Measuring Financial Stability:

The Construction of Aggregate Financial Stability Indices for Canada and the U.S.

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ABSTRACT

The aim of this paper is to develop Aggregate Financial Stability Indices (AFSI) for the analysis of the stability of the Canadian and American financial system. The imbalances of the financial systems have caused many undesirable economic and social costs. In order to prevent these costs, the development of AFSI has become a standard for assessing the soundness of financial systems. The AFSI is constructed using financial data over the period of 1990-Q1 to 2010-Q4. The AFSI is made up of fourteen indicators and contains three sub-indices: financial development index (FDI), financial vulnerability index (FVI) and financial soundness index (FSI). The survey of Illing and Liu (2006) was used to point out the major events that undermine the financial stability of Canada and the US. The AFSI was successful at identifying major episodes of financial instability during the sample period. The index illustrates that subprime mortgage crisis in the U.S. had the biggest impact on Canadian and American financial system, followed by the event of September 11, 2001. Econometrics results confirm the sensitivity of the index to changes in key economic indicators.

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1. Introduction

The past couple decades have been characterized by many episodes of remarkable financial stress. Financial stress, as defined by Hakkio and Keeton (2009), is disruption to the normal and smooth functioning of financial markets. Financial crises are due to the financial system's instability that at some point unwinds, potentially creating extensive financial tensions (Borio and Drehmann, 2009). Financial crises have risen in intensity and frequency, and have threatened the soundness and strength of the international financial system. These global financial imbalances have economic and social costs all nations.

Most nations or central banks have developed their own measure of financial stability depending on the size and nature of its economy. Economists and policymakers continue to struggle with the responsibility of constructing comprehensive indices and indicators to use as surveillance and predictive tools in minimizing the probability and severity of financial crises. It is difficult to measure the exact performance of financial system, as the major challenge to construct a useful measure of financial stability is the non-existence of an agreement about the definition (Morales and Estrade 2010).

There are a variety of definitions for financial stability but none have a consensus. Marcelo et al. (2008) define it as the authorities providing sufficient assurance for the efficiency of intermediation between demanders and suppliers of funds during negative shocks. The European Central Bank (2009) defines financial crisis as any interruption to the normal state of the financial system. Similarly, most of the literature reviews about financial stability are retrospective and qualitative analyses. In addition to an early warning system and stress testing, the aggregate index produces a single quantitative measure which can be used to capture and predict the stability of the banking and financial sectors.

The aim of this research is to build up two separate aggregate financial stability indices (AFSI); one for Canada and one for the U.S. to analyze the stability of their financial systems. This paper attempts to answer questions such as: how have the Canadian and American financial systems been impacted by major domestic and international events which are considered stressful? How has the sub-prime mortgage crisis of 2007-2009 affected the financial system compared to other crises since 1990? What time period has been the most financially stable period since 1990?

The papers that come closest to this research are Illing and Liu (2006), Albulescu (2008) and Morris (2010). Illing and Liu (2006) created the financial stress index (FSI) for a developed country. This paper extends their analysis by adding various variables and testing if they are better indicators; although, the methodology employed here is different than Illing and Liu (2006). The model used is based on the methodology utilized by Albulescu (2008) and Morris (2010) which creates a single financial stability index by aggregating sub-indices covering microeconomic and macroeconomic variables. This research takes different groups of individual indicators related to financial stability into account. Taking the availability of the data into consideration, the indicators which are included in the model characterize the financial system's vulnerability, its development, and the stability of the banking sector which plays a significant role in building the investors' confidence.

In order to establish an agreement of which events have been the most stressful and destabilizing for the financial system since 1980, Illing and Liu (2006) conducted a survey of senior Bank of Canada economists and policymakers. The survey contained 34 major internal and foreign events, and it asked participants to rank the events in order of their severity. Of these events, 9 originated in Canada, 12 in America and 13 out of North America. This paper

will compare the result of the survey to the recent crisis to examine to what extent and how the Canadian and American financial markets were impacted.

Our AFSIs show general deterioration in early 1990s due to the peso crisis of Mexico, the Asian crisis and the Russian debt defaults. The AFSI drops during the high-tech price collapse in 2000 and during the incident of September 11, 2001. The years of 2004 until late 2007 seem to be the most stable episodes during the sample period. The AFSIs have its most abrupt fall in 2008 due to the recent global financial crisis. Moreover, the AFSI proved responsive to changes in key macroeconomic indicators such as GDP growth rate, money supply (M2) growth rate, volatility in exchange rate and 3-month treasury bills rate.

The remainder of the paper is structured as follows. In Section 2, an overview of the relevant literature can be found. Section 3 states details on the methodology utilized in constructing the aggregate financial stability indices and its constituent sub-indexes. In section 4, we cover descriptive analysis of factors impacting the evolution of the aggregate index and its components. In section 5, an econometric validation of the index is presented. The final section offers conclusions.

2. Literature Review

Due to increased volatility of financial markets, most of the quantitative and qualitative analysis and research about financial stability and stress level have been developed in the last decade. Kaminsky (1998) examined and developed a study for currency crisis. She created the early warning system based on empirical analysis tested in twenty countries from 1970 to 1995. Moreover, she put forward four different composite indicators and examined them in terms of precision of forecasting and calibration, which is a method of estimation of some parameters of a

model as a step in the analysis of other parameters. These indicators were tested for the Asian crisis and it was found that the Asian economies were in terrible state. Their economies showed strong and obvious signs of distress which surfaced almost 18 months before the collapse of their currency. It could be inferred from those signs that the crisis could have been anticipated. Furthermore, her result indicated that most crises have been created in nations with fragile economy and destabilizing signs emerging in various sectors of their economy. Her paper indicated the need for a tool to correctly measure financial stability and to predict a financial turmoil.

The regulatory agencies of many governments have focused their research and study to develop the potential early warning indicators through stress testing exercises. Morales and Estrada (2010) came up with a financial stability index (FSI) that can be used to determine the stress level of the financial system in Columbia. They built their index using the indicators such as capital, credit risk, return ratios and liquidity. Through various models, explained in the literature, the weights of appropriate financial indicators were given. Generally, a high weight was given to the profitability and credit risk ratios. The approaches utilized were: the variance equal approach count data models and the principal component. These approaches are all methods of assigning weights to the indicators which are included in the index (See methodology section for more explanation). Their results show that their index determines the stress level of the system successfully. To study the behaviour of the stress level, the authors also performed the forecasts of the index. The forecast was done through two models: Autoregressive Integrated Moving Average Model (ARIMA), and Vector Error Correction Model (VECM). Considering the index as a continuous measure, the authors expected that the FSI could be used as a reference for future analysis of financial stability.

Feridun (2004) examined the fundamental causes of the financial crisis based on a probit model and drawing lessons from the Russian crisis. In the probit model, twenty monthly macroeconomic and financial sector variables were included. The 20 indicators were selected on the basis of currency crisis theories and previous empirical literature. The sample period for this study was January 1988 to August 1998. The results of the empirical analysis pointed that important indicators are world oil prices, GDP per capita, foreign direct investment over GDP, foreign exchange reserves, export growth, inflation, real exchange rate, real interest rates, stock prices and current account over GDP. Some indicators such as real interest rates, public debt, lending and deposit rate spread, and bank reserve over bank assets behaved in the opposite way of one would have expected. Most of these indicators were also used in the construction of our AFSIs as well.

Financial markets are vital sources of funding for businesses, banks and indirectly also for households. Financial stress, defined by Sandahl et al. (2011), is a distraction that breaks the financial markets' ability to act as a "resourceful intermediary between buyer and seller". Sandahl et al. (2011) developed an index of financial stress for Sweden in an attempt to reflect the degree of financial stress in a simple and comprehensive way. Their study included data for a total of four components from the capital market as well as the foreign exchange market for the time period of January 1997 to July 2007. The indicators, used in the index, were normalized and equal weights were allocated to each indicator. Consequently, the authors tested how their index was impacted by different historical reference periods and different weighting methods. Their result concluded that the formation of the index is impacted to some extent over time. A unit change in the index corresponded to an adjustment equivalent to a standard deviation which is calculated based on the historical reference period. The four indicators, included, corresponded to the total of their

historical mean values, when the index level reached zero. Since their index was an average value of many indicators, it provided an overall depiction of the degree of financial stress in the Sweden financial system. However, a further examination and analysis of sub-components could raise the understanding of the early warning indicators of financial stress. In the future, the construction of the index should be adjusted in terms of choice of historical reference period, since a normal level may alter over time as a result of regulation and structural changes in the financial system.

