Forward Dimension Technology Importance (FDTI) and the Backward Dimension Technology Importance (BDTI). The last section will present a new index, *i.e.* Patent Innovation Technology Factor (PITF), to support the scientific community in its attempts to quantify technology.

4.2 Assumptions

We postulated the following:

Patent citations indicate links between patented innovations. This is conducive to compulsory standards, set by patent authorities, by which the inventor must abide. Citation information about a new invention based on previous inventions is presented on the official patent registration forms.

We adopted the assumptions posited by the Jaffe and Trajtenberg group (Jaffe and Trajtenberg, 2002) that when "patent B cites patent A of patent this points to a flow of knowledge from A to B, and therefore may constitute a 'paper trail' for technology knowledge spillover".

These assumptions were based on the concept of the Journal Impact Factor used for the rate of importance of scientific articles. As Article B is cited in ten articles while Article A is cited in fifty articles, Article A is therefore considered cited as a more significant reference.

Second generation patent citations may indicate the amplification of "Technological Importance". The assumption is that citing patents are more important than cited patents, while forward second generation patents (citing) are more

important than backward second generation patents. Still, as the majority of the studies using forward patent citations conclude (Sapsalis, 2006), it is probable that the most significant factor is that the number of forward patent citations is closely associated with the importance value of a patent. Thus, backward citation information constitutes the primary point of departure for further research, and will determine the nature of the research. Forward citation information will be informative concerning the subsequent impact of research outcomes.

4.3 Second generation Patent Discrimination

Following identification of the problems in the accuracy of equations $Eq_{(1.1)}$ and $Eq_{(1.5)}$ in section 2.5 above, we found that one of the main problems is the lack of differentiation between citing and cited patents. We will explore this issue by employing the Backward Dimension in the manner used for the Forward Dimension.

We expanded Figure 2.6 to produce Figure 4.6 by discriminating between each patent's second generation backward and forward. For example, P1b, backward first generation in Figure 2.6 consists of seven second generation patents. In Figure 4.6, we plotted the same seven patents; however, four were cited patents and three citing patents. The discrimination concept clearly describes the difference between second generation patents that were cited or citing in the forward and backward dimension.

Six groups of patents were obtained (Figure 4.1).

These groups will constitute the base for generating calculations and establishing our hypotheses.

Patent$_{(Mp)}$- Measured patent.

$\mathbf{F}_{(FG)}$ - Forward Dimension, first generation patents.

$\mathbf{B}_{(FG)}$ - Backward Dimension, first generation patents.

$\mathbf{B}_{(sgb)}$ - Backward Dimension, second generation backward patents.

$\mathbf{B}_{(sgf)}$ - Backward Dimension, second generation forward patents.

$\mathbf{F}_{(sgf)}$ - Forward Dimension, second generation forward patents.

$\mathbf{F}_{(sgb)}$ - Forward Dimension, second generation backward patents.

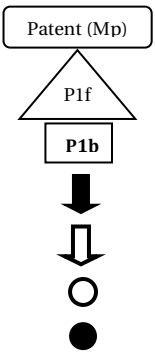
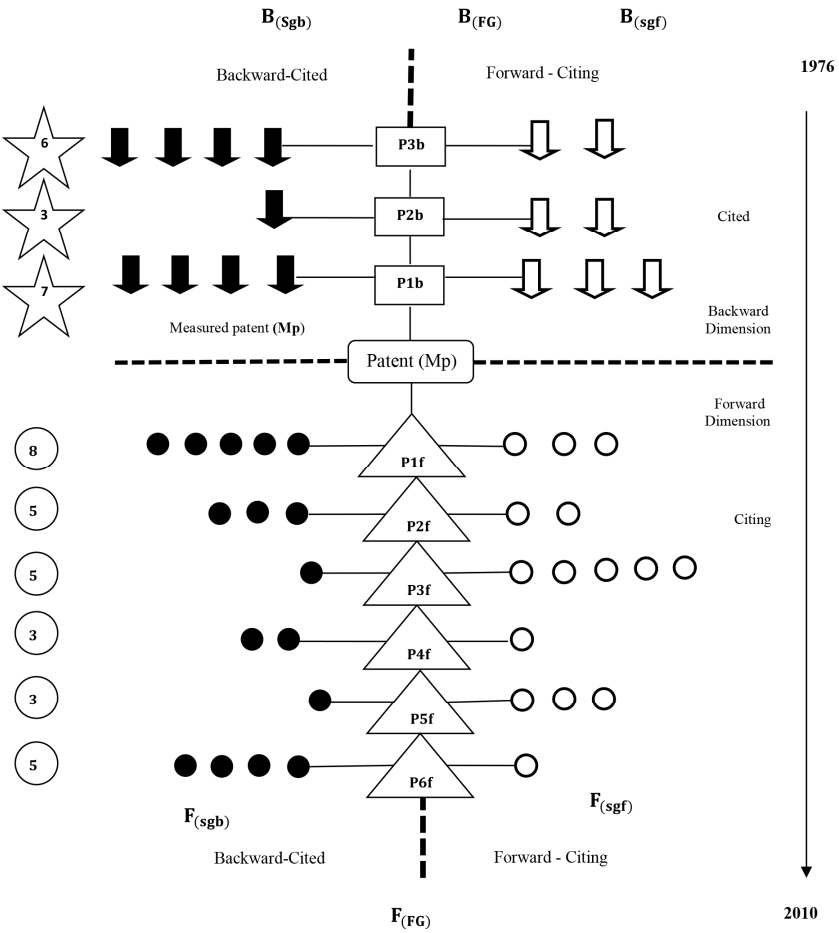


