Visualized Financial Performance Analysis: Self-Organizing Maps(MS)

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***Abstract*—This study reviews expediency and discusses about self-organizing map (SOM) in financial performance management and analysis of a Canadian bank, and financial data of Royal Bank of Canada (RBC) has been analysed with SOM application. The SOM is used widely for many financial applications, including financial institutions towards financial crisis of 2008. Where it is an automatic data-analysis technique, which is mostly applied to visualization and clustering in data exploration. The objective of this study is to evaluate financial performance and to comprehend the influences of International Financial Reporting Standards (IFRS) after the convergence in year 2011. Effects of Management Decision and Analysis (MD&A) on financial performance were also analyzed from reported financial data gathered through financial statements of RBC. SOM Ward clustering for visualization facilitates in assessing the fundamental nature based on a set of maps and clustering attribute solutions for measuring financial performances. Result of this study indicates that SOM must be a practicable application designed for financial performance analysis and measures for many financial sectors.**

Keyword—Self-organizing map (SOM); financial performance; International Financial Reporting Standards (IFRS); Canadian Generally Accepted Accounting Principles (CGAAP); Management Decision and Analysis (MD&A)

I. INTRODUCTION

The SOM is a neural network based, unsupervised projection, visualization and clustering method quite often used for data exploration and analysis. As it's considerably one of the potential application for data mining and pattern recognition [9], [10]. This technique has been comprehended for financial performance measurement and analysis in recent years. Where SOM application has been used in many areas of financial applications [4], including financial performance comparisons, such as financial crisis monitoring and stock price forecasting [1], [14] to name a few. In general, SOM is an ideal tool for building visualisation through clustering, as it reduces dimensionality and data. In the SOM, however, these models are automatically connected with nodes of regular, normally two-dimensional grid in an orderly mode in which models that are more similar become automatically connected with nodes in the adjacent grid, while dissimilar models must be situated further away from each other in the grid. The structure of this kind makes it possible to understand the insight into the topological relationship of data, especially of high dimensional in nature.

The SOM algorithm is an unsupervised-learning algorithm, and it creates a two-dimensional map from n-dimensional input data. This describes about input nodes, a two-dimensional map. These neurons respond most strongly to certain values. Strength of that responsiveness is normally marked in colour, where these areas can be distinguishable from one another, then such data are said to be clusterable or classifiable such as SOM-Ward-Clusters. Data sets are presented in sequence to a neutral network, thereafter one neuron is chosen among them, which will represent the data set, for example a neuron-winner most suitable for that data is searched from this process. Indeed, some of its nearest neighbours are also subject to this setting. Once all data are presented, all these neurons will appear in an organized manner and constitute some fields of certain values, once it's completed the SOM process is considered to be over. However, SOM reflects data of higher dimensionality on a map of lower dimensionality

As SOM utilizes unsupervised training of algorithms, which belongs to a general class of Artificial Neutral Networks based non-linear regression technique that can be trained to organize data in order to disclose far unknown patterns or structures. Where, it has been used to construct visual predictions of different phenomena and only recent studies conducted by many researchers [2], [12]. This study makes use of SOM to analyse visually financial performance of RBC to evaluate ten-year period. This includes pre and post IFRS convergence and effects of 2008 financial crisis, together with MD&A of management's faithful representation – stewardship. Financial performance can be measured in different dimensions, which comprises profitability, liquidity and insolvency and visualizing these dimensions simultaneously for a time period is effortless with the use of SOM technique among other methods. Where SOM allows clustering for financial performance indicators accordingly and analysis provides whether there is any significant changes that have taken place during this time period. The SOM is well matched for representing non-linear relationship between input neurons (attributes). Current and future financial performance indicators must be mapped to construct two-dimensional grid. As the overall financial performance developed by management through MD&A may reflect management's point of view of on bank's performance for that fiscal period.

II. Self-Organizing Maps

Teuvo Kohonen's SOM is an effective technique that can be used for several general purposes abstraction of multivariate mean profiles through projection into a lower dimension. This consists of two layers: input and output layer. Number of neurons in the input layer equals to the number of data (variables), and the output layer is two-dimensional topology grid, called map, composed of a specified nodes (neuron). The SOM differs from other form of data analytical methodology, where it performs clustering through vector quantization and projections, while preserving the neighbourhood. As its have the advantages of regular grid shape for linking visulaization while having the simplest and fast learning algorithms. During this learning process each neurons learn to pull towards data with similar characteristics, and neighbouring neurons also learn, with weakening weight, to pull towards similar data. As this training begins with an initialization phase, while the size of the map is determined with number of neurons. Analysis with SOM can be related to cross-sectional applications, where it is commonly utilized for classification of clustering and predicting data for a wide range of fields such as finance and economics, environmental science, engineering, and bio-medical studies [5]. SOM algorithm is similar to k-means clustering algorithm [11], while the output of a SOM is topological and neighbouring clusters are similar. In fact, k-means is an efficient algorithm for large datasets, in particular, suitable for detecting hyperspherical clusters, as such compact and well-separated data [7]. The k-means method is the most widely known data-clustering scheme and this method consists of two steps. Initial step is to analysis the principal components that is used to reduce the dimensionality of the dataset thereafter the k-means clustering is performed