Central banks, depending on the nature and characteristics of their economy, utilize different economic indicators when constructing their financial stress index. Misina and Tkacz (2008) studied whether a combination of credit expansions and upward movements in asset prices increase the likelihood of financial crises in Canada. Affirmatively, Borio and Lowe (2002) answered this question for a sample of 34 countries; however, it is difficult to answer this question for individual advanced countries such as Canada, Norway and Sweden, where financial crises are rare or non-existent. Since 1900, Canada has not experienced any twin crises (banking and currency crises), and has had only four currency crises since 1945. To test this question, the authors used the financial stress index (FSI) developed by Illing and Liu (2006). Consequently, they used both linear and threshold models and evaluated their performance by comparing them to the benchmark model. In the benchmark model, the future value of the financial stress index is forecasted by utilizing only its lagged value. Even though, the findings depended on the forecast horizon and the type of model used, their results showed that some mixes of credit and asset price variables are important predictors of financial stress. It is worth mentioning that business credit emerged as the important leading indicator in both models (linear and non-linear) at the one and two year horizons. At the shorter term, the Fed fund rates seem to significant indicator of financial

stress in the linear models. The international indicators were less effective and played a smaller role (Misina, and Tkacz, 2008).

Alternatively, some researchers have come up with a common financial stress index for several countries. Slingenberg and Haan (2011) used a financial stress index for 13 OECD (Organization for Economic Cooperation and Development) countries. The 13 countries were Australia, Belgium, Canada, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, the UK and the US. They wanted to examine whether a combination of variables can help forecasting of financial stress. In developing a multi-country FSI, the authors employed the following criteria for indicators: the data should be available for many countries at high frequency and for a long period, the indicators should be comparable, and should cover the entire financial system. To examine their question, they used two different models. First, to test the explanatory power of variables for the index, they calculated models for the whole sample period, and then the variables of interest were added to the lagged values of the stress index. Second, to test whether their variables provide the out of sample forecasting characteristics of the model, they used the methodology utilized by Misina and Tkacz (2009). Their result was somewhat vague and suggested that financial stress is hard to forecast for a group of countries. Several variables have forecasting power for certain countries, but not for others. For a large number of countries, there are only a few variables that can improve the prediction.

Louzis and Vouldis (2011) constructed the financial systematic stress index (FSSI) for the Greek financial market. It was developed to take into account the systematic nature of stress by considering the correlations between factors of stress. Their research and methodology was mainly based on the work of Hollo et al. (2010) where they applied insights from standard portfolio theory to the aggregation of specific sub-indices. Each sub-index was an indicator of financial stress on a

specific market segment. Then, the indices were aggregated in the same way as individual risks by "taking into account the cross-correlations between individual asset returns" (Louzis and Vouldis, 2011). Additionally, the authors expanded their approach by utilizing multivariate GARCH, a data-driven approach, to construct time-varying cross-correlations. Their approach was able to capture immediate changes in the correlation arrangement, therefore improving the ability of the index to identify systematic events accurately. To build their index, they used variables that contain both market and balance sheet data. Similar to the survey of Illing and liu (2006), Louzis and Vouldis also conducted a survey among the Greek economists and policy makers to identify periods of financial crises. The authors consequently tested whether rise of the FSSI causes actual financial crisis. Their FSSI was proved to be able to accurately identify the periods of crisis as well as the systematic stress in the Greek financial markets. In order to propose the appropriate policy guidance in terms of financial crises, a correct description and analysis of the systematic nature of stress is crucial.

Generally, in order to understand the impact of financial stress on economic activity, it is significant to know that financial cycles are perpetual aspect of the economic system as well as greatly impact the system. Cardaraelli, Elekdag and Lall (2011) analyzed the experience of 17 developed countries with episodes of financial stress and economic cycles from 1980 to 2007. They tried to draw lessons from these experiences by distinguishing them on the basis of the preconditions that were present at the time when the financial stress period started. Their paper, using a FSI, provided an analytical model to examine the impact of financial imbalances, in particular banking stress, on the real economy. The authors identified the periods of financial distress by constructing an index based on high-frequency price variables which could indicate stress of the securities, banking and foreign exchange markets. Their study proved that financial

imbalance is most often an antecedent of economic downturn. In spite of financial innovation, which has raised the importance of security markets in various countries, banking distress is more likely to have huge impacts on economic activity. One of the major benefits of their constructed FSI was that it was based on consistent set of indicators across 17 developed economies; thus, it provided cross-country analysis. Furthermore, their FSI successfully discovered episodes of financial stress not linked to economic contractions.

To assess the Romanian financial sector stability, Albulescu (2008) constructed an Aggregate Financial Stability Index (AFSI) over the period of 1996-2008. The author selected twenty prominent economic indicators and distributed the indicators among four sub-indices. In building the aggregate financial stability index, all indicators were normalized and their values ranged from zero to one. In developing the index, the author gave equal weights to each of the indicators. To construct the aggregate index, the weights for the sub-indexes were assigned based on their importance to Romanian financial system. Consequently, the author tested the robustness of the aggregate index to various drivers of macroeconomic stability. Subsequently, he used a stochastic model to present a forecast of the aggregate financial stability index for the Romanian financial sector. Starting with 2000, his results showed an advancement of the stability level in Romania. In the analysis of AFSI, an obvious fall of this index during the crisis period was observed; although, his forecast did not show any sign of financial crisis in 2008. It either might be that the Romanian financial market is not a big international market and it was not affected at all, or it was impacted later on as the crisis started to spread globally.

Morris (2010) constructed an aggregate financial stability index (AFSI) for Jamaica using banking system data over the period 1997-2010. He built the AFSI for Jamaica by adding microeconomics and macroeconomics indicators as well as international indicators into a single

measure, using the methodology and model built by Albulescu (2008). Due to data availability or different characteristics of Jamaican economy, a couple of the indicators included in the Romanian index were not employed by Morris's study. A close reflection of banking sector performance over the sample period was shown by the evolution of the index. Moreover, he proved the sensitivity of the index to variability in key economic indicators using econometrics. In order to assist the policy makers to determine the future stability of financial system and banking sector, the author forecasted one year ahead using Monte Carlo simulations. His forecast indicated a decline in Jamaica's AFSI toward the end of 2010.

The financial stress index (FSI) provides a timely snapshot of simultaneous stress in the financial markets. Illing and Liu (2006) developed an index of financial stress for a developed country and used Canada as an example. The authors used continuous variable with a range of values, where the high values were called financial crises. They got information on financial stress using several techniques including factor analysis (a method of assigning weights to the indicators), econometric benchmarking (comparing the outcome of their stress tests to the result of the survey obtained from the economists at Bank of Canada) and Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) modeling.

The authors also employed an internal Bank of Canada survey to establish a consensus on which events have been most stressful for the financial markets over the past 25 years. This survey was used to condition the choice of variables. Of all these events, nine of them were Canadian in origin, twelve events were American in origin, and thirteen events originated outside of North American. Events, considered to be most stressful to Canadian financial market, in ascending order are: October 1987 stock market crash, reputational aftershocks from bank failures (1985-1986), Less Developed Countries (LDC) crises (early 1980s), early-1990s real estate collapse and

banking losses, August 1981 spike in interest rates, Asian crisis (1987-1998), CCB and Northland failures (1985), Mexican crisis (1994-1995), Russian debt default (1998), long-term capital management (LTCM) collapse (1998), and high-tech price collapse (2000), events of September 11, 2001. Consequently, the authors used the version of FSI that provided better match with the results of their survey. Their FSI provided an ordinal evaluation of stress and imbalances in the financial markets. In particular, they proved that alternative measures of financial crisis, provided in many literatures, did not reflect the Canadian experience. Their FSI is considered as an important tool in analyzing the financial system and macroeconomic imbalances.

3. Methodology

The aim of this paper is to construct a quantifiable and continuous measurement which can be used to determine the stress of Canadian and American financial systems. As the literature suggests, there are various methods and techniques to create a financial stability index. We follow a similar method to that of Albulescu (2008) and Morris (2010). We use quarterly data from 1990Q1 – 2010Q4 (see the appendix A for data sources). In order to build an AFSI that can accurately measure financial stress, two preconditions are required: (1) selection of appropriate variables and (2) consideration of the weight that each variable in the index takes.

3.1 Selecting Variables

The choice of the variables or stress indicators is of vital significance for the development of financial stability index as they should represent the main aspects of financial stability. For both Canadian and American financial systems, 14 variables are selected for

inclusion in the AFSI. These variables are indicative of financial system stability including financial development, financial vulnerability and financial soundness. Since the banking sector is one of the most important sectors of the financial system, most of the indicators, included in the AFSI, are related to banking. In order for the AFSI to represent the entire financial system, key variables are selected from each market such as the equity market, the credit market, the money market and the foreign exchange market.

3.1.1 The Equity Market

The equity market is where companies obtain their own capital. Whether through IPOs (Initial Public Offerings) or new issues, it offers an important source of funding for companies. Moreover, it provides risk analysts and other stakeholders with valuable information about investors' evaluations of risk. There are various ways of assessing financial stress on the equity market. Many papers consider stock share price indices as a good measure of the equity market. Therefore, we include the stock share price index of the Toronto Stock Exchange (TSX) Market for Canadian AFSI and S&P 500 for the US AFSI. The stock price index indicates the market expectations for the banking sector. As explained by Grimaldi (2010), a rise of this indicator may be suggestive of a possible bubble or upcoming imbalance, while a long-lasting decrease of it is a sign of stress. Stock market crashes are one of the key signs of financial crises (Reinhart and Rogoff, 2010). Therefore, it is crucial to add equity market indicators to assess the risk associated with the stock market.