Figure 4.1 Patent Construction extended Explanation



The discrimination of second generation patents in Figure 4.1 produces an improved resolution of the different second generation groups of patents. Compared to results for four groups (Jaffe and Trajtenberg, 2002), we generated six patent groups to express patent technological importance. Six groups were generated based on the assumptions that citing patents are more important than cited patents and that forward second generation patents (citing) are more important than backward second generation patents. After distinguishing between

the forward and backward first and second generation patent citations, and discriminating between the number of forward and backward first and second generation patent citations, we can determine the dynamic second generation weighted factor for the second generation patent.

4.4 Dynamic Second Generation Patent Weighted Factor: Empirical Algorithm

The pioneer researchers who developed the basic equations arbitrarily determined the relative weight of second generation patents as half the weight of first generation patents, *i.e.* the weighted factor for Forward and Backward second generation patents is always $\lambda = 0.5$. Their decision was comprehensive and did not take into consideration distinctions between citing and cited second generation patents. Accordingly, we stressed the necessity for an equation that would manifest the weight of λ in second generation patents, while emphasizing that citing patents would receive a greater weight than cited patents. The purpose of the new weight was to express both the Forward Dimension and Backward Dimension second generation patent weight in a dynamic manner, according to the total quantity of second generation patents, and a greater weight to citing patents of the second generation. We plan to generate a new dynamic λ factor through the discrimination of the second generation citing and cited patents. This will lead to an improved resolution of patent importance. We plan to use the basic $\text{Eq}_{(1.1)}$ for $\text{IMPORTF}_{(\text{JT})}$ and to substitute the fixed lambda factor of 0.5 with the new lambda dynamic forward.

4.5 Dynamic Weighted Factor: Forward Dimension

In the following case, we describe the Measured Patent - $\text{Patent}_{(\boldsymbol{Mp})}$, the patent that we want to analyze. This patent has one first generation patent P1f in the forward dimension, and there are the second generation patents, of which four patents were cited and four patents citing patents.

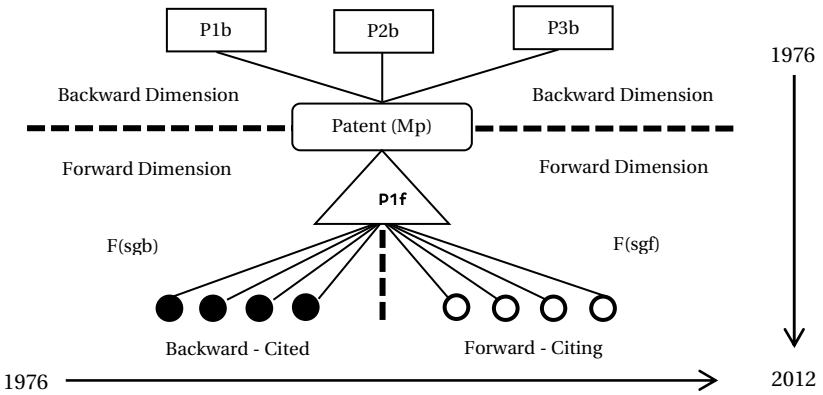
Patents P1b, P2b and P3b represent the first generation backward dimension.

