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AN ANALYSIS OF SEASONALITY IN THE CANADIAN FINANCIAL FLOW SERIES

by

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RESUME

Cette étude cherche à déterminer s'il y a de la saisonnalitée dans les séries de Flux Financier. On a trouvé que 138 des 367 séries (37.6%) ont besoin d'ajustement saisonnier.

Même si les données couvrent une période de 25 ans seules les douze dernières années ont été retenues pour la désaisonnalisation. Ceci a permi d'améliorer significativement la qualité de l'ajustement. De plus, on a éliminé, les valeurs extrêmes dans quelque cas (38 séries) pour le pas contaminer l'estimation de la composante saisonnière. Dans 23 cas il a été nécessaire de réduire de 4 à 6 ans (en plus de la réduction initiale) la durée des séries pour éviter l'impact des changements dans la structure des celles-ci.

L'analyse finale indique que la majorité des séries ne se prète pas encore à un ajustement saisonnier de qualité respectable.

1.0 Introduction

Last fall a study was carried out by J. Brox and J. Taillon (1986) to determine if it was feasible to seasonally adjust the Canadian Financial Flow statistics. They selected a submatrix of 38 series from the close to 400 available components. On the basis of this sample, their conclusion was that the majority of the series displayed seasonality which could be identified and removed successfully from the data.

In light of this information, the Time Series Research and Analysis Division undertook the task of finding the most appropriate set of seasonal adjustment options for the full Financial Flow matrix. Following the recommendations of Brox and Taillon, the series were first converted into quasi-stock form to help the seasonal adjustment program reveal better the trend-cycle seasonal and irregular component of each series. This conversion also allowed for the application of the multiplicative option which is more suitable to the structure of the financial flow series than the additive one (the only one available for series with negative values in it).

The sections to follow will discuss the different stages of the seasonal adjustment process. Section 2 describes how the length of the series was determined. Section 3 deals with the problem of the treatment of outliers. In Section 4, a set of statistics is presented which served as a basis for the assessment of seasonal adjustment quality. Based on these statistics, recommendations are made regarding which series should be seasonally adjusted. Finally, Section 5 concludes the study.

2.0 Selection of the Time Span to be included in the Analysis

A useful tool in the analysis of the series were the graphs of the original data and the corresponding periodograms. In inspecting the graphs of the original data, it became evident that a large number of the series underwent structural changes in the seventies, while others had significant values available only in the past eight to ten years. Graph 1 and Graph 2 are examples of the two cases respectively.

From the point of view of seasonal adjustment it is preferable to have a homogeneous series with no breaks in the pattern therefore, it was decided to cut the length of the series and use only the last eleven years of data (starting in the first quarter of 1975) in the seasonal adjustment procedure. Since the primary objective of the seasonal adjustment of financial flow data is to help describe more accurately the current trends in the economy the decision to exclude data prior to 1975 will not have an adverse effect on the analysis. On the contrary, current trends will become more apparent because of the more reliable estimates of seasonality produced from a more homogeneous series. As an added benefit, the shortening of the time span increased the number of series whose quality was considered acceptable for seasonal adjustment. The year 1975 was selected as the starting period for all series, including the ones whose structure did not undergo changes, to provide a uniform treatment for the great majority of the series.

It was still not possible to fix the starting year as 1975 for all the series because a small number of them had breaks in pattern after 1975. (See Graph 3). These series were processed separately with starting dates ranging from 1979 to 1981 in order to obtain the best possible seasonally adjusted estimates.

3.0 The Treatment of Outliers

The method used for the seasonal adjustment of the Financial Flow series, the X-11-ARIMA (DAGUM 1980) has a built-in extreme identification routine designed to eliminate the influence of outliers on the estimation of seasonality. The problem is that because of the iterative nature of the method some of these extreme values could contaminate the trend-cycle component before the extreme identification process takes place and distort the results. It is thus advisable to remove known outliers from a series before seasonally adjusting it.

The identification of outliers was carried out with the aid of the graphs. In certain cases (such as in the series shown in graph 4) the presence of extreme values was evident. Quite often when an extreme value was located in a series through visual inspection the existence of such extremes was also indicated by X-11-ARIMA which identified an irregular more than three standard deviations away from the average at the given time point. These extremes were then removed from the series and replaced by an average value entered as priors before the final seasonal adjustment took place. The extremes were reintroduced into the seasonally adjusted series at the end of the process. This procedure ensured that the estimation of seasonality was not affected by unusually high or low values in the series.