III. Canadian Banks – Synopsis

The financial crisis has come and gone over years and these happenings are not new to global economy. Where, historical economic events have taught the world, that these economics conditions shape the financial market conditions as an example declines and lack of customer confidence. Deflating speculative bubbles are also not a new concept. The stock market crisis in 1929, the dot-com bubble in 2000, even the financial crisis in 2008 shared the same features. In order to overcome the financial crisis of 2008, regulators have introduced changes to regulatory guidelines, including capital and liquidity demands, as the key factor in determining the business plans, while changing the cost profile of products and services offered by banks. Canadian banks have been impacted by these regulatory changes significantly, in particular changes made to the financial systems. Process changes were made based on newly introduced regulations. Banks have demonstrated again that their ability to adapt towards those changes in economic conditions and regulatory environments to this date. Where their capital structure remains strong, which provides the stability in uncertain times. However, uncertainty produced by vast range of regulatory changes and proposals includes significant layers of complexity to the system, both in Canada and abroad. Following a remarkable turnaround in 2009 the RBC continuous to strengthen through financial markets. As its financial performance ratios were maintained at strong levels after the introduction of regulatory capital changes under Basel III and the adoption of IFRS.

IV. Research Methodology

The basic idea behind SOM neural network is to represent information as it processes through a neuro-physiological progression. Development of synaptic connections within neurons has been based on frequency of sensorial stimuli. The conceptual connection, which remains in between, input signals and the synaptic adoption of neurons, first defined by Teuvo Kohonen mathematically in 1982. Throughout this process, individual neurons become responsive to certain specific pattern inside input signals. As a result, the neighbouring neurons tend to learn the signals of similar pattern. This learning rule is known as Kohonen Algorithm, which is simple logic [9], [13]. The SOM technique provides simultaneous aptitude such as projections and clustering of data, where this neutral network utilizes an unsupervised competitive learning process, which was first introduced by Tevuo Kohonen in 1982 and further modifications were made after that, especially in 1997 to 2001. The network of nodes contains an input and output layer, in which number of layers equals to the dimension of data, where output layer is known as the topological grid. The basic algorithm of SOM preserves the topological map while the number of neurons is fixed from the beginning. The training process begins with reference to vectors ordered based on two principle components. Then after the training algorithm is followed by two more steps such as finding the best-matching units (BMU), and adjust reference vectors. First step represents the comparison, using Euclidean distance between each unity each input data vector x_j, where j denotes 1, 2, 3, 4 ….. N, with network reference vector m_i, and i represent 1, 2, 3, 4….. M. In order to find the best match (BMU) m_b,

$$\| x_j - m_b \| \min_i \{\| x_j - m_i \|\} \qquad (1)$$

The distance between data vector x_j and the BMU m_b is less than or equal to the distance between x_j and any other reference vector m_i. Thereafter, second step make adjustments to each reference vector m_i with the batch updating algorithm [9], [14].

$$m_i(t+1) = \frac{\sum_{j-1}^{N} h_{ib(j)}(t) x_j}{\sum_{j-1}^{N} h_{ib(j)}(t)} \qquad (2)$$

Where t represents a discrete time coordinate and $h_{ib(j)}$ denotes neighbourhood function.

$$h_{ib(j)} = \exp\left[\frac{\|r_b - r_i\|^2}{2\sigma^2(t)}\right] \qquad (3)$$

As r_b and r_i are the two dimensional coordinates of reference vectors of m_b and m_i , while the radius of the neighbourhood $\sigma(t)$ ε (0,2) decreasing function of time *t.* At the start, from half diagonal of the grid size ($\sigma = X^2 + Y^2)^{2}$ / 2), radius decreases monotonously towards a specific tension value. As large neighbourhood, radius result in solid maps that preserve topological ordering at the cost of quantization accuracy considered as a general rule. Rest of the parameters determine the size of the map, based on number of nodes, and map format, as such ratios of X and Y dimensions alongside the training process, for example number of training cycles. The quality of the map can be measured by way of quantization error (QE). It represents the best fit of the map to data and can be denoted by following equation:

$$QE = \frac{1}{N} \sum_{j\text{-}1}^{N} || x_j - m_{b(j)} ||^2 \qquad (4)$$

It measures an average distance between all input vectors x_i, and their equivalent best-matching reference vectors m_b.