3.1.2 The Credit Market

It is a market that helps firms to increase funds through debt issuance. A current study and analysis of the credit market could reveal a great deal of information about the relative health of a large portion of the financial system. We included a few indicators from this market, such as total credit, interest spread and consumer credit. 'Total Credit' is added because it gives information about the financial intermediation level (Albulescu, 2008). The higher the level of this indicator, the more mature and developed the banking sector is (Morris, 2010). We also included 'consumer credit' which reflects the net new financing acquired by non-financial companies from several sources (Keshishbanoosy et al., 2008). The 'interest spread', which is calculated as the difference between the average lending rate and the average borrowing rate, provides information about the level of development of financial system. In other words, interest rate spread is the lending rate charged by banks on loans to customers minus the deposit rate paid by banks for demand, saving or time deposits. A rise of 'interest spread' negatively impacts the financial system. It is worth mentioning that the credit market is a broad market that includes the bond market as well as the money market.

3.1.3 The Money Market

The inclusion of indicators from the money market improves the ability of index to recognize financial imbalance. The money market, the main source of financial liquidity for financial institutions, includes loans with maturities of one year. Both financial firms and banks obtain short-term funding through the money market via various channels such as interbank loans or borrowing via certificates (Sandahl et al., 2011). Due to the relatively positive performance of the money markets, they have not been the focus of past academic

research, but more attention has been given to them since the outbreak of recent financial crisis (Holthausen and Phill, 2010). Interruptions to the money market, as noted by Sandahl et al. (2011), could rapidly lead to negative consequences for the financial system, as it makes up a significant source of short-term funding for financial firms and banks.

The indicators, we included from money markets are: the 'total loans to deposit ratio', the 'inflation rate', the 'deposits/M2 ratio', and the '(reserve/deposits) / (note & coins/M2)' ratio. The 'total loans to deposit' ratio is calculated by dividing a bank's total loans by its total deposits. If this ratio is high, it implies that the bank may not be liquid enough to face any unexpected fund requirement (Keshishbanoosy et al., 2008). The inclusion of 'inflation rate' is important as it is considered as a macroeconomic vulnerability indicator. The main objective of the Bank of Canada is price stability, keeping the inflation rate at the 2 per cent midpoint of a target range of 1 to 3 per cent (Macklem, 1998). Inflation rate is important for the financial stability, since an increase of it can decrease investors' confidence and can have negative impacts on the economy through higher nominal interest rates. The 'deposits/M2' ratio indicates the relation between consumption and savings. An increase of this ratio is related to a savings enlargement, a consumption fall and a currency appreciation (Albulescu, 2008). The '(reserve/deposits) / (note & coins/M2)' ratio illustrates the reaction of bank's reserves to extreme withdrawals of money (Albulescu, 2008).

3.1.4 Foreign Exchange Market

Both the Canadian and the American firms and banks receive a large amount of their funding in foreign currencies. Thus, it is vital for both economies that domestic firms and banks have access to capital markets in other currencies with good terms (Keshishbanoosy et

al., 2008). The foreign exchange (Forex) market is a decentralized international market where international currencies are traded. Moreover, it sets the relative values of various currencies (Levinson, 2006).

Table 1: AFSI Indicators

Indicators	Impact	Symbol	Subgroup
*Stock Market Index	+	D_{1t}	FDI
Total Credit	+	D_{2t}	FDI
Interest Spread	-	D_{3t}	FDI
Inflation Rate	-	V_{1t}	FVI
General Budget Deficit/Surplus	+	V_{2t}	FVI
Current Account Deficit/Surplus	+	V_{3t}	FVI
REER	-	V_{4t}	FVI
Consumer Credit	+	V_{5t}	FVI
Loan (% deposits)	-	V_{6t}	FVI
Deposits/M2	+	V_{7t}	FVI
(Reserves/Deposits) / (Notes & Coins / M2)	+	V_{8t}	FVI
Capital/Assets	+	S_{1t}	FSI
Net Financial Investment	+	S_{2t}	FSI
Housing Price Index (HPI)	+	S_{3t}	FSI

* Toronto Stock Exchange (TSX) index for Canada; S&P 500 index for the US.

Foreign exchange stress can occur regardless of the type of exchange regime. Unanticipated fluctuations create ambiguity in the market which impacts its efficiency and liquidity (Illing and Liu, 2006). More attention has been focused to foreign exchange market

since 2003, when currency trading rose as investors, in particular hedge funds investors, started speculating in foreign exchange market in the hopes of making more money (Levinson, 2006). Depending on what type of exchange regime a country has, foreign exchange imbalance can be represented through several variables.

In order for domestic banks and firms to have access to capital markets in other currencies, well-functioning "foreign capital markets and a smoothly-functioning market for managing the financial risk that accompany borrowed capital in foreign currencies" are needed (Sandahl et al., 2011). If this risk is not managed properly, the cost of capital can rise or the access to international currency can become limited. Hence, it is helpful to add an indicator for the foreign exchange market in the financial stability index. We included the absolute changes of 'real effective exchange rate' (REER) into the index. The changes in 'real effective exchange rate' can impact the net export and subsequently the GDP of a country.

3.1.5 Other Indicators

There are a few other indicators which are essential for the construction of the stability index, such as: general budget deficit/surplus, current account deficit/surplus, net financial investment and housing price index. The general budget deficit/surplus or fiscal deficit/surplus signals about investors' confidence in the economy (Morris, 2010). For instance, investors may lose confidence in government to maintain stable growth if the budget deficit is very high. The current account deficit/surplus demonstrates the country's vulnerability to outside factors or exogenous shocks. Moreover, the current deficit makes a country a net debtor to the rest of the world. Net financial investment indicates how sound the financial system is. This measure helps to give a sense of how much money is being invested

in the financial market. The housing price index (HPI) tracks changes in home prices. Most of the time, an increase in the HPI points to increased demand for housing as well as a rise of economic activities in housing market.

3.2. Combining the Variables into a Single Index

Now that the indicators are selected and defined, they have to be quantified. First, we create three sub-indices and place the indicators among these three categories. As shown in table 1, the three sub-indices are: the financial development index (FDI), the financial vulnerability index (FVI) and the financial soundness index (FSI). The financial development index contains 'stock market index', 'total credit', and 'interest spread'. The financial vulnerability index includes 'inflation rate', 'general budget deficit/surplus', 'current account deficit/surplus', 'REER', 'consumer credit', 'total loans', 'deposit/M2' and '(reserve/deposit) / (note & coins/M2)'. The last sub-index, financial soundness index, is made up of 'capital asset ratio', 'net financial investment' and 'housing price index'.

Establishing the "accuracy level and measurement scale" is an important step of building an aggregate index (Illing and Liu, 2006). Usually, different indicators have different units which make the aggregation complicated and impossible. Thus, the values of indicators have to be normalized. There are various methods of normalization suggested by literature such as: statistical normalization, mathematical normalization, axiological normalization and empirical normalization. Statistical normalization is a method in which all values are expressed in standard deviation around their mean (Albulescu, 2008). Mathematical normalization is a method of data conversion through functions in which the values range between an upper and lower bound such as +1 and -1 (Chilcote and Scott, 1973). Axiological normalization is somewhat similar to empirical normalization in that the desirable outcome is

assigned ‘1’ and the undesirable outcome is assigned ‘0’(Chilcote and Scott, 1973). Empirical normalization, which we used to normalize our data, is a technique in which the maximum value is assigned ‘1’ and the minimum value is assigned ‘0’. The formula for empirical normalization is as follow:

$$Y_{it} = \frac{X_{it} - \min(X_i)}{\max(X_i) - \min(X_i)} \quad (1)$$

Where Y_{it} represents the normalized indicator at time t and X_{it} represents the value of indicator at time t. Similarly, $\max(X_i)$ illustrates the maximum or best value, while $\min(X_i)$ represents the minimum or worst values of each indicator.

The most difficult and tricky part is determining how to assign weights to each variable. It is hard to identify which indicator or indicators affect the index more than the other ones. The difficulty in assigning weights to variables is due to an “absence of a reference indicator that makes it possible to verify the precision of weights and to perform tests with them” (Morales and Estrada, 2010). There are a variety of ways we can assign weights to each indicator. These methods are, but not limited to, factor analysis, principal component, transformation using sample CDFs (Cumulative Distribution Functions), qualitative response approach, multi-criteria approach, credit weights, variance-equal weights and assigning the same weights using arithmetic average.

Factor Analysis and Principal Component Analysis:

The factor analysis and principal component approach are very similar and comparable. Both methods identify trends in data, stating the data’s similarities and

differences. The key point in principal component approach is to find a series, by mixing the chosen variables, in such a manner that the most of the variance created by the variable is taken into consideration by the combination. It utilizes the correlation between variables to create a small set of components that sum up the correlation between variables empirically (Shlens, 2009). The only difference between factor analysis and principal component method is that factor analysis considers only the variability that is common among the chosen indicators; while, principal component approach takes into account the total variability created by the indicators (Morales and Estrada, 2010).