Outliers were identified in about 50 series and in 38 cases the removal of these outliers considerably improved the quality of seasonal adjustment. In the remaining series the irregular component was so large that eliminating a few outliers did not sufficiently change the proportion of seasonal and irregular variation in the series and the final quality was still unacceptable.

4.0 The Selection of Series to be Seasonally Adjusted

Once the length of the series was determined and the series were adjusted a priori to eliminate the influence of extremes, all the Financial Flow matrix series were processed through the X-11-ARIMA program.

The next step was to decide which of these seasonally adjusted series were of acceptable quality. The objective of seasonal adjustment is to decompose a time series into a trend-cycle, seasonal and irregular component and by removing the estimated seasonality from the series reveal better the underlying trend-cyclical movement. This decomposition is successful only if the amount of seasonal variation present in the series is sufficiently large compared to the amount of irregular movement otherwise the program cannot separate the two with reliability.

The program gives several indications of the relative importance of these two components. One such indication is an F-test for stable seasonality (in Table D8 of the program) which is basically a one-way analysis of variance test measuring if the quarterly averages are significantly different from each other given the overall random fluctuation in the series. This test is carried out on the seasonal-irregular ratios i.e. after removing the trend-cycle. Because of the presence of autocorrelation in the random component the usual cut-off point (an F-value of 4.41 for a ten-year long series) cannot be used to indicate significant variation. Empirical evidence has shown that an F-value of 6 to 7 corresponds more to the 1% significance level. Series with F-values beyond this value have significant seasonality.

A companion test to the stable seasonality test measures the amount of moving seasonality present. The less the seasonal component changes from

year to year the more reliably it can be estimated by the program. The identifiable seasonality test developed by Lothian and Morry (1978a) combines the stable seasonality and moving seasonality F-test. If the amount of stable seasonality is large enough compared to the amount of moving seasonality, the identifiable seasonality test value is less than 1 indicating acceptable quality.

The X-11-ARIMA also calculates (in Table F2.B) the percentage contribution of the quarter-to-quarter movement in the three components (irregular, trend-cyclical and seasonal) to the total variation in the series, denoted by I, C and S respectively. These statistics also gives some indication of the relative size of the seasonal and irregular components in the series, the higher the ratio S/I, the better are the chances that seasonality can be removed successfully. If the ratio of S/I drops below 1.0 the adjustment is most likely not reliable.

Another way of judging the amount of seasonal variation in the series is by examining if the periodogram contains relative peaks at the seasonal frequencies (.25 cycles per quarter and .5 cycles per quarter) compared to the power present at the irregular frequencies. In certain cases where the stable seasonality F-test and identifiable seasonality test indicated marginal quality, the periodogram was used to decide whether the series should be adjusted or not.

Finally, a further aid in determining the quality of adjustment was the 'total quality' indicator which is a weighted average of eleven other quality measures described in Lothian and Morry (1978b). These measures compare the relative size of seasonal and irregular, irregular and trend-cycle components to that found in seasonal series of average quality.

Series whose total quality [illegible] are considered to be of unacceptable quality.

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The most [illegible] of the series was the [illegible] adjustment was [illegible] cases. In a few exceptional [illegible] example, the series 130/80 (non-financial government enterprises [illegible] liabilities - municipal government bonds) which series [illegible] of an [illegible] 14 had to be [illegible] to the constant level [illegible] in the last 8 quarters [illegible] of the seasonal [illegible] of 4 or [illegible] recorded [illegible] a priori for outliers [illegible] the presence of one or two extreme [illegible] but [illegible] irregular variation in the series.

Series [illegible] 5, 6 and 7 constituted [illegible] cases. The general [illegible] that as long as [illegible] other statistics indicated [illegible] adjustment [illegible] identifiable [illegible] quality [illegible] be adjusted. In a few cases, the cut-off [illegible] but the [illegible] showed [illegible] seasonal [illegible] the adjustment was accepted. In other series the total quality [illegible] larger than 3 and this high value was mainly [illegible] weak trend in the series which [illegible]

Series whose total quality measure is higher than 1 are considered to be of unacceptable quality.