This paper uses SOM methodology to gain inside in RBC financial performance in particular, after financial crisis and convergence to IFRS. The movements in share prices (basic and diluted) alongside dividends yield and payout has been analyzed to identify financial performance of RBC and the effects of regulatory influences. Here the focus was more on how different financial factors indicated in RBC financial statements could contribute to bank's movements from one set of clusters to another. In this paper, financial data set, consist of financial statements from RBC for a period of ten years, as of 2007 to 2016. A number of financial indicators were chosen to evaluate the financial performance of RBC, and SOM were used to analyse these financial data set. The analysis of SOM-Ward-Clusters reveals different types of financial performances indicators, and this paper is based on that research. Financial Performance indicators from MD&A and financial statements of RBC have been obtained through financial reports, which were then used to create a data set. This data set was used as input data to SOM method to analysis visualization and clustering of financial performance of RBC. Following financial performance measures and indicators have been chosen for this study;

A. Net Income: Reported by Segments

- Personal and commercial banking (PCB)
- Capital Markets (CMS)
- Wealth Management (WM)
- Insurance (INS)

B. Key Financial Ratios:

- Return on Equity (ROE)
- Efficiency Ratio (E_Ratio)
- Non-interest income (NII)
- Net Interest Margin (NIM)
- Return on Risk-weighted assets (RWA)
- Provision for Credit Losses on impaired loans (PCL)

C. Earning per share (EPS):

- Basic EPS
- Diluted EPS

D. Dividends

- Dividend yield
- Dividend payout ratio

E. Share Price

- Common Share Price

F. Capital Performance Measures (CPM):

- Tier 1 Capital Ratio (Tier 1_CR)
- Total Capital Ratio (T_CR)

V. Research Analysis

The chosen financial performance indicators have been analyzed with SOM method, while using the unsupervised learning technique to process those financial data set created from RBC financial statements. It has formed visualization and has provided SOM-Ward-Clusters together with individual financial performance specific clusters. Based on the analytical outcome of financial performance indicators alongside visualized clusters are described under six different headings;

A. Net Income – Reported by Segments

The RBC is one of the leading diversified financial institutions in North America, which provides personal and commercial banking, capital markets, wealth management and insurance related products and services in Canada, United States and 36 other countries globally. It is one of the largest banks in the world, based on its market capitalization. Business segments reporting based on financial statements and MD&A have been categorized under four different headings;

- Personal & Commercial Banking (PCB) – Canadian, United States & 36 other countries around the world.
- Capital Markets (CMS) – Corporate and Investment banking, Global Markets and Others.
- Wealth Management (WM) – Canadian, United States and International Wealth Management, and Global Asset management.
- Insurance (INS) –Canadian & International Insurance.

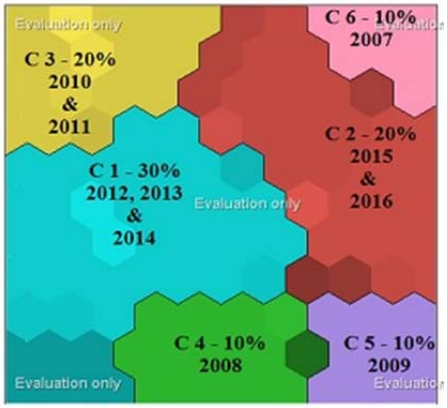

Fig. 1. SOM-ward-clusters –segment reporting.

The SOM-Ward Cluster identifies six different clusters for net income segment reported in the financial performance provided by the RBC management under MD&A, for those four categories mentioned above, as such PCB, WM, INS and CMS. As such, cluster 1 and cluster 2 has been reported under IFRS regime while IFRS conversion took placed in the last quarter of year 2011 (ie: November, 2011). SOM-Ward-Cluster identifies these six clusters in Fig. 1. The major net income contributor is PCB where it represents 54% on an average compare to all other categories for last ten-year period in this study. The reported net income has been growing from $5 billion to 10 billion expect for years 2009 to 2012, where there has been a net loss from discontinued operations, such as $1.8 billion in 2009 & 2011, $0.5 billion in 2010, and $0.05 billion in 2012. This is an indication of the effects, resulted from financial crisis of 2008.

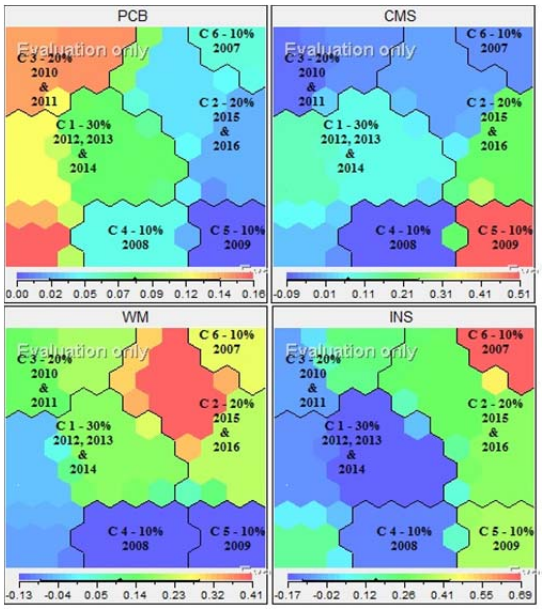

Fig. 2. Reported net income (PCB, CMS, WM & IMS).