In this case we describe the measured patent - $\text{Patent}_{(Mp)}$ the patent that we want to analyze. $\text{Patent}_{(Mp)}$ has one first generation patent P1f in the forward

dimension, and there are four patents that were cited ○ and four patents citing ● patents.

Patents P1b, P2b, P3b represent the first generation backward dimension.

Figure 4.2 Dynamic Weighted Factor: Forward Dimension



The dynamic weight factor was developed empirically. Considering assumptions, we arrived at an empirical algorithm for the dynamic λ factor of the second generation forward and backward citation patents.

We adopted the Jaffe and Trajtenberg (2002) assumption that every first generation patent receives the value of one $\lambda_{F(FG)(P1f)}$=1

The main idea is to generate individual factors for the second generation patents - $\lambda_{F(fsg)(P1f)}$ so as to project the dynamic weight to express technological importance. We arrived at the conclusion that the best way to express the second generation weight was by employing the following equation:

$$Eq_{(4.1)}$$

$$\boldsymbol{\lambda_{F(fsg)(P1f)}} = \frac{\mathbf{F_{(sgf)(P1f)}}}{\mathbf{F_{(sgf)(P1f)} + F_{(sgb)(P1f)}}}$$

Where:

$\boldsymbol{\lambda_{F(fsg)(P1f)}}$	= λ F Dynamic Forward Dimension for P1f patent second generation patents
P1f	=Patent P1, Forward dimension, first generation. (Figure 4.2)
$\mathbf{F_{(sgf)}}$	=Forward Dimension, second generation forward patents.(citing)
$\mathbf{F_{(sgb)}}$	=Forward Dimension, second generation backward patents.(cited)

In order to avoid zero and infinity results we did the following:

The value of one was added to the numerator - $F_{(sgf)(P1f)}$ to avoid zero results to $\lambda_{F(fsg)(P1f)}$ figure.

The value of one was added to the denominator to avoid infinity results to $\lambda_{F(fsg)(P1f)}$ figure.

$\boldsymbol{Eq_{(4.2)}}$

$$\boldsymbol{\lambda_{F(fsg)(P1f)} = \frac{1+F_{(sgf)(P1f)}}{1+F_{(sgf)(P1f)}+F_{(sgb)(P1f)}}}$$

We will analyze the Lambda forward results for: $\lambda_{F(fsg)(P1f)}$ for P1f to demonstrate the process of calculation.

The Lambda forward results for: $\lambda_{F(fsg)(P1f)}$ (Figure 4.2) are:

$\boldsymbol{Eq_{(4.3)}}$

$$\boldsymbol{\lambda_{F(fsg)(P1f)} = \frac{1+F_{(sgf)(P1f)}}{1+F_{(sgf)(P1f)}+F_{(sgb)(P1f)}} = \frac{1+4}{1+4+4} = \frac{5}{9}}$$

Then

$$\boldsymbol{\lambda_{F(fsg)(P1f)} = \frac{5}{9}}$$

4.6 Dynamic Weighted Factor: Backward Dimension

In the following section we describe Patent$_{(Mp)}$, the analyzed patent. This patent has three first generation patents, P1b, P2b and P3b, in the backward dimension.

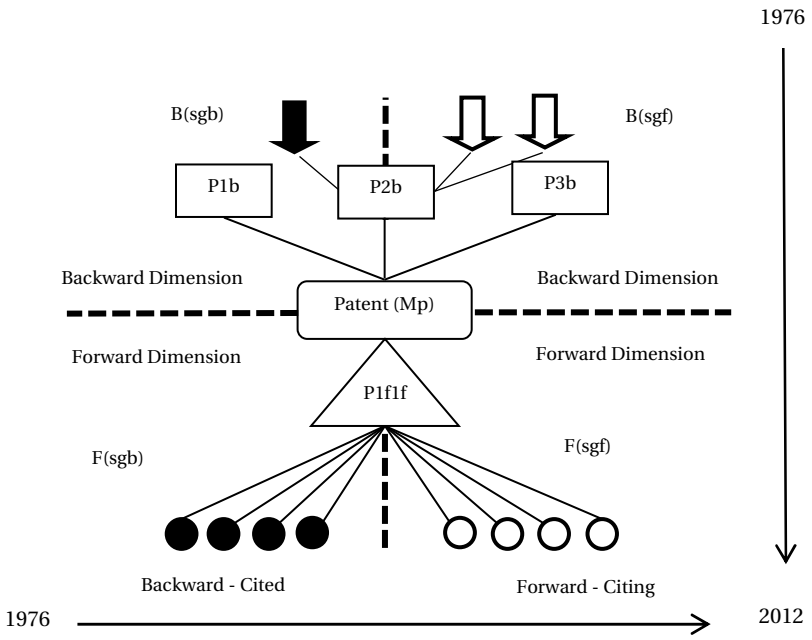
We will concentrate on patent P2b first generation Backward that has one cited patent and two citing patents in the backward dimension. Patents P1f represent the first generation forward dimension.