The above statistics were recorded for all the Financial Flow series and the selection of acceptable series was made on the basis of these statistics and the shape of the periodogram.

The most important factor in judging the quality of the series was the F-statistics for stable seasonality. If this value exceeded 7 the adjustment was considered acceptable in almost all the cases. The few exceptions included, for example, the series 150180 (non-financial government enterprises - liability - municipal government bonds) which series inspite of an F-value of 14 had to be rejected due to the constant level displayed in the last 8 quarters, that signalled termination of the seasonal pattern of previous years. (Graph 5) Series with stable F-values of 4 or below were automatically rejected. (It should be recalled that the recorded F-values came from series which were adjusted a priori for outliers thus such low performance was not due to the presence of one or two extreme values, but to the existence of too much irregular variation in the series.)

Series with F-values of 5, 6 and 7 constituted borderline cases. The general rule for acceptance was that as long as all the other statistics indicated adequate adjustment (i.e. identifiable seasonality $\lesssim 1.00$, Total quality $\lesssim 1$, $S/I > 1$) the series should be adjusted. In a few cases, the cut-off points were slightly exceeded but the periodogram showed strong seasonal peaks and thus the adjustment was accepted. In other series the total quality measure was somewhat larger than 1 but this high value was mostly the result of an unusually weak trend in the series which did not

affect the proper identification of the seasonal component.

Using these criteria, 138 series were found to be of acceptable quality. These series together with the statistics: F-statistics Identifiable seasonality. Total quality, I, C, S are listed in Appendix B and C. Appendix B contains the series with 1975 as the starting year. The series in Appendix C should be adjusted starting with data from 1979 to 1981. The series marked with * had one or two extremes removed a priori.

TABLE 1. Proportion of Series to be seasonally adjusted by sector breakdown

Sector	No. of seasonally adjusted / Total number of series	% of adjusted
I-II	16/26	61.5
III	13/26	50.0
IV	10/33	30.3
V	3/13	23.1
VI	16/50	32.0
VII	7/28	25.0
VIV	8/31	25.8
IX	10/30	33.3
X	14/28	50.0
XI	10/28	35.7
XII	5/6	83.3
XIII	4/24	16.7
Total	22/44	50.0
Overall Total	137/368	37.6

Sectors I-II, (Persons and Unincorporated businesses) VI (Chartered Banks) and the total contain the largest number of acceptable series, as indicated in Table 1 with 16, 16 and 22 series respectively. However, in terms of percentages sectors I-II, XII (Social Security Funds) III (Non-financial Private Corporations) and the total show the best performance. 50 to 83% of the series in these sectors display seasonality that can be identified and removed successfully. At the level of the complete Financial Flow matrix the average percentage is 37.6% corresponding to 138 acceptable series out of the available 367 series. The sectors least suitable for seasonal adjustment were sectors V and XIII (Monetary Authorities and Rest of the World).

5.0 Conclusion

This study investigates the suitability of the Canadian Financial Flow matrix series for seasonal adjustment. Out of the 367 series analysed 138 contain seasonality that can be identified and removed reliably by the X-11-ARIMA seasonal adjustment program.

The selection of series for seasonal adjustment was based on certain statistics produced by the X-11-ARIMA program regarding the relative size of the seasonal, irregular and trend-cycle component present in the series. In addition to these statistics the periodogram of the original data was used as well in determining the presence or absence of seasonality.

The length of the series (originally 25 years) was reduced to include data from 1975 only in the seasonal adjustment procedure. This measure was taken to avoid distortion of the estimated seasonal component due to the presence of breaks in many of the series in the earlier years. This reduction in length not only improved the quality of adjustment but also increased the number of series that were considered acceptable for seasonal adjustment. For a few series it was necessary to make the time span even shorter using only data starting in 1979, 1980 or 1981, depending on the structure of the series in question.

In 38 cases, extremes were identified and removed from the series, a priori to improve the seasonal adjustment process. These extremes were reintroduced into the seasonally adjusted data after. It is hoped that with the availability of the 138 series, seasonally adjusted as recommended in this study, the current analysis of Financial Flows will be greatly facilitated.