The Personal and Commercial Banking (PCB) sector provides a wide range of banking and investing services related to personal banking, businesses of retail and small business banking, together with commercial banking. This sector operates in Canada, United States and Caribbean. In year 2009, reported net income was the lowest and represents 48% in comparison with overall reported net income for the period (cluster 5, blue colour). This is after effects of 2008 financial crisis (PCB). Cluster 1 represents year 2015 and 2016, which indicates the highest net income of $5.0 billion and $5.2 billion shown in Fig. 2. As a result these two years has been grouped together, likewise years 2012, 2013 and 2014, alongside years 2010 and 2011 were grouped based on reported net income. Instead, years 2007, 2008 and 2009 were clustered separately due these years composition of reported net income basis.

Capital Markets (CMS) activities comprise of investment banking, corporate banking, capital markets, and other services. These products and services includes corporate and investment banking alongside equity and debt obligation. As shown in CMS segment cluster, Fig. 2, in year 2008 net income dropped by 9% compare to year 2007 in particular, due to insatiability in the financial market conditions because of financial meltdown (blue colour). This sector was able to regain and made 51% increase in net income on the following year 2009 (red colour).

Wealth Management (WM) serves affluent and high net worth clients while providing assets management products and services long with other wealth management solutions. Fig. 2 highlights that cluster 4 (2008) and cluster 5 (2009) shows financial distressed as consequence of financial conditions that prevailed during those years because of financial crisis. It is obvious that those two clusters have been recognized in blue colours separately. Due to those economic conditions the reported net income decreased by 13% and 12 % in those two years, while improvements in financial markets conditions allowed this sector to make continuous progress thereafter. The RBC reported a strong financial performance in WM sector in year 2010.

Insurance (INS) provides a wide range of products and solutions such as life, health, home, auto, and travel insurance. The INS cluster in Fig. 2 indicates that the reported net income for year 2007 shows an increase of 46.4% compare to previous year while in 2008, indicates a decrease of 12%. As a result, RBC made a decision to sell-off a portion of its United States business operations. However, this segment continued to be impacted by low interest rate environment and underwent changes in the regulatory setting as well. Indeed, insurance segment have managed these challenges and have continued to see earnings growth with an increased growth in their revenues. Fig. 3, given below highlights the net income details related to segments reporting.

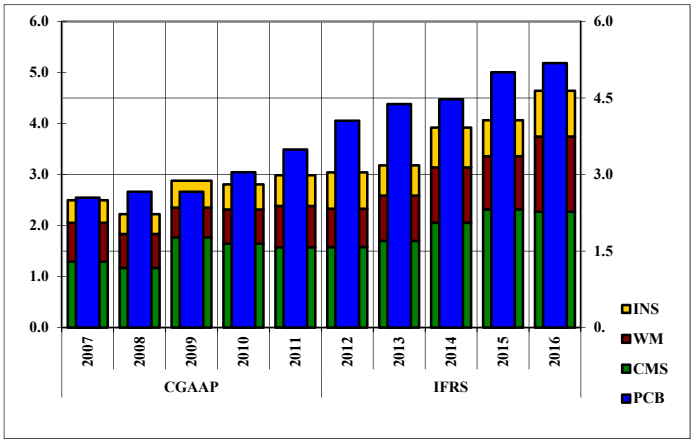

Fig. 3. Net incomes - Segments Reporting.

The net income from segment reporting reveals that on average more than 53% of the total net income is generated through PCB (blue colour column) while CMS, WM & INS represents 13.5%, 8.5% and 25% respectively (Fig. 3). In year 2011, RBC pulled back its United States operations, while selling off its retail-banking sector (PBC). As the RBC, global presences remain strong, focusing on corporate, institutional along with its high net worth clients in capital markets and wealth management sectors. Despite all these changes, RBC managed to maintain its net income due to expansion in other sectors of the bank.

B. Key Financial Ratios

Those changes in the regulatory requirements had significant impacts on bank's financial performances including ROE and Efficiency Ratio. In particular, new regulations related to information technology systems together with management of new reporting requirements. The selected key ratios were computed from following formulae;

- ROE = Net Income/Shareholder's Equity
- E_Ratio = Non-interest expenses / Revenue
- NII = Non-Interest Income/ Total Revenue
- NIM = Net Interest Income/ Total Average Assets
- Return on Risk-weighted Assets (RWA)
- Provision for Credit Losses on impaired loans (PCL)

RWA and PCL, these two ratios were introduced after the implemented of new regulations on capital requirements and IFRS impairment standard. The RWA is determined on the basis of assets adjusted by regulatory for risk-weight factor in order to reflect riskiness of on and off-balance sheet exposures. The PCL is a provision made by the management to determine the level of credit losses, which includes both provisions on impaired loans and loans not yet identified as impaired.

SOM-Ward-Clusters demonstrate effects of regulations and other economic factors during this ten-year period. SOM-Ward-Clusters recognize six different clusters, while differentiating 2007, 2008 and 2009 separately (Fig. 4). As year 2007 represents the highest percentage for ROE and NII, such as 24.7% and 65.7% while 2008 indicates the highest E_Ratio of 57.2% and 2009 has the highest PCL of 0.72%. These three years were distinguished from other years because of their financial performances indicators as indicated in Fig. 4.