Cumulative Distribution Functions (CDFs) Method:

Another method is a transformation based on sample cumulative distribution functions (CDFs). In this technique, each variable is transformed into a percentile based on its sample CDF. It is transformed in a way that the last percentile, like the 99^{th} percentile, indicates a high stress level, while the value of first percentile shows a low level of instability (Illing and Liu, 2006). The transformed variables are then averaged employing both 'chain-linked' arithmetic and geometric means (Albulescu, 2008).

The Qualitative Response Approach:

The qualitative response approach is based on econometric calculation where the relation between stress variables and the dependent variable, depicted as bank crisis, is modeled. The dependent variable is developed from the qualitative information that comes from financial crisis periods. A regression is run and the weight for each explanatory variable is inferred from the result of the regression (Morales and Estrada, 2010).

Multi-criteria Approach:

Multi-criteria approach is weighting the indicators based on their importance. It includes classification based on various objectives (Albulescu, 2008). In other words, it is an objective approach where weights are assigned based on several criteria.

Credit Weights Approach:

Another method is credit weights which is assigning weights to variables based on the relative size of the market they impact. If the market makes a large percentage of total credit in the economy, then higher weights are assigned to the variables. In this approach the weights have some economic significance. A 'chain-linked weighting' system is used since the relative size of each market alters over time (Illing and Liu, 2006).

The Equal Variance Approach:

The equal-variance weight approach, one of the most commonly used methods, standardizes the variables so that they can be shown in the same unit. Then equal weights are allocated to the variables. The mean is subtracted from each variable before it is divided by its standard deviation. This method is most commonly used since it is easy to calculate and it has a better fit in comparison with other complex techniques (Morales and Estrada, 2010).

3.2.1. Assigning Weights to Canada's AFSI

In calculating the composite indices of Canada and the US, we use principal component analysis (PCA) to assign the weight for each indicator in the sub-indices and the weight of each sub-index to get the aggregate index. We used PCA approach because it is one of the most commonly used methods and it also removes any correlation among the

independent variables (multi-collinearity). In principal components analysis, we take out from a set of 'p' variables a condensed set of 'm' factors or components that are accountable for most of the variance in the 'p' variables. These principal factors or components are inferred from the correlations among the 'p' variables, and each component is estimated as a weighted sum of the 'p' variables (Shlens, 2009). In other words, PCA is a linear transformation that transforms the data to a new coordinate system such that the direction with the most variance lies on the first coordinate (called the first component), the second most variance on the second coordinate, and so on. Using the principal component analysis, we got the following weights (refer to table 2 of the appendix):

$$FDI_t = 0.43xD_{1t} + 0.49xD_{2t} + 0.08D_{3t} \quad (2)$$

Referring to Table 1, D_{1t}, D_{2t}, D_{3t} are Toronto Stock Exchange (TSX) index, total credit and interest spread respectively. The TSX index, total credit and interest spread represent 43%, 49% and 8% of the variance of the sub-index respectively.

$$FVI_t = 0.21xV_{1t} + 0.14xV_{2t} + 0.13xV_{3t} + 0.01xV_{4t} + 0.20xV_{5t} + 0.13xV_{6t} + 0.15xV_{7t} + 0.03xV_{8t} \quad (3)$$

Where $V_{1t}\ to\ V_{8t}$ are inflation, general budget deficit/surplus, current account deficit/surplus, real effective exchange rate, consumer credit, loans, deposit/M2 and (Reserves/Deposits) / (Notes & Coins / M2) respectively and characterize 21%, 14%, 13%, 1%, 20%, 13%, 15% and 3% of the variance of the Financial Vulnerability Index correspondingly.

$$FSI_t = 0.49xS_{1t} + 0.01xS_{2t} + 0.50xS_{3t} \quad (4)$$

Where S_{1t}, S_{2t}, S_{3t} are capital asset ratio, net financial investment and housing price index respectively. They accordingly account for 49%, 1% and 50% of the variance of the sub-index.

At last, the aggregate financial stability index for Canada is composed as below:

$$AFSI_t = 0.50xFDI_t + 0.34xFVI_t + 0.16xFSI_t \quad (5)$$

Where FDI is financial development index, FVI is financial vulnerability index and FSI is financial soundness index. In that order, they signify for 50%, 34% and 16% of the variance of the Aggregate Financial Stability Index.

3.2.2. Assigning Weights to the US AFSI

Similarly, the PCA method is used to assign weights to the variables and the sub-indices to obtain the aggregate financial stability index for the US. The sub-indices and the AFSI are composed as following (also see table 3 of the appendix):

$$FDI_t = 0.52xD_{1t} + 0.42xD_{2t} + 0.06D_{3t} \quad (6)$$

According to PCA, the S&P 500 index, total credit and interest spread characterize 52%, 42% and 6% of the variance of the Financial Development Index (FDI) respectively.

$$FVI_t = 0.17xV_{1t} + 0.04xV_{2t} + 0.12xV_{3t} + 0.11xV_{4t} + 0.17xV_{5t} + 0.09xV_{6t} + 0.15xV_{7t} + 0.15xV_{8t} \quad (7)$$

Where inflation, general budget deficit/surplus, current account deficit/surplus, real effective exchange rate, consumer credit, loans, deposit/M2 and (Reserves/Deposits) / (Notes

& Coins / M2) represent 17%, 4%, 12%, 11%, 17%, 9%, 15% and 15% of the variance of the Financial Vulnerability Index correspondingly.

$$FSI_t = 0.46xS_{1t} + 0.05xS_{2t} + 0.49xS_{3t} \quad (8)$$

Based on PCA, capital asset ratio, net financial investment and housing price index respectively account for 46%, 5% and 49% of the variance of the sub-index.

$$AFSI_t = 0.34xFDI_t + 0.33xFVI_t + 0.33xFSI_t \quad (9)$$

Accordingly, financial development index (FDI), financial vulnerability index (FVI) and financial soundness index (FSI) signify for 34%, 33% and 33% of the variance of the Aggregate Financial Stability Index.

4. Results

The main goal of AFSI is to provide a picture of the stability of financial system. Nonetheless, interpreting the index, as noted by Illing and Liu (2006), remains an issue among scholars. The evolution of our AFSI and its sub-indices successfully follows stability and instability in the financial markets over the sample period. Figure 1 and 2, in the appendix; depict the evolution of three sub-indices and the AFSIs for Canada and the US respectively. An increase in the AFSI demonstrates financial stability, while a fall indicates financial stress.

The result of the survey, that Illing and Liu (2006) conducted to establish the list of stressful events for the financial markets, will be used in this section to assess the AFSI for both countries. The list of the events was taken from every Monetary Policy Report since 1995 and every Bank of Canada Annual Report since 1977. Since the sample period of this paper is

from 1990-Q1 to 2010-Q4, all events occurring since 1990 are relevant for this research. Events ranked as the most stressful to the financial markets are: the early 1990s real estate collapse and bank losses in Canada, the Mexican crisis (1994-1995), the Asian crisis (1987-1998), the Russian debt default (1998), the long-term capital management (LTCM) collapse in the U.S. (1998), the high-tech price collapse (2000), and the events of 11 September 2001. Another important event which certainly destabilized the financial system was the sub-prime mortgage crisis of 2008 and the consequent global recession.

4.1. Testing for Stationarity

Before we begin the analysis of the AFSIs, it can be observed from figure 3 (Canada AFSI) and figure 4 (the US AFSI) of the appendix that there is a time trend in both of the indices; thus, it is non-stationary. The problem with non-stationary series is that changes happen with probabilities that do not depend on the current level of the series. Moreover, it causes random walk which is random consecutive steps (Dickey and Fuller, 1979). A dickey fuller test was also performed to confirm the non-starionarity of the indices (see table 4 and 5 in the appendix). For both Canada AFSI and the US AFSI, the unit root hypothesis cannot be rejected even at the 10% level, with p-values of 0.417 and 0.774 respectively.

Two approaches were used to make the indices stationary. The first approach is to treat the data as unit root non-stationary. In this case, taking the first difference removes the unit root problem and creates a stationarity series. Against this background, we used Dickey Fuller test to examine if the index had unit root. We also added the intercept and a deterministic time trend term which helped the explanatory power of the test. We performed the test for each of the AFSI as follows:

$$\Delta AFSI_t = a_0 + a_1 t + a_2 AFSI_{t-1} + \omega_t \quad (10)$$

Where $\Delta AFSI_t$ is the change in the AFSI i.e. $(AFSI_t - AFSI_{t-1})$, a_0 is the intercept, t is a deterministic time trend, $AFSI_{t-1}$ is one period lagged term, both a_1 and a_2 are coefficients and ω_t is the error term. In Dickey Fuller test, the null hypothesis is $(H_0 : a_2 = 0)$, meaning unit root, and the alternative hypothesis is $(H_1 : a_2 < 0)$, inferring no unit root. As seen in table 6 and table 7 (see the appendix), there is no unit root at 1% significance level. Figure 5 and 6 (in the appendix) shows the graphical representation of the first-difference approach for both of the indices.

The second approach is to treat the data as level trend non-stationary. In this approach the AFSI was regressed against time to obtain the residuals, and a dickey fuller test was performed on the residuals to see if it is stationary. The unit root hypothesis is rejected at 1% significance level for both countries (see table 8 and 9 of the appendix). Additionally, figure 7 and 8 (of the appendix) illustrates the residual approach of both indices.