References

BROX, J.A. and TAILLON, J. (1986): "Seasonality and the Canadian Financial Flow Statistics: Report on a Study in progress", working paper 86-01, Econometric Analysis Division, Statistics Canada.

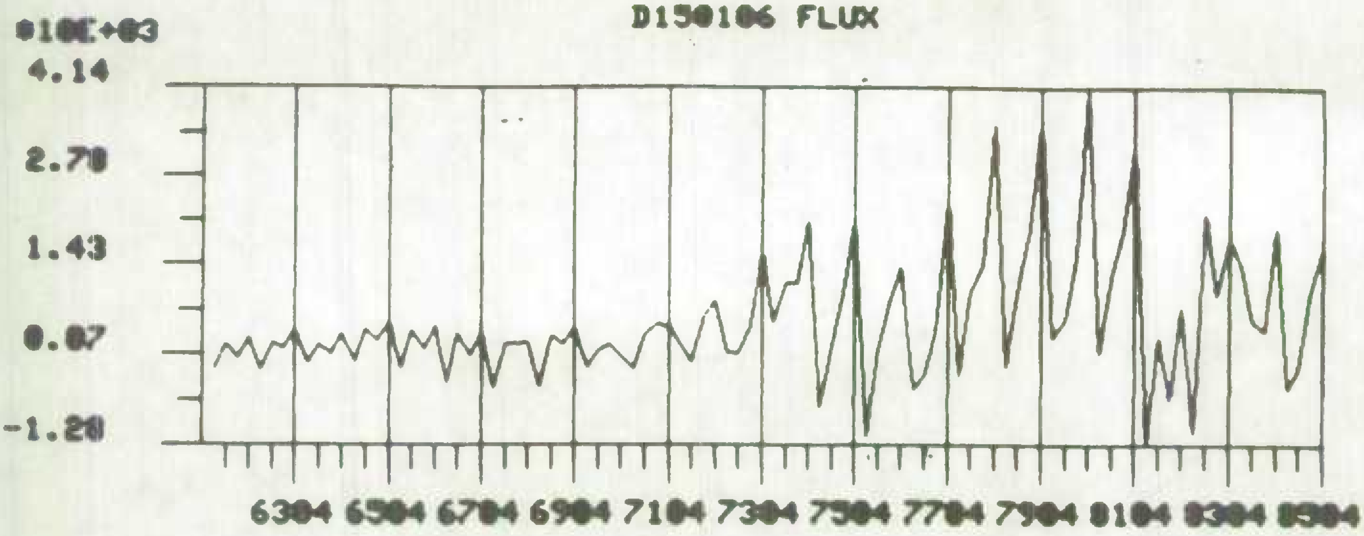
DAGUM, E.B. (1980): The X-11-ARIMA Seasonal Adjustment Method, Statistics Canada, Catalogue No. 12-564.

LOTHIAN, J. and MORRY, M. (1978a): "A Test for the Presence of Identifiable Seasonality when Using the X-11-ARIMA Program", Research Paper, Seasonal Adjustment and Time Series Staff, Statistics Canada.