In this case we describe Patent$_{(Mp)}$, the patent that we want to analyze. This patent has three first generation patents, P1b, P2b, P3b, in the backward dimension.

We will concentrate on patent P2b first generation Backward that has one cited patent ⬇ and two ⇩ citing patent in the backward dimension.

Patents P1f represent the first generation, Forward Dimension.

Figure Dynamic Weighted Factor: Backward Dimension



The assumption is that every first generation patent receives the value of one, $\lambda_{FG(P1b)} = 1$

The main idea is to generate an individual lambda factor for each second generation patent - $\lambda_{(bsg)(P2)}$. In that way we will project the dynamic weight to express the technological importance.

We arrived empirically at the conclusion that the best way to express the second generation weight is through the following equation:

$\boldsymbol{Eq_{(4.4)}}$

$$\boldsymbol{\lambda_{DB(bsg)(P2b)} = \frac{B_{(sgf)(P2b)}}{B_{(sgf)(P2b)} + B_{(sgb)(P2b)}}}$$

Where:

$\boldsymbol{\lambda_{DB(bsg)(P2b)}}$ = λ Dynamic, Backward Dimension for P2 patent second generation patents

P2b = Patent 2b first generation Backward Dimension. (See Figure 4.3)

$\boldsymbol{B_{(sgf)(P2b)}}$ = Backward Dimemsion second generation forward patents. (citing)

$\boldsymbol{B_{(sgb)(P2b)}}$ = Backward Dimension second generation backward patents. (cited)

The value of one was added to the numerator to avoid zero results.
The value of one was added to the denominator to avoid infinity results.

The empirical dynamic lambda factor for P2b is as follows:

$\boldsymbol{Eq_{(4.5)}}$

$$\boldsymbol{\lambda_{DB(bsg)(P2b)} = \frac{1 + B_{(sgf)(P2b)}}{1 + B_{(sgf)(P2b)} + B_{(sgb)(P2b)}}}$$

We will analyze the lambda forward results for: $\lambda_{F(fsg)(P1f)}$ for P2b to demonstrate the process of calculation.

The lambda backward results for: $\lambda_{B(bsg)(P2b)}$ *from (Figure 4.3)*

$$\boldsymbol{Eq_{(4.6)}}$$

$$\boldsymbol{\lambda_{DB(bsg)(P2b)} = \frac{1 + B_{(sgf)(P2b)}}{1 + B_{(sgf)(P2b)} + B_{(sgb)(P2b)}} = \frac{1+2}{1+2+1} = \frac{3}{4}}$$

Then

$$\boldsymbol{\lambda_{DB(bsg)(P2b)} = \frac{3}{4}}$$

4.7 Forward and Backward Dimension Technology Importance

In this section, we will integrate the dynamic weighting factor forward dimension into the Forward Dimension Technology Importance (FDTI) that will replace the IMPORTF(JT) equation, followed by calculations of FDTI based on Figure 4.2.

We will continue with the integration of the dynamic weighting factor backward dimension into the Backward Dimension Technology Importance (BDTI) followed by calculations of BDTI based on Figure 4.3.