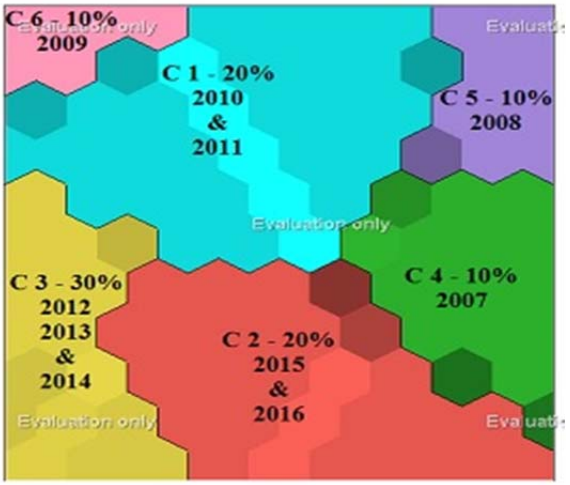

Fig. 4. SOM-Ward-Clusters.

The ROE cluster indicates that year 2009 has the lowest ROE ratio of 12% compare to other years. Apart from 2009 (12%) and 2011 (13%), the RBC has done well in terms of ROE, compared to other Canadian banks, which on average represents 15%. As financial performance point out that RBC is the most efficient bank in Canada with <51% efficiency ratio. Contributions from non-interest income as a percentage of total revenue (NII) identifies that performance measure reflect an overall average of 57%, as illustrated in Fig. 5.

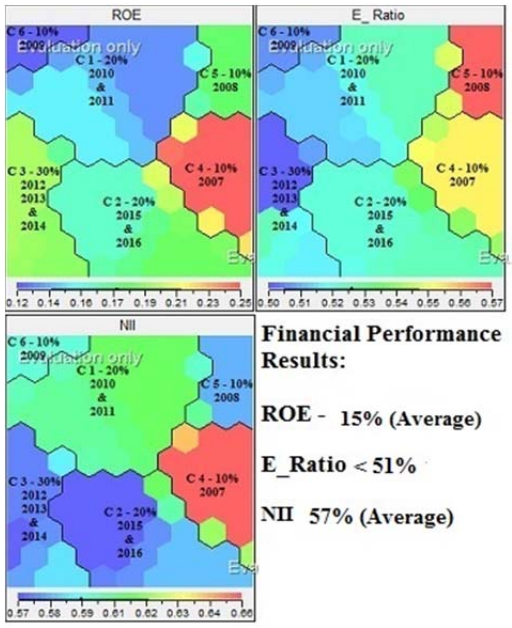

Fig. 5. ROE, E_Ratio & NII Cluster.

Fig. 6, given below explains about ROE, E_Ratio and NII in detail. The ROE, dropped to 12% in 2009, compare to other years, which are on average 15% or above. However, the RBC maintained its E_Ratio at 51% or greater in this ten year period of study. There is a decline of NII by 3.4% in 2010, and was an increase of 2.5% in 2011 after IFRS adoption. Thereafter NII increased moderately by reaching 12.0% in 2016.

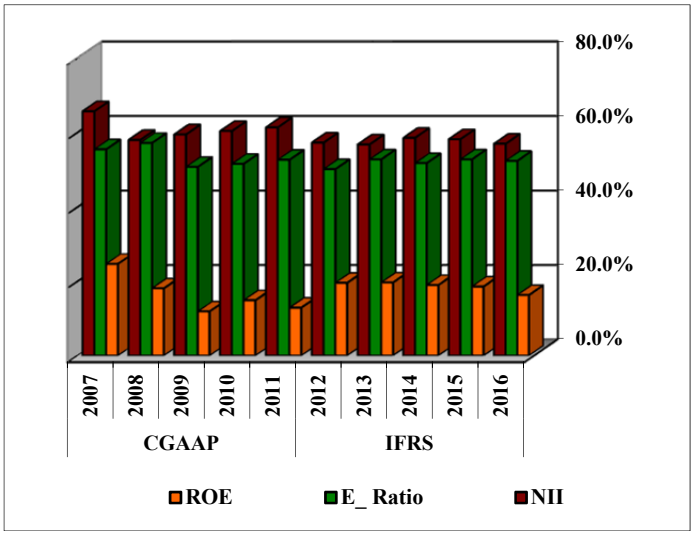

Fig. 6. ROE, E_Ratio and NII.

Provision for Credit Losses (PCL) are recorded to recognize estimated losses on impaired loans, along with losses that have been incurred but haven't yet identified in RBC loans portfolio. Where, this portfolio comprises on-balance sheet exposures, such as loans and acceptances,

together off-balance sheet items such as letters of credit, guarantees together with non-funded commitments.

PCL has been changed in presentation as well as in classification due to IFRS requirements. Where PCL have to be presented, based on whether provision for credit losses has been assessed collectively or individually. PCL on impaired loans are included in the results of each business segment to reflect the appropriateness of expenses related to conduct each of those business segments. The impacts of PCL on impaired loans as a percentage of average net loans and acceptances can be seen as moderate since its introduction as such after the convergence to IFRS. It has been decreased from 0.72% in 2009 – Fig. 7 (Red colour Cluster), and now remains flatten at 0.26%. However, RBS have seen slight increase in impaired personal loans and other related provisions. Fig. 7 describes about RBC, PCL, RWA and NIM in this paper.