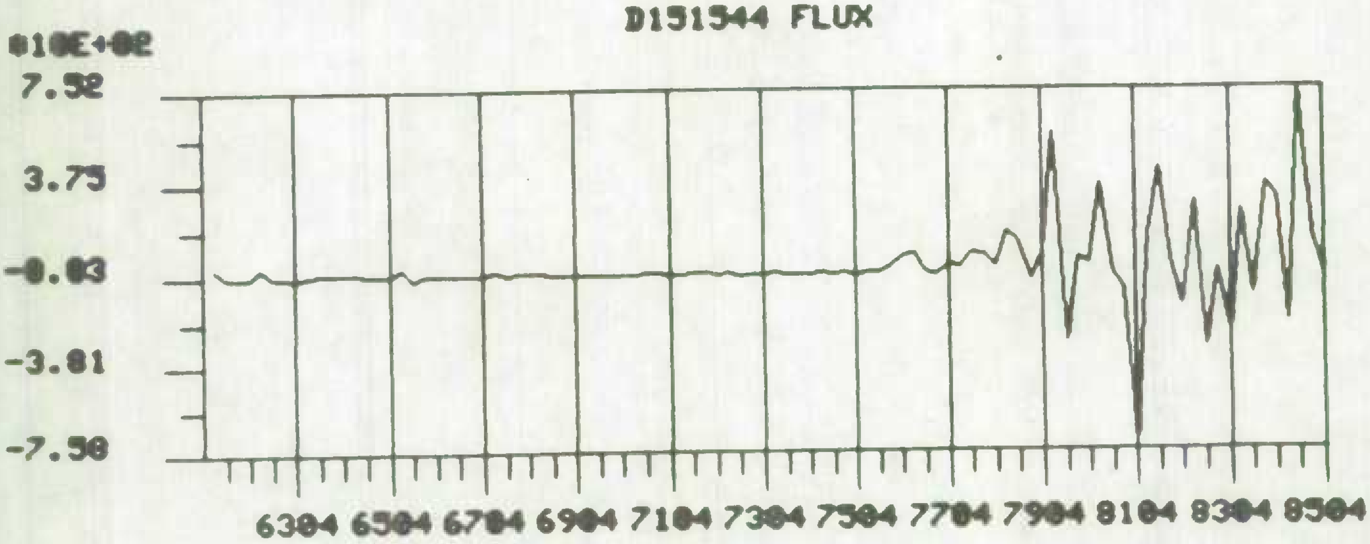
LOTHIAN, J. and MORRY, M. (1978b): "A Set of Quality Control Statistics for the X-11-ARIMA Seasonal Adjustment Program", Research Paper, Seasonal Adjustment and Time Series Staff, Statistics Canada.

APPENDIX 'A'

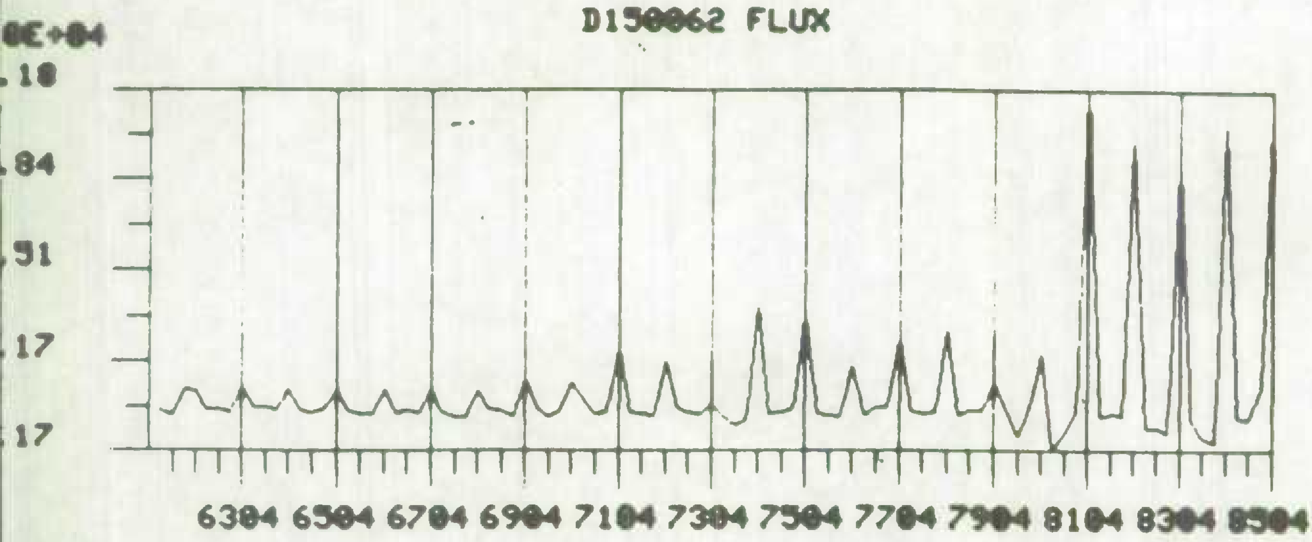
GRAPH 1. Non-financial private corporations - Liabilities
Trade Payables