4.7.1 Forward Dimension Technology Importance (FDTI)

In this section, we will integrate the dynamic forward dimension equation results into the new Forward Dimension Technology Importance equation. In order to give more weight to the citing patents we decided to multiply the citing patents by the results of $\lambda_{(DF)}$ lambda dynamic results.

$$\boldsymbol{Eq_{(4.7)}}$$

$$\boldsymbol{FDTI_{(Mp)(P1)} = F_{(FGP1)} + \left(F_{(sgf)(P1f)}\right)\left(\lambda_{DF(fsg)}\right)}$$

Where:

$\mathbf{FDTI_{(Mp)(P1)}}$ = **Forward dimension technology importance of measured patent.**

$\mathbf{F_{(FGP1)}}$ = **Patent P1, Forward dimension, first generation.**

$\boldsymbol{\lambda_{DF(P1)}}$ = **λ Dynamic Forward Dimension. of P1 patent.**

We have calculated the Lambda dynamic results

$\boldsymbol{Eq_{(4.8)}}$

$$\boldsymbol{\lambda_{F(fsg)(P1f)} = \frac{F_{(sgf)(P1f)}}{F_{(sgf)(P1f)} + F_{(sgb)(P1f)}}}$$

$\boldsymbol{Eq_{(4.9)}}$

$$\mathbf{FDTI_{(Mp)(P1)} = F_{(FGP1)} + \left(F_{(sgf)(P1f)}\right)\left(\frac{F_{(sgf)(P1f)}}{F_{(sgf)(P1f)} + F_{(sgb)(P1f)}}\right)}$$

$\boldsymbol{Eq_{(4.10)}}$

$$\mathbf{FDTI_{(Mp)(P1)} = F_{(FGP1)} + \frac{F_{(sgf)(P1f)}{}^{2}}{F_{(sgf)(P1f)} + F_{(sgb)(P1f)}}}$$

The Forward Dimension Technological Importance $FDTI_{(Mp)(P1)}$ equals the Forward first generation of the Measured Patent plus the forward second generation forward patent of P1 - $F_{(sgf)(P1f)}$ multiplied by the Forward second generation forward patent $F_{(sgf)(P1)}$ group plus one, divided by the sum of the Forward second generation forward $F_{(sgf)(P1)}$ and Forward second generation backward $F_{(sgb)(P1)}$ plus one. As previously, the value of one was added to the numerator to avoid zero results and the value of one was added to the denominator to avoid infinity results for the $\lambda_{(DF)}$ figure.

The value of one was added to the denominator to avoid infinity results to $FDTI_{(P1)}$ figure.

$Eq_{(4.11)}$

$$\mathbf{FDTI_{(P1)}} = \mathbf{F_{(FGP1)}} + \frac{\mathbf{1 + F_{(sgf)(P1f)}}^{2}}{\mathbf{1 + F_{(sgf)(P1f)} + F_{(sgb)(P1f)}}}$$

Where:

$\mathbf{FDTI_{(Mp)(P1)}}$ = Forward Dimension Technology Importance of measured patent.

$\mathbf{F_{(FGP1)}}$ = Forward Dimension, first generation patent P1.

$\mathbf{F_{(sgf)(P1f)}}$ = Forward Dimension, second generation forward patents (P1)

$\mathbf{F_{(sgb)(P1f)}}$ = Forward Dimension, second generation backward patents. (P1)

We used the basic $Eq_{(1.1)}$ and substituted the dynamic $Eq_{(1.2)}$ for the fixed lambda factor of 0.5. The first generation patents received a lambda equal to one, and the second generation patents received the dynamic lambda as described in $Eq_{(1.1)}$.

Forward Technology Importance equals the sum of forward, first generation patents plus the sum of the second generation forward group of patents to the power of two, divided by the sum of forward and backward second generation of patents plus one.

The value of one was added to avoid zero results to $FDTI_{(Mp)}$ figure.

$Eq_{(4.12)}$

$$\mathbf{FDTI_{(Mp)}} = \mathbf{1} + \sum_{\mathrm{PF_{(FG)=P1}}}^{\mathrm{PF_{(FG)=Pn}}} \mathrm{F_{(FG)}} + \sum_{\mathbf{PF_{(sg)=P1}}}^{\mathbf{PF_{(sg)=Pn}}} \frac{\mathbf{1 + F_{(sgf)}}^{2}}{\mathbf{1 + F_{(sgf)} + F_{(sgb)}}}$$

Where:

$\mathbf{FDTI_{(Mp)}}$ - Forward Dimension Technology Importance of measured patent

$\mathbf{F_{(FG)}}$ - Forward Dimension, first generation patents

$\mathbf{PF_{(sg)=P1}}$ - Forward Dimension, second generation, first patent

$\mathbf{PF_{(sg)=Pn}}$ - Forward Dimension, second generation, last patent

$\mathbf{F_{(sgf)}}$ - Forward Dimension, second generation, forward patents (Citing)