4.2. Assessment, Comparison and Benchmarking

Many studies of financial crises state the lack of knowledge and reasoning of investors as one of the main causes of financial stress and financial turmoil. Crises often occur soon after major technical and financial innovations which change investors' expectations and present them with new type of financial opportunities. Mostly lack of knowledge about the new financial innovations and derivatives may help us explain how investors sometimes overestimate asset values (Kindleberger and Aliber, 2005). Sometimes insufficient or failures of government regulations are also cited as a cause of financial crisis. Recently, many countries have changed their regulation polices in order to prevent future financial crises.

However, excessive government interventions have also been blamed as a possible cause of financial crisis (Gordy and Howells, 2004). In some cases, rogue trades and fraudulent activity have caused huge losses for the financial markets leading to financial stress (Kothari, 2010).

Another contributing factor to financial crisis, which is often cited, is leverage or borrowing to finance investment. Leverage magnifies the potential returns from investment, but also creates risk of bankruptcy. Subsequently, bankruptcy may spread financial turmoil from one firm to another (Simkovic, 2009). In addition, mismatch of asset-liability is also often cited as a cause of financial stress. When the risks associated with a firm's assets and debts are not properly aligned, then the firm has asset-liability mismatch (Diamond and Dybvig, 2000). Furthermore, contagion, the idea that financial crises might spread from one firm to another or from one country to another, has been cited the reason to how and why many financial crisis quickly spread to other countries and in some cases becomes a global phenomenon (Kaufman and Scott, 2003). The causes of financial crises differ depending on the country, and the nature of its economy and its trade with other countries.

The events, that are considered the most stressful to the financial system by the survey of Illing and Liu (2006), are clearly shown in both of the AFSIs. Benchmarking, comparing the outcome of our composite index to the result of the survey, tests the suitability and appropriateness of the aggregate index. As illustrated in figure 9 and 10 (below), a general deterioration was observed in both the Canada and the US AFSI. During the early 1990s, the Canadian AFSI is more volatile due to real estate collapse and bank losses in Canada, with the index declining below -0.5 in first quarter of 1993. Consequently, the index shows improvement in the financial system in late 1993. Meanwhile, the US AFSI has steadily

declined in half of 1990s. Both Canada and the US had strong trade ties with Mexico through NAFTA (North American Free Trade Agreement); therefore, the emergence of the peso crisis in Mexico in 1994 impacted both the Canadian and American financial markets. As a result, a decline in both of the AFSIs can be seen. The US, having had stronger ties with Mexico, was hit harder, with the index reaching -0.61. According to Illing and Liu (2006), volatility in the financial markets, due to the Mexican crisis, was one of the main factors that caused the imbalance in 1994.

The Asian Crisis (1987-1998) was generally considered to be destabilizing for North American markets; however, there were few real linkages between the North American and the East Asian markets. In 1990s, the AFSI indicates higher volatility in Canada than in the US. Based on Illing's and Liu's survey, most of the economists and policy makers at the Bank of Canada ranked the Asian Crisis as one of the most stressful events, well above the Nikkei market crash of 1990. Introduction of new financial innovations, lack of bank regulations and contagion were some of the factors that caused the financial downturn in East Asian economies. The Asian crisis caused commodity prices to decrease, which resulted in a worsening of macroeconomic indicators in Canada and the US.

Similarly a worsening of the AFSI of both countries, as pointed out in figure 9 and 10, can be noticed in 1998, when Russia defaulted on their debt as well as long-term capital management (LTCM) collapsed in the US. Following that, the index shows a general positive trend up until 2000 for both countries, with the US index reaching 0.40 while the Canadian index reaching 0.93.

Figure 9: Benchmarking and Assessment of Canada AFSI

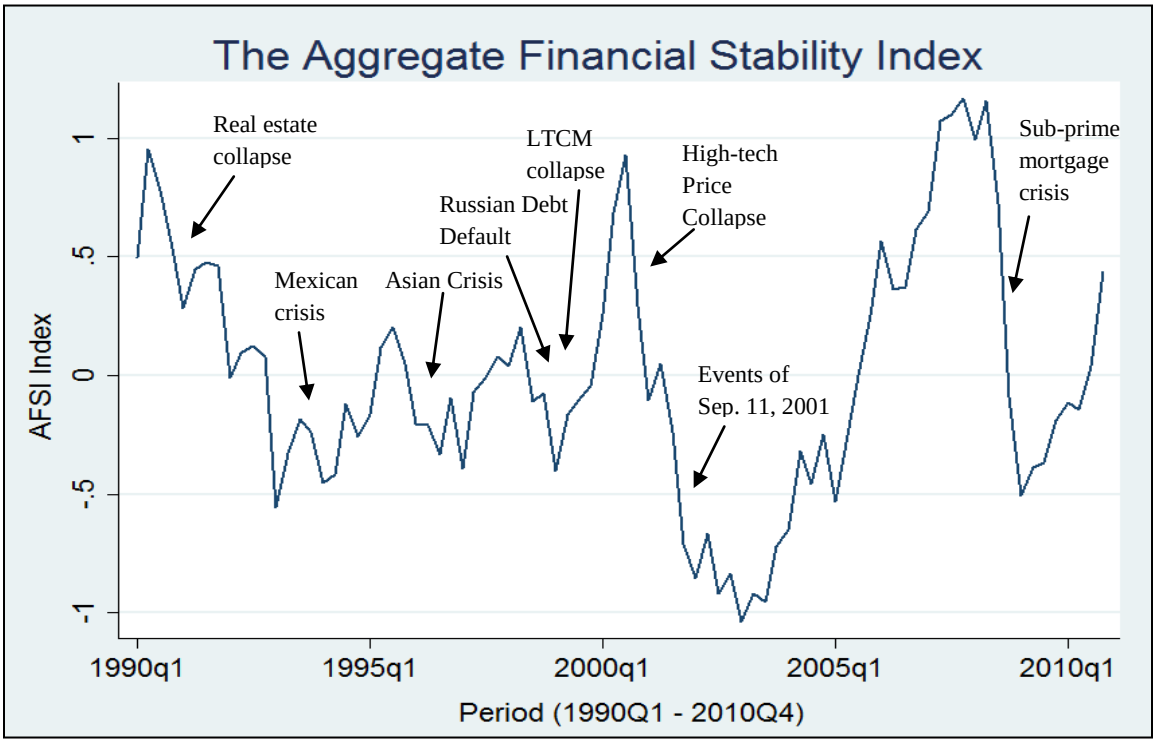
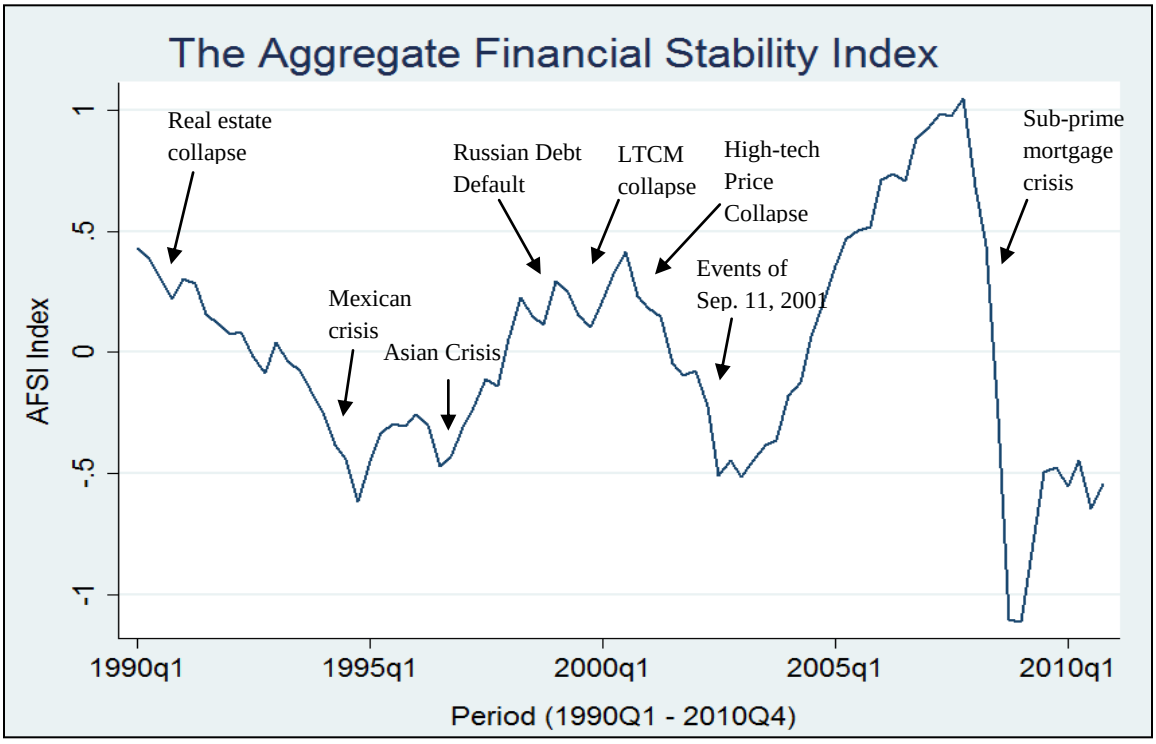


Figure 10: Benchmarking and Assessment of the US AFSI



In 2000, the AFSI shows a decline as the high-tech price collapse occurred, which greatly impacted the Canadian and the US financial markets. It seems that Canadian markets were hit harder than US since the Canadian AFSI dropped from 0.93 in 2000-Q3 to -0.10 in 2001-Q1. Meanwhile, the US AFSI fell only by 0.24 points from 2000-Q3 to 2001-Q2. Consequently, the events of September 11, 2001, which clearly affected both countries' financial systems, caused the AFSIs to fall sharply. As a result, the Canadian AFSI slumped, reaching its lowest level -1.04 in 2003-Q1; while the US index in 2003-Q1 dropped down to (-0.52), still well above the Canadian AFSI. Price volatility in the market and investors' loss of confidence were the key factors of this sharp decrease (Illing and Liu, 2006).