Return on risk-weighted assets (RWA), denotes RBC exposure to credit, market and operational risk for regulatory capital requirements. The financial crisis of 2007 and 2008 was mainly driven by financial institutions investments in sub-prime mortgages. That these mortgage loans had far greater risk of default, than managers and regulators hasn't believed that it might be possible. In particular, when customers defaulted their payments, many financial institutions, lost large amount of capital and some even became insolvent. To avoid those situations in the future, regulators have now stipulated that bank must group its assets together by risk category, as the amount of capital required is matched with the level of risk of each asset.

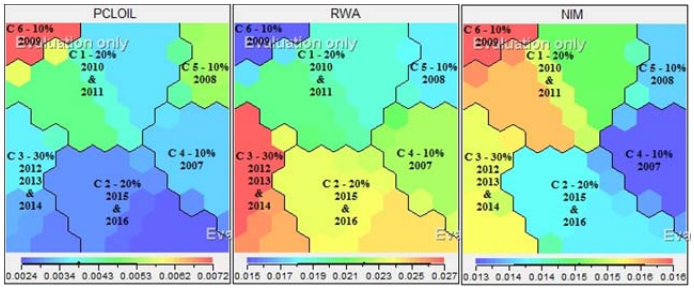

Fig. 7. PCL, RWA & NIM Clusters.

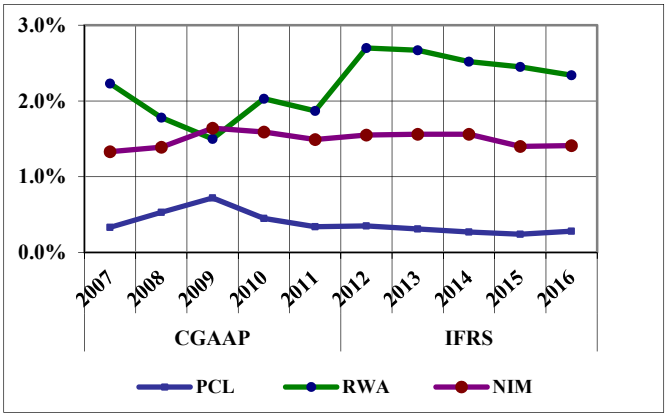

Fig. 8. PCL, RWA and NIM.

The goal is to prevent banks from losing large amounts of capital when a particular asset class declines sharply in value. Risk-weighted assets are used to determine the minimum amount of capital that must be held by banks to reduce the risk of insolvency. The SOM cluster, in Fig. 7 identifies year 2009 in blue colour (1.5%), as its represents the lowest percentage compare to all other years. However, years 2007 and 2016 to some extent has the same percentage such as 2.2% (2007) and 2.3% (2016), where this can be seen in Fig. 8.

Net interest margin (NIM), denotes net interest as a percentage of total average assets. Where it is computed as net interest divided by average earning assets. Average amounts are calculated using methods intended to approximate the average of the daily balances for that period. The RBC has faced with significant interest margin compression because of, operating at a low interest rate environment for years. It hasn't increase much since the 2008 credit crisis. Bank of Canada have indicated that interest rates were kept at lower rate due to the expectation of lower inflationary conditions, which made banks harder to manage improvements to net interest margin more difficult to achieve.

The reported net interest margins reflected in year 2009, 1.64%, which is the highest percentage compare to other years. This is simply because of reduction in total assets by 9.5% as well as an increase in net interest income by 18% compare to year 2008. SOM segment cluster in Fig. 7 identifies it in light blue colour. Since 2012, it is within the range of 1.4% to 1.6% as shown in Fig. 8.

C. Earnings per Share (EPS)

The basic EPS (EPS_B) is calculated as net income available to common shareholders divided by the average number of shares outstanding for that period. Where it is obvious that from the RBC data set there have been no change due to dilution of earnings per share, and the Fig. 9 illustrates this situation. However, in 2008 there has been a drop of 19.6%, compare to an increase of 16.2% in 2007. Further, in 2009 it dropped again by 24%, this is merely due to the effects of financial crisis. However, this situation has changed and in 2010, there has been an increase of 34.7%, which can be seen in Fig. 9 given below.

Diluted EPS (EPS_D) is computed as net income available to common shareholders divided by the average number of shares outstanding adjusted for the dilutive effects of stock options and other convertible securities. This can be observed in Fig. 9 that there is only a negligible difference between basic EPS and diluted EPS (almost same numbers).

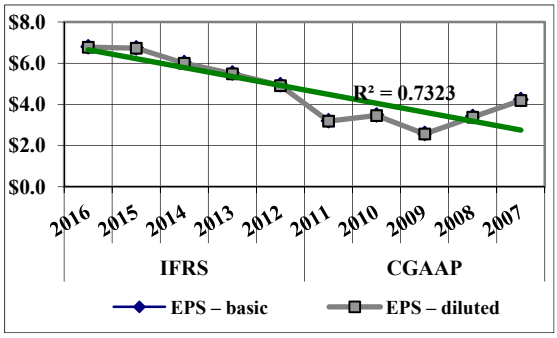

Fig. 9. EPS basic and EPS diluted.