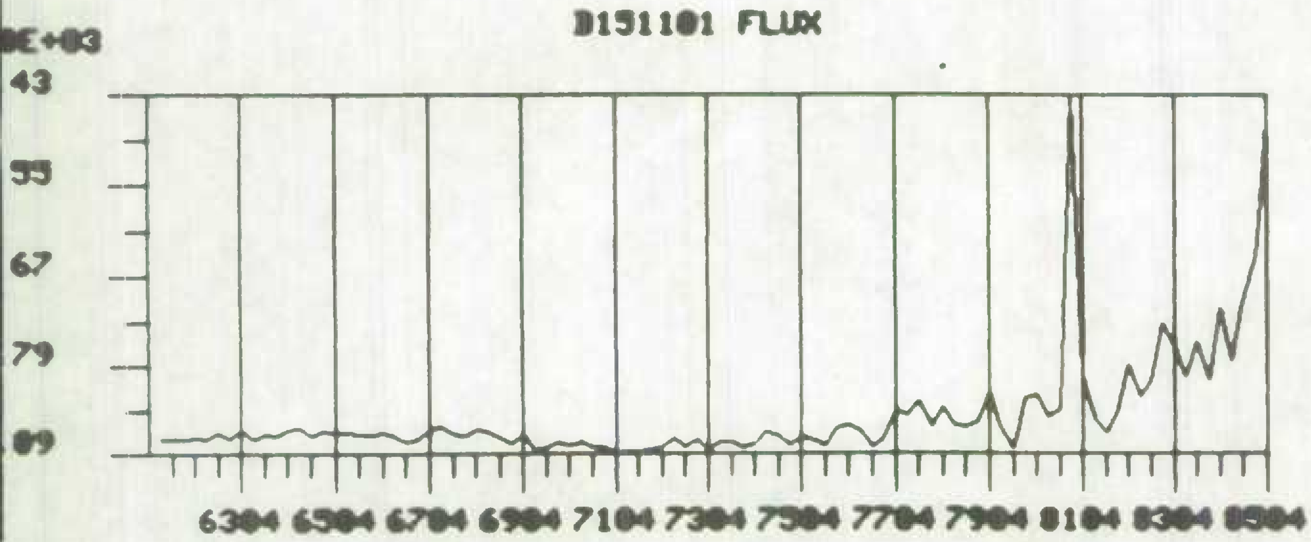
GRAPH 2. Other levels of government and hospitals - Assets
Government of Canada Treasury Bills



GRAPH 3. Persons and Unincorporated Businesses - Assets
Government of Canada Bonds