From 2003 to late 2007, both of the AFSIs grow steadily. The years of 2004 to late 2007 seem to be the most financially stable episodes during the sample period for both economies. In the fourth quarter of 2007, both of the AFSIs reach highest level, in the time period studied here, with the US index at 1.05 and the Canadian index at 1.17. Unfortunately, the sub-prime mortgage crisis, which started in early 2008, began to affect the Canadian and the US markets. Hence, a general deterioration and a large slump of the AFSIs can be observed in 2008.

The sharp fall of the index during the global financial crisis of 2008 is different than the other events that stressed the financial markets of Canada and the US. It precipitated the largest and steepest fall in the sample period, followed by the event of September 11, 2001. The Canadian economy seemed to have recovered quickly and the financial system have been stabilizing since mid 2009; however the US economy seemed to have struggled and their financial markets were not quite stable even till late 2010.

5. AFSI Econometric Validation

The AFSI successfully identified and recognized the periods of financial instability in Canada and the US. Nevertheless, an empirical assessment of the AFSI was also done by using OLS (Ordinary Least Squares), to test the performance of the index in response to changes in some key economic indicators. The AFSI was regressed against the growth rate of GDP, volatility of exchange rate, three-month Treasury bills yields, growth of money supply (M2), and a dummy variable capturing episodes of financial imbalance. These four of the main economic indicators were selected as independent variables because their movements impact the economy greatly.

Before regressing the index against the above-mentioned variables, a unit root test has to be performed to make sure that the variables included in the OLS regression are stationary and do not have unit root. Therefore, we performed a dickey fuller test to see whether the variables are stationary or non-stationary. Table 10 of the appendix shows the result of the unit root test for the Canadian macroeconomic indicators, and table 12 of the appendix illustrates the unit root test result for the US. As it can be observed, the p-values are very big; thus, we fail to reject the unit root null hypothesis, indicating that the key economic variables are non-stationary.

The first-difference approach was used to remove non-stationarity in the independent variables. As the results are shown in table 11 and 13 of the appendix, the null hypothesis is rejected, indicating no unit root in any of the variables. The value of the t-statistics test for Canadian GDP is less than the critical value of Dickey Fuller at 5 per cent significance level; thus, rejecting the null hypothesis at 5 per cent. Likewise, the value of t-statistics for rest of Canada and the US economic indicators are smaller than the critical value at 1 per cent

significance level; hence, rejecting the null hypothesis at 1 per cent. Additionally, the p-value for each indicator is very small, which signifies the presence of no unit root.

Finally, the two regressions were run to study the AFSIs in response to changes in some major macroeconomic variables:

$$AFSI_t = B_0 + B_1 GDP_t + B_2 M2_t + B_3 EX_t + B_4 TB_t + \varepsilon_t \qquad (11)$$

Where $AFSI_t$ is the aggregate financial stability index at time t, GDP_t is the growth rate of GDP at time t, $M2_t$ is the growth rate of money supply or M2 at time t, EX_t is volatility in exchange rate at time t, TB_t is the 3-months treasury bills yield at time t, B_0, B_1, B_2, B_3, B_4 and B_5 are coefficients, and ε_t is the error term.

The results of the regressions are shown in table 14 and 15 below. For Canada, the t-statistics values for GDP growth rate and money supply (M2) at 1 per cent significance level were higher than the t-test critical value; hence, rejecting the null hypothesis and inferring that the variables are statistically significant at 1 per cent. Similarly, the 3-month treasury bills yield and the exchange rate are statistically significant at 5 and 10 per cent respectively. As shown in table 13, for the US, all the key economic indicators are statistically significant at 1 per cent. In addition, for both countries the p-value of each variable is very small which again points out the explanatory power of these variables and their correlations with the AFSIs.

We expected the coefficients of GDP growth rate, M2 growth rate and 3-months T-bill to have a positive sign, while coefficient of volatility of exchange rate to have a negative sign. As shown in table 12 and 13, both of the AFSIs have a positive correlation with GDP growth rate and 3-months T-bill, while only Canada AFSI has a positive correlation with money supply (M2) growth rate.

Table 14: Analysis Summary for Canada

OLS Regression Results		
Variables	Coefficient	P-value
Constant	0.10 (5.38***)	0.000
GDP	0.403 (12.19***)	0.000
Money Supply (M2)	0.149 (2.78***)	0.007
Exchange Rate	0.039 (1.71*)	0.095
3m T-bills	0.094 (2.32**)	0.023
Observations	84	
R-squared	0.947	

Note: *, **, *** indicates the rejection of the null hypothesis in favour of alternative hypothesis at 10, 5 and 1 per cent level of significance respectively.

Table 15: Analysis Summary for the US

OLS Regression Results		
	Coefficient	P-value
Constant	0.067 (6.98***)	0.000
GDP	0.863 (19.28***)	0.000
Money Supply (M2)	-0.233 (-4.99***)	0.000
Exchange Rate	0.063 (3.78***)	0.000
3m T-bills	0.051 (3.54***)	0.001
Observations	84	
R-squared	0.989	

Note: *, **, *** indicates the rejection of the null hypothesis in favour of alternative hypothesis at 10, 5 and 1 per cent level of significance respectively.

Positive correlations between AFSI and these variables means that as these economic indicators increase (fall), the AFSI rises (decreases) too. On the other hand, the US AFSI has a negative correlation with money supply (M2) growth rate. The correlation between the AFSI and volatility of exchange is the most interesting one, since one would expect that a rise in exchange rate volatility would cause a decline in the index; however, it seems to be the opposite, based on our findings.

Moreover, the adjusted R-squared which is a measure of goodness-of-fit, are around 94 and 98 per cent for Canada and the US respectively, indicating that there is a strong connection between these variables and the AFSIs. It also points out the percentage of changes in the AFSI explained by the changes in these variables.

6. Conclusions

Financial stress is defined as any sort of interruption in the normal state of the financial system. The financial stress index (FSI) or the aggregate financial stability index (AFSI) is an important tool for economists and policy makers to assess the economy and propose policies. The AFSI is one of the methods which can be used to measure the systematic financial stability. We built aggregate financial stability indices for Canada and the US to examine the stability of their financial systems.

Our methodology was based on the approach proposed by Albulescu (2008) and Morris (2010). A total of 14 indicators were included in the index from different markets, such as the equity market, the credit market, the money market, the foreign exchange market as well as few other important macroeconomic indicators. The selection of individual indicators depends on the features of the system as well as the availability of data. The

empirical normalization technique was employed to normalize the variables. Principal components analysis was utilized to allocate weights to each variable to construct sub-indices as well as to assign weights to sub-indices to obtain the composite index. A number of domestic and international events, which were ranked by senior economists at the Bank of Canada as the events that destabilized the financial system, were used as a benchmark to assess appropriateness of the index. The index was successful at tracking the financial stability closely during these incidents.

The index showed that the Canadian and American financial system have had its ups and downs like many other countries. In early 1990s, the composite indices were somewhat volatile due to the peso crisis of Mexico, the Asian crisis and the Russian debt defaults. The Canada AFSI was more volatile than the US AFSI in the first half of 1990s. The Canadian and American financial markets appeared to be stabilizing between 1998 and 2000, until the high-tech price collapse occurred. Following that, the indices had a huge dip due to the events of September 11, 2001. The Canada AFSI reached its lowest level following the events of Sep. 11, 2001. The most financially stable time-period for Canada and the US in the sample period, studied here, appeared to be 2004 up until late 2007. In late 2007, both of the indices reached their highest level, with the Canada AFSI being higher than the US AFSI. A massive deterioration of the indices was observed in early 2008 due to the impacts of the sub-prime mortgage crisis in the U.S. This recent financial crisis was much different than earlier events since it caused the index the sharpest and steepest decline.

The AFSIs were regressed against GDP growth rate, money supply (M2) growth rate, exchange rate volatility and 3-month treasury bills rate to study the response of the AFSIs against the changes in these macroeconomic indicators. The regression results indicate that

the above-mentioned variables are statistically significant and have explanatory power. A correlation between AFSIs and these variables was observed.