Economic profit (EPS) is the amount of the excess ROE over the cost of bank's equity capital, which has created a point of reference by connecting the performance of the bank and its line of businesses to the cost of equity capital for the RBC. Non-controlling interest has been adjust retrospective for two years and reported under shareholders equity as non-controlling interest from year 2012 according to IFRS requirements.

D. Dividends

Dividends section highlights the changes in dividend yields and dividend payout ratios. The SOM-Ward-clusters identifies seven difference clusters highlighted in Fig. 10. As indicated cluster 1 and cluster 2 represent IFRS years and correspond to a total of 60%. This indicates that dividend yield and dividend payout ratios are within the range of 4% to 5% and 46% to 48% respectively. Where, it shows that the RBC has established a consistent dividend policy, and maintained that throughout the years from 2011 to 2016.

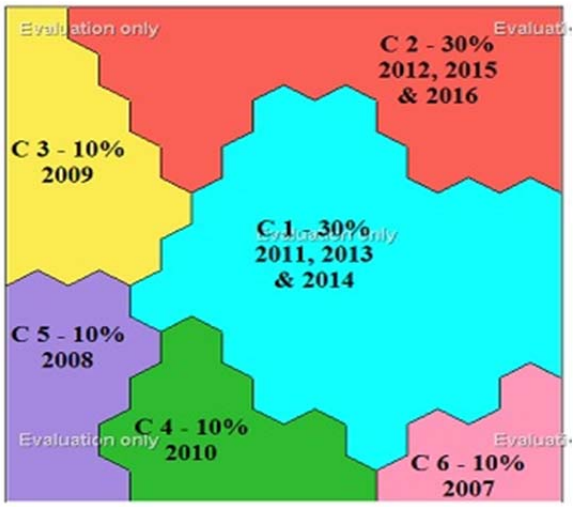

Fig. 10. SOM-ward-clusters for dividends.

It is obvious from individual clusters given in Fig. 11 that dividend yield and dividend payout ratios have differed in GAAP years. Where, the year 2007 had the lowest dividend yield (3.3%) and dividend payout ratios (43%). However, year 2008 represents the highest dividend payout ratios (59%) while year 2009 indicates the highest dividend yield (4.8%).

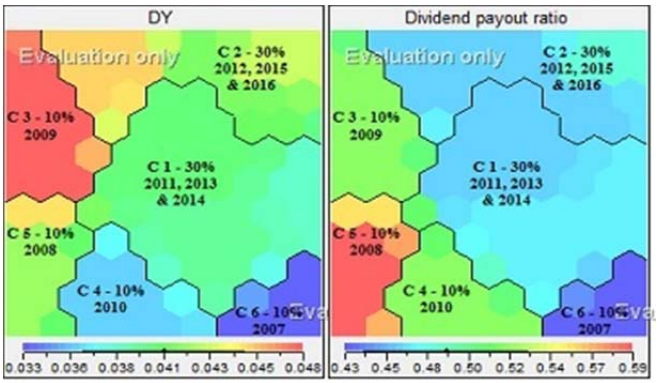

Fig. 11. Dividend yield & dividend payout ratio.

E. Common Share Price

In common share price, there has been volatility in the share price since financial crisis of 2008 along with financial Markets had a volatile year in 2008. However, Canadian banks including RBC share price did not suffer the same decline in 2008-2009. Nevertheless, financial markets have remained well above the depths of the global financial crisis of 2008 for Canadian banks. After a remarkable turnaround in 2009 and continued strength through to the first half of 2011, the equity market dropped off in the second half of the year. Canadian equity market demonstrated a strong performance in 2012, closing the year above levels seen during the collapse of Lehamn Brothers in 2009. This can be seen in Fig. 12, where it has picked up the phase and climbed up in 2014, while dropped in the first quarter of 2015. However, in 2017, it almost reached $97.0 per common share and Fig. 12 demonstrates these share price movements in RBC stock prices. Where Canadian banks have the right mechanisms in place to accommodate economic challenges and equipped by well-managed inflationary expectations and a highly accommodative monetary policy.

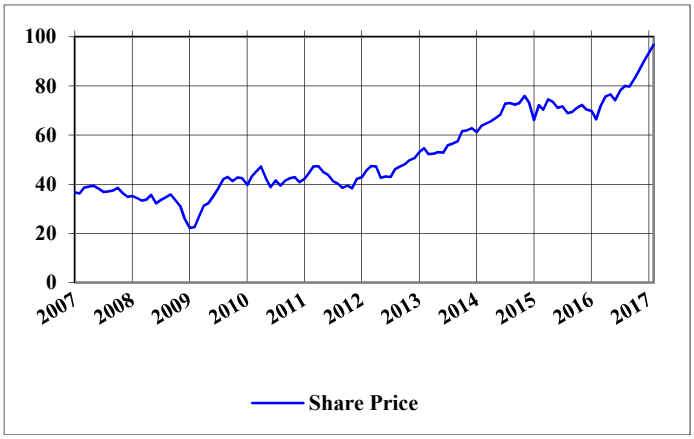

Fig. 12. RBC common share prices.