$\mathbf{F_{(sgb)}}$ - Forward Dimension, second generation backward patents (cited)

Solving the technological importance $\mathrm{FDTI}_{(\mathrm{Mp})}$ of Figure E

$$\boldsymbol{Eq_{(4.13)}}$$

$$\mathbf{FDTI_{(Mp)}} = \mathbf{1} + \sum_{\mathrm{PF_{(FG)=P1}}}^{\mathrm{PF_{(FG)=Pn}}} \mathrm{F_{(FG)}} + \sum_{\mathbf{PF_{(sg)=P1}}}^{\mathbf{PF_{(sg)=Pn}}} \frac{\mathbf{1 + F_{(sgf)}}^{2}}{\mathbf{1 + F_{(sgf)} + F_{(sgb)}}}$$

$$\boldsymbol{Eq_{(4.14)}}$$

$$\begin{aligned} = \mathbf{1} + \boldsymbol{P1(FG)} + \boldsymbol{P2(FG)} + \boldsymbol{P3F(FG)} + \boldsymbol{P4(FG)} + \boldsymbol{P5(FG)} + \boldsymbol{P6(FG)} + \mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P1f)}} \\ + \mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P2f)}} + \mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P3f)}} + \mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P4f)}} + \mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P5f)}} \\ + \mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P6f)}} \end{aligned}$$

$$\boldsymbol{Eq_{(4.15)}}$$

$$\boldsymbol{P1(FG)} + \boldsymbol{P2(FG)} + \boldsymbol{P3F(FG)} + \boldsymbol{P4(FG)} + \boldsymbol{P5(FG)} + \boldsymbol{P6(FG)} = \mathbf{1+1+1+1+1+1} = \mathbf{6}$$

$$\boldsymbol{Eq_{(4.16)}}$$

$$\mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P1f)}} = \frac{\mathbf{1 + F_{(sgf)(P1f)}}^{2}}{\mathbf{1 + F_{(sgf)(P1f)} + F_{(sgb)(P1f)}}} = \frac{\mathbf{1 + 4^2}}{\mathbf{1 + 4 + 4}} = \frac{\mathbf{17}}{\mathbf{9}} = \mathbf{9.88}$$

$$\boldsymbol{Eq_{(4.17)}}$$

$$\mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P2f)}} = \frac{\mathbf{1 + F^2_{(sgf)(P2f)}}}{\mathbf{1 + F_{(sgf)(P2f)} + F_{(sgb)(P2f)}}} = \frac{\mathbf{1 + 2^2}}{\mathbf{1 + 3 + 2}} = \frac{\mathbf{5}}{\mathbf{6}} = \mathbf{0.83}$$

$$\boldsymbol{Eq_{(4.18)}}$$

$$\mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P3f)}} = \frac{\mathbf{1 + F^2_{(sgf)(P3f)}}}{\mathbf{1 + F_{(sgf)(P3f)} + F_{(sgb)(P3f)}}} = \frac{\mathbf{1 + 5^2}}{\mathbf{1 + 1 + 5}} = \frac{\mathbf{26}}{\mathbf{7}} = \mathbf{3.71}$$

$$\boldsymbol{Eq_{(4.19)}}$$

$$\mathbf{F_{(sgfb)}}\boldsymbol{\lambda_{(P4f)}} = \frac{\mathbf{1 + F^2_{(sgf)(P4f)}}}{\mathbf{1 + F_{(sgf)(P4f)} + F_{(sgb)(P4f)}}} = \frac{\mathbf{1 + 1^2}}{\mathbf{1 + 2 + 1}} = \frac{\mathbf{2}}{\mathbf{5}} = \mathbf{0.40}$$

$$\boldsymbol{Eq_{(4.20)}}$$

$$\mathbf{F_{(sgfb)}\lambda_{(P5f)}} = \frac{\mathbf{1 + F^2_{(sgf)(P5f)}}}{\mathbf{1 + F_{(sgf)(P5f)} + F_{(sgb)(P5f)}}} = \frac{\mathbf{1 + 3^2}}{\mathbf{1 + 1 + 3}} = \frac{\mathbf{10}}{\mathbf{5}} = \mathbf{2.00}$$

$$\boldsymbol{Eq_{(4.21)}}$$

$$\mathbf{F_{(sgfb)}\lambda_{(P6f)}} = \frac{\mathbf{1 + F^2_{(sgf)(P6f)}}}{\mathbf{1 + F_{(sgf)(P6f)} + F_{(sgb)(P6f)}}} = \frac{\mathbf{1 + 1^2}}{\mathbf{1 + 4 + 1}} = \frac{\mathbf{2}}{\mathbf{6}} = \mathbf{0.33}$$

$$\boldsymbol{Eq_{(4.22)}}$$

$$\boldsymbol{FDTI_{(Mp)}} = \mathbf{1 + 6 + 9.88 + 0.83 + 3.71 + 0.40 + 2.00 + 0.33 = 24.15}$$