The construction of the index should also be adjusted in terms of the choice of historical reference period, since a normal level may alter over time as a result of regulation and structural changes in the financial system. A Further research can be done to test whether the AFSI can appropriately forecast the future status of the Canadian and American financial markets. Similarly, it can be researched to find if the index can detect the emergence of financial crisis. In addition, an AFSI with the same indicators and same methodology, utilized here, can be built for another country, whose economy is similar to Canada and the US, to test the suitability of the index for other countries.

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Appendix A: Data Sources

The data for Canada are taken from: Statistics Canada and Datastream Advance.
The data for the US are obtained from: Federal Reserve Bank of St. Louis, International Financial Statistics (IFS), and National Bureau of Economic Research (NBER).

Appendix B: Results/Calculations

Table 2: Principal Component Analysis for Canada

Dependent Variable	Independent Variables	Weight
Financial Development Index (FDI)	Toronto Stock Index	0.43
	Total Credit	0.49
	Interest Spread	0.08
Financial Vulnerability Index (FVI)	Inflation Rate	0.21
	General Budget Deficit/Surplus	0.14
	Current Account Deficit/Surplus	0.13
	REER	0.01
	Consumer Credit	0.20
	Loan (% deposits)	0.13
	Deposits/M2	0.15
	(Reserves/Deposits) / (Notes & Coins / M2)	0.03
Financial Soundness Index (FSI)	Capital/Assets	0.49
	Net Financial Investment	0.01
	Housing Price Index (HPI)	0.50
Aggregate Financial Stability Index (AFSI)	Financial Development Index (FDI)	0.50
	Financial Vulnerability Index (FVI)	0.34
	Financial Soundness Index (FSI)	0.16

Table 3: Principal Component Analysis for the U.S.

Dependent Variable	Independent Variables	Weight
Financial Development Index (FDI)	S&P 500 Index	0.52
	Total Credit	0.42
	Interest Spread	0.06
Financial Vulnerability Index (FVI)	Inflation Rate	0.17
	General Budget Deficit/Surplus	0.04
	Current Account Deficit/Surplus	0.12

	REER	0.11
	Consumer Credit	0.17
	Loan (% deposits)	0.09
	Deposits/M2	0.15
	(Reserves/Deposits) / (Notes & Coins / M2)	0.15
Financial Soundness Index (FSI)	Capital/Assets	0.46
	Net Financial Investment	0.05
	Housing Price Index (HPI)	0.49
Aggregate Financial Stability Index (AFSI)	Financial Development Index (FDI)	0.34
	Financial Vulnerability Index (FVI)	0.33
	Financial Soundness Index (FSI)	0.33

Table 4: Dickey Fuller Test of Canada AFSI for Unit Root

Canada AFSI Index			
Test Stat	1% crit. Value	5% crit. Value	10% crit. Value
-2.33	-4.08	-3.47	-3.16
MacKinnon p-value	0.417		

Table 5: Dickey Fuller Test of the US AFSI for Unit Root

The US AFSI Index			
Test Stat	1% crit. Value	5% crit. Value	10% crit. Value
-1.646	-4.077	-3.467	-3.160
MacKinnon p-value	0.774		

Table 6: The Result of the Dickey Fuller Test

First Difference of Canada AFSI Index			
Test Stat	1% crit. Value	5% crit. Value	10% crit. Value
-8.18	-4.08	-3.47	-3.16
MacKinnon p-value	0		

Table 7: The Result of the Dickey Fuller Test

First Difference of the US AFSI Index			
Test Stat	1% crit. Value	5% crit. Value	10% crit. Value

-5.52	-4.08	-3.47	-3.16
MacKinnon p-value	0.000		

Table 8: The Result of the Dickey Fuller Test (with a drift)

Residuals of Canada AFSI Index			
Test Stat	1% crit. Value	5% crit. Value	10% crit. Value
-2.35	-2.373	-1.664	-1.292
MacKinnon p-value	0.0106		

Table 9: The Result of the Dickey Fuller Test (with a drift)

Residuals of The US AFSI Index			
Test Stat	1% crit. Value	5% crit. Value	10% crit. Value
-1.659	-2.373	-1.664	-1.292
MacKinnon p-value	0.050		

Table 10: Canadian Macroeconomic Indicators

Unit Root Test Results		
	Dickey Fuller	
	Test Statistics	P-value
GDP	(-2.053)	0.572
M2	(2.87)	1
Exchange Rate	(-1.191)	0.912
3m T-bills	(-2.75)	0.216

Note: *, **, *** indicates the rejection of the null hypothesis in favour of alternative hypothesis at 10, 5 and 1 per cent level of significance respectively.

Table 11: First Difference of Canadian Macroeconomic Indicators

Unit Root Test Results

	Dickey Fuller	
	Test Statistics	P-value
GDP	(-3.943**)	0.011
M2	(-4.701***)	0.000
Exchange Rate	(-6.669***)	0.000
3m T-bills	(-8.05***)	0.000

Note: *, **, *** indicates the rejection of the null hypothesis in favour of alternative hypothesis at 10, 5 and 1 per cent level of significance respectively.

Table 12: The US Macroeconomic Indicators

Unit Root Test Results		
	Dickey Fuller	
	Test Statistics	P-value
GDP	(-2.065)	0.566
M2	(-1.736)	0.735
Exchange Rate	(-2.632)	0.265
3m T-bills	(-1.555)	0.809

Note: *, **, *** indicates the rejection of the null hypothesis in favour of alternative hypothesis at 10, 5 and 1 per cent level of significance respectively.

Table 13: First Difference of the US Macroeconomic Indicators

Unit Root Test Results		
	Dickey Fuller	
	Test Statistics	P-value
GDP	(-4.798***)	0.000
M2	(-6.511***)	0.000
Exchange Rate	(-6.251***)	0.000
3m T-bills	(-4.351***)	0.003

Note: *, **, *** indicates the rejection of the null hypothesis in favour of alternative hypothesis at 10, 5 and 1 per cent level of significance respectively.