F. Capital Performance Measures (CPM)

According to RBC, they have expected that transition to IFRS may perhaps reduce the capital level of the bank. The regulatory capital reporting under IFRS commenced with the conversion to IFRS on November 1, 2011. Impacts of regulatory capital and multiples was cushioned by Office of the Superintendent of Financial Institution's (OSFI) transitional guidance, whereas permitting banks to phase out the impacts of IFRS on Tier 1 capital over a five quarter period beginning in 2012 (first quarter). This phase-in amount was based on the impact to retained earning as result of IFRS conversion in November 2011, and it has been determined on straight-line basis. Higher earning in 2011 allowed the bank to partially set-off the transitional impacts of regulation. It has reduced the phase-in amount due to IFRS conversion effects on Tier 1 capital nearly $1.8 billion from $2.2 billion in the first quarter of 2012 (reduced by 0.4 billion). The decrease in shareholders equity was 5% instead of 9%, which was originally anticipated by the RBC. However, internal capital generation through earning growth was the primary driving force behind the continued capital strength for RBC.

The tier 1 capital ratios were maintained at strong levels before and after the regulatory changes for capital under Basel III and convergence to IFRS.

The SOM-Ward-Clusters for capital performance measures have identified clusters as shown in Fig. 13. The Cluster 1, represents years 2009 and 2010, these two years has the exact percentages for capital requirements, such as 13% for tier 1 capital and 14% for total capital. Cluster 2 (2007&2008), the lowest levels of capital requirement such as tier 1 capital 9%, and the total is 11% (Fig. 14), while these two amounts are in excess of regulatory percentages i.e.: 7.5% and 10.5%. All other years, as such clusters 3, 4, 5 and 6 have exceeded the stipulated percentage for capital requirements. Conversely, cluster 5, (2011 & 2012) has the highest total capital requirements for example 15%.

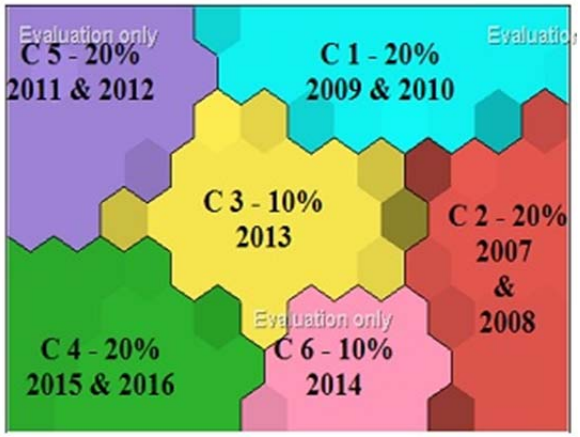

Fig. 13. SOM-ward-clusters, capital performance measures.

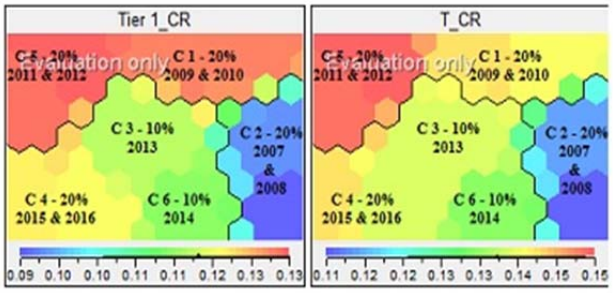

Fig. 14. Tier 1 and total capital.

The level and pace of regulatory changes that have impacted Canadian banks including RBC are significant. The uncertainty created by the vast range of regulatory changes and proposals adds specific layers of complexity to the systems. These changes can make basic planning decisions more difficult for banks, while let along dealing with ever changing macro-economic environment. However, these rules provide banks operating in an evolving landscape, both in Canada and abroad.

VI. Conclusions

The SOM processing and visualization have enhance the financial performance analysis of the RBC. Where the usefulness of SOM in financial performance analysis has proved that financial data have shown indications that financial performance measure can be done with SOM technique. Indeed, it has revealed expected patterns through SOM-Ward-Clusters and other segment clusters. Future work should focus on exploiting the broader literature on furthering and enhancing the SOM processing and visualization for more utilization in financial performance analysis.

The Canadian economy rebound strongly in 2010, because of considerable monetary and fiscal stimuli, to boost financial sector and high commodity prices. However, economic activity continued to expand at a solid rate in year 2011. The combination of global economy, lower commodity prices along with weakening demand has slow down the pace of recovery than anticipated. The external environment has played a major role in Canadian economy. The financial and corporate sectors retained a strong position during 2011. Bank profits are now back in line with pre-Lehman levels and business credit continues to grow, as firms take advantage of historically low funding costs. Additionally, capital ratios have kept banks at healthy levels and well under control.

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