We used the basic $Eq_{(1.2)}$ and substituted the dynamic $Eq_{(1.2)}$ for the fixed lambda factor of 0.5. The first generation patents received a lambda equal to one, and the second generation patents received the dynamic lambda as described in $Eq_{(4.5)}$

Forward Technology Importance equals the sum of forward, first generation patents plus the sum of the second generation forward group of patents to the power of two, divided by the sum of forward and backward second generation of patents plus one.

The value of one was added to avoid zero results for $FDTI_{(Mp)}$.

4.7.2 Backward Dimension, Technology Importance $FDTI_{(Mp)}$

In this section, we integrate the dynamic backward dimension results equation into the new Forward Dimension Technology Importance equation. In order to give more weight to the citing patents we multiplied the citing patents with the results of lambda dynamic results.

$$\boldsymbol{Eq_{(4.23)}}$$

$$\mathbf{BDTI_{(Mp)(P2b)}} = \mathbf{B_{(FGP1)}} + \left(\mathbf{F_{(sgf)(P2b)}}\right)\left(\boldsymbol{\lambda_{DB(fsg)}}\right)$$

Where:

$\mathbf{FDTI_{(Mp)(P1)}}$ - Forward Dimension Technology Importance of measured patent.

$\mathbf{B_{(FGP1)}}$ -Patent P1, Backward dimension, first generation.

$\boldsymbol{\lambda_{DB(P1)}}$ - λ Dynamic Backward dimension of P2b patents.

We have calculated the Lambda Dynamics results

$\boldsymbol{Eq_{(4.24)}}$

$$\boldsymbol{\lambda_{DB(fsg)(P2b)}} = \frac{\mathbf{B_{(sgf)(P2b)}}}{\mathbf{B_{(sgf)(P2b)}} + \mathbf{B_{(sgb)(P2b)}}}$$

$\boldsymbol{Eq_{(4.25)}}$

$$\mathbf{BDTI_{(Mp)(P2b)}} = \mathbf{B_{(FGP2b)}} + \left(\mathbf{B_{(sgf)(P2b)}}\right)\left(\frac{\mathbf{B_{(sgf)(P2b)}}}{\mathbf{B_{(sgf)(P2b)}} + \mathbf{B_{(sgb)(P2b)}}}\right)$$

$\boldsymbol{Eq_{(4.26)}}$

$$\mathbf{BDTI_{(Mp)(P2b)}} = \mathbf{B_{(FGP2b)}} + \frac{\mathbf{B_{(sgf)(P2b)}}^2}{\mathbf{B_{(sgf)(P2b)}} + \mathbf{B_{(sgb)(P2b)}}}$$

The Backward Dimension Technological Importance $BDTI_{(Mp)(\mathrm{P2b})}$ equals the Backward first generation of the Measured Patent plus the backward second generation forward patent to the power of two of P2b plus one divided by the sum of the backward second generation forward $B_{(sgf)(\mathrm{P2b})}$ and backward second generation $B_{(sgb)(\mathrm{P2b})}$ plus one. The backward dynamic factor $\lambda_{DB(bsg)(\mathrm{P2b})}$ equals the Backward second generation forward group of patents of P1- $B_{(sgf)(\mathrm{P2b})}$ multiplied by the Backward second generation forward $B_{(sgf)(P1)}$ plus one divided by the sum of the Backward second generation forward $B_{(sgf)(P1)}$ plus Backward second generation backward $B_{(sgB)\mathrm{P2b})}$ plus one. We decided to add one to avoid infinity results.

In $\lambda_{\mathrm{DB(P2b)}}$ the value of one was added to the numerator to avoid zero results and the value of one was added to the denominator to avoid infinity results.