Figure 1: Canada AFSI and the Sub-indices

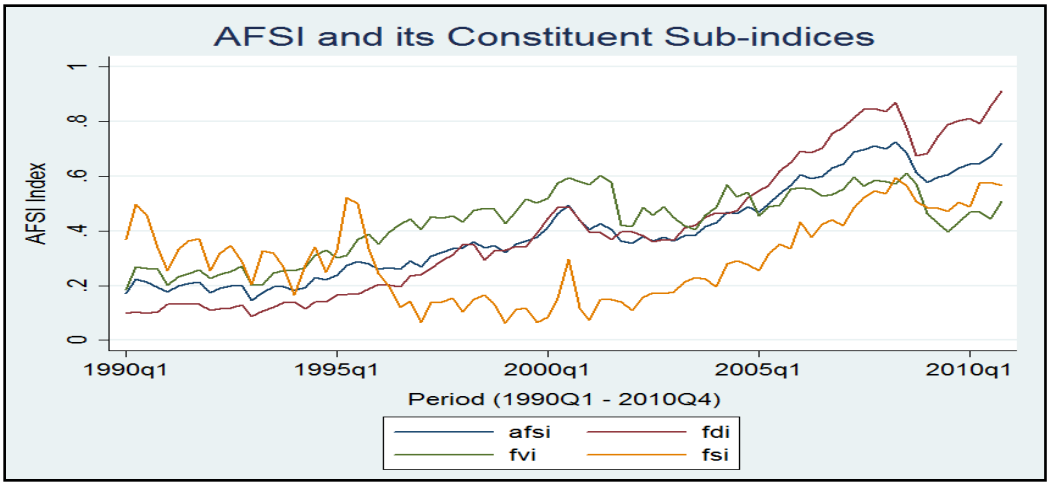

Figure 2: The US AFSI and the Sub-indices

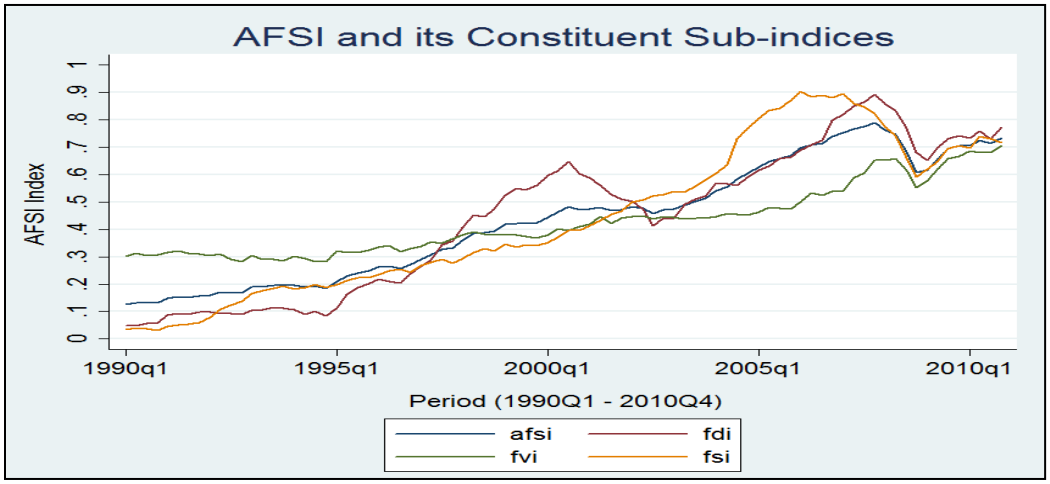

Figure 3: Canada AFSI Time Analysis

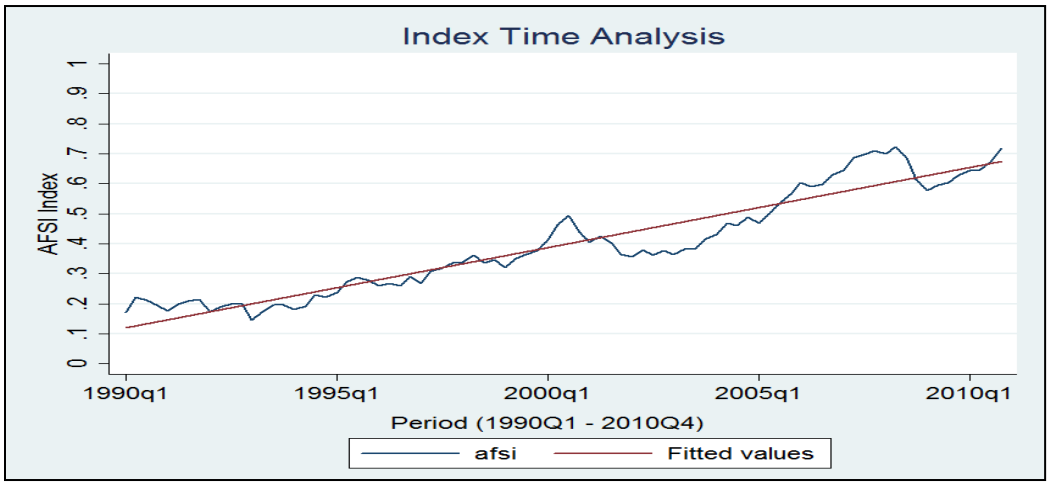

Figure 4: The US AFSI Time Analysis

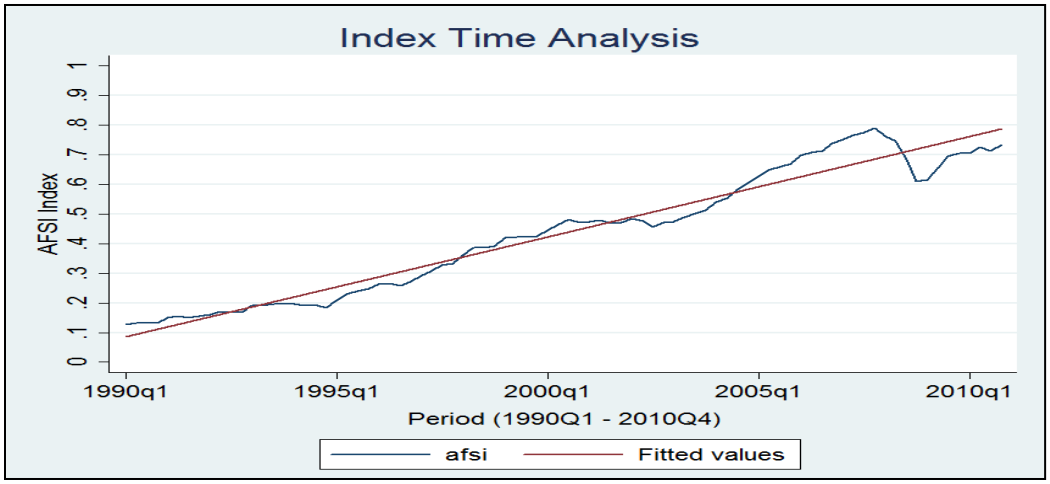

Figure 5: The First-Difference of Canada AFSI

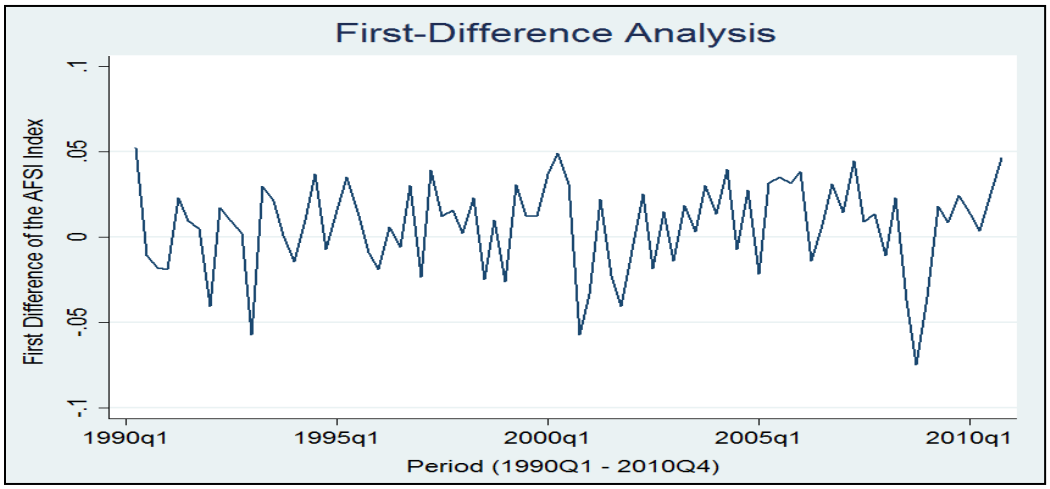

Figure 6: The First-Difference of the US AFSI

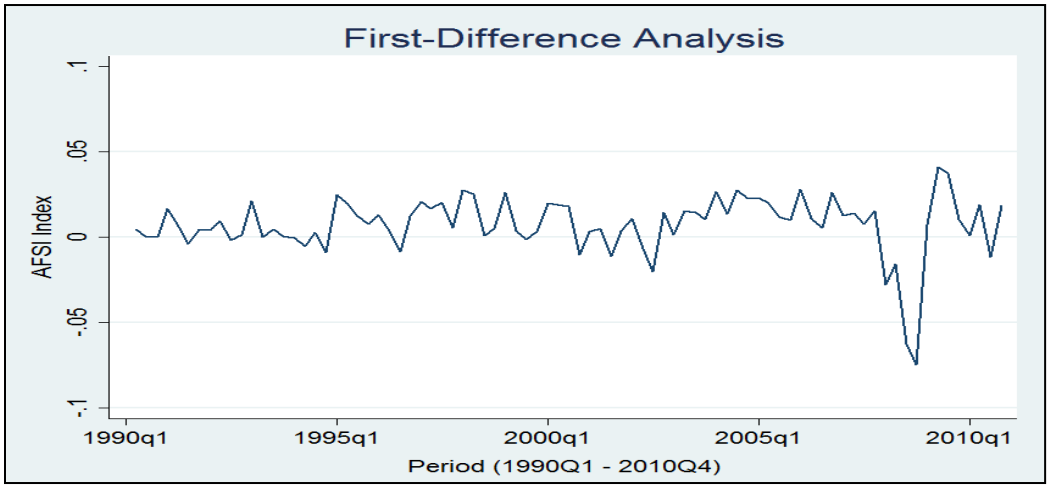

Table 7: Residuals of Canada AFSI

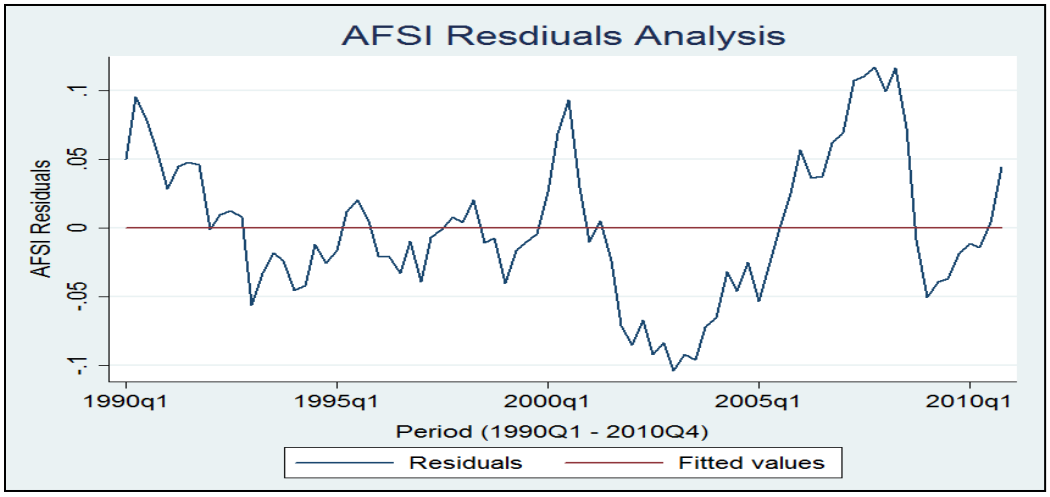

Table 8: Residuals of the US AFSI