The empirical dynamic lambda factors are as follows:

Eq$_{(4.27)}$

$$\boldsymbol{\lambda_{DB(P2b)}} = \frac{\mathbf{1 + B_{(sgf)(P2b)}}^{2}}{\mathbf{1 + B_{(sgf)(P2b)} + B_{(sgb)(P2b)}}}$$

Where:

$\boldsymbol{\lambda_{DB(P2b)}}$ - λ Dynamic Backward dimension of P2b patent.

P2b - Patent P2b first generation Backward Dimension,

$\mathbf{B_{(sgf)}}$ -Backward Dimension, second generation forward patents (citing)

$\mathbf{B_{(sgb)}}$ -Backward Dimension, second generation backward patents (cited)

Backward Importance equals the sum of first generation backward patents plus the sum of the second generation forward group of patents to the power of two, divided by the sum of the second generation forward plus second generation backward patents plus one.

Eq$_{(4.28)}$

$$\mathbf{BDTI_{(Mp)}} = \mathbf{1} + \sum_{PB_{(FG)=P1}}^{PB_{(FG)=Pn}} B_{(FG)} + \sum_{\mathbf{PB_{(sg)=P1}}}^{\mathbf{PB_{(sg)=Pn}}} \frac{\mathbf{1 + B_{(sgf)}}^{2}}{\mathbf{1 + B_{(sgf)} + B_{(sgb)}}}$$

Where:

$\mathbf{BDTI_{(Mp)}}$ -Backward Dimension, Technology Importance of measured patent

$\mathbf{PB_{(sg)=P1}}$ Backward Dimension, first Patent, first Patent

$\mathbf{PB_{(sg)=Pn}}$ Backward Dimension,first generation,last Patent

$\mathbf{B_{(FG)}}$ - Backward Dimension, first generation patents

$\mathbf{B_{(sgf)}}$ - Backward Dimension, second generation forward patents (citing)

$\mathbf{B_{(sgb)}}$ - Backward Dimension,second generation backward Patents (cited)

$$Eq_{(4.29)}$$

$$\mathbf{BDTI_{(Mp)}} = 1 + \sum_{PB_{(FG)=P1}}^{PB_{(FG)=Pn}} B_{(FG)} + \sum_{\mathbf{PB_{(sg)=P1}}}^{\mathbf{PB_{(sg)=Pn}}} \frac{\mathbf{1 + B_{(sgf)}}^2}{\mathbf{1 + B_{(sgf)} + B_{(sgb)}}}$$

$$Eq_{(4.30)}$$

$$= \mathbf{1 + P1(BG) + P2(BG) + P3F(BG) + B_{(sgP1b)}\,\lambda_{DB(P1b)} + B_{(sgP2b)}\lambda_{DB(P2b)} + B_{(sgP3b)}\lambda_{DB(P3b)}}$$

$$Eq_{(4.31)}$$

$$\mathbf{P1(BG) + P2(BG) + P3F(BG) = 1 + 1 + 1 = 3}$$

$$Eq_{(4.32)}$$

$$\lambda_{DB(P1b)} = \frac{\mathbf{1 + B_{(sgf)(P1b)}}^2}{\mathbf{1 + B_{(sgf)(P1b)} + B_{(sgB)(P1b)}}} = \frac{1 + 3^2}{1 + 4 + 3} = \frac{10}{8} = 1.25$$

$$Eq_{(4.33)}$$

$$\lambda_{DB(P2b)} = \frac{\mathbf{1 + B_{(sgf)(P2b)}}^2}{\mathbf{1 + B_{(sgf)(P2b)} + B_{(sgb)(P1b)}}} = \frac{1 + 2^2}{1 + 1 + 2} = \frac{5}{4} = 1.20$$

$$Eq_{(4.34)}$$

$$\lambda_{DB(P3b)} = \frac{\mathbf{1 + B_{(sgf)(P3b)}}^2}{\mathbf{1 + B_{(sgf)(P3b)} + B_{(sgb)(P3b)}}} = \frac{1 + 2^2}{1 + 4 + 2} = \frac{5}{7} = 0.70$$

$$Eq_{(4.35)}$$

$$\mathbf{BDTI_{(Mp)}} = 1 + 3 + 1.25 + 1.20 + 0.70 = 7.15$$

$$\mathbf{BDTI_{(Mp)}} = 24.70$$

$$\mathbf{BDTI_{(Mp)}} = 7.15$$

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