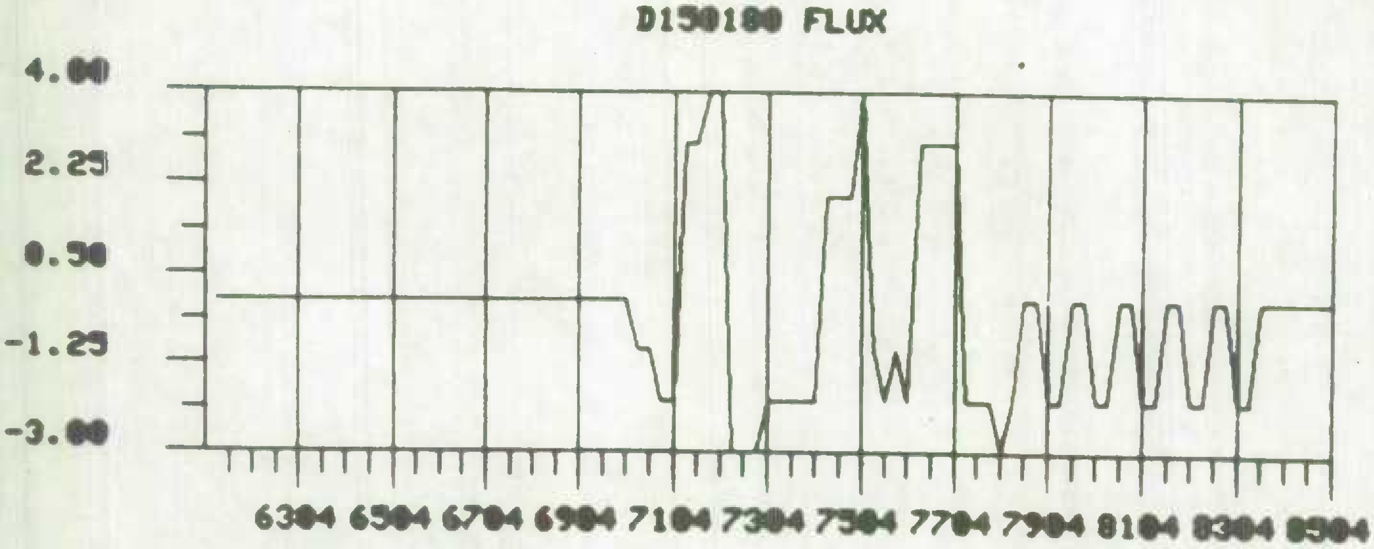


GRAPH 4. Other Private Financial Institutions - Liabilities
Stocks



GRAPH 5. Non-Financial Government Enterprises - Liability

Municipal Government Bonds



Appendix B

Series to be Seasonally Adjusted Starting in 1975

tor	CANSIM Number	F Statistic	Identifiable Seasonality	Total Quality	I	C	S
	150046*	16	0.534	.41	.82	95.91	3.26
	150032	19	.593	.46	5.71	82.03	12.26
	150033	7	.84	.51	1.03	97.10	1.87
	150045*	7	.997	.81	2.77	91.83	5.07
	150063*	23	.507	.52	14.68	29.78	50.72
	150066	12	.681	.44	0.42	98.24	1.34
I	150048	27	.442	.58	6.59	12.13	81.28
	150049	19	.557	.76	20.63	14.47	64.91
	150050	10	.716	.51	3.22	92.86	3.92
	150070	27	.462	.31	2.41	88.64	8.95
	150052	56	.389	.56	10.59	10.40	79.02
	150054*	13	.636	.61	12.93	59.23	26.94
	150071	8	.946	.95	28.93	33.70	37.37
	150056	6	.932	.55	0.90	98.01	1.09
	150061*	12	.836	.81	8.31	27.08	64.00
	150080*	8	.749	.85	5.82	77.13	16.91
	150081	29	.415	.44	1.88	91.27	6.85
	150083	8	.844	1.11	36.63	22.09	41.28
	150103	17	.818	.51	6.46	71.41	22.13
	150104	14	.771	.56	1.14	94.78	4.07
	150106	42	.476	.44	3.05	53.89	43.06
	150108	8	.813	.74	7.04	79.99	12.97
	150109	19	.511	.52	13.00	63.42	23.58
	150110	12	.956	.91	28.27	32.47	39.26
	150111*	8	.916	.63	7.67	82.63	9.14
	150116	9	1.092	.60	2.60	90.39	7.01
	150117	31	.395	.46	6.95	53.33	39.72
	150137	36	.349	.31	1.13	92.38	6.49
	150140	10	.737	.86	26.59	52.07	21.34
	150144	48	.367	.54	13.23	39.04	47.72
	150148	12	.914	1.03	35.17	26.90	37.93
	150152	12	.674	.64	18.92	44.23	36.85
	150160	14	.690	.56	7.16	52.89	39.95
	150163*	72	.279	.34	3.75	17.32	78.54
	150165*	36	.383	.54	15.61	23.22	59.18
	150174	18	.572	.63	7.35	58.82	33.82
	150356	67	.337	.57	6.49	4.94	88.57
	150359*	140	.177	.26	3.45	26.01	69.03
	150362	61	.327	.73	6.26	1.63	92.11

tor	CANSIM Number	F Statistic	Identifiable Seasonality	Total Quality	I	C	S
	151534	59	.287	.46	12.73	23.88	63.39
	151535	40	.422	.48	4.47	59.00	36.53
	151538	39	.483	.61	13.12	16.93	69.95
	151556	70	.262	.50	7.81	6.80	85.38
	151561	30	.422	.54	14.93	16.25	68.82
	151565	10	.800	.56	2.32	92.40	5.28
	151570	26	.435	.58	7.74	12.23	80.03
	151735	80	.303	.25	0.30	93.61	6.09
	151736	80	.303	.25	0.30	93.61	6.09
	151738*	15	.907	.64	2.46	83.48	13.17
	151739	121	.231	.20	0.30	89.01	10.69
	151741	57	.306	.29	1.69	79.70	18.60
	151804	10	.683	.49	5.25	85.64	9.11
I	151805	14	.557	.50	3.70	92.69	3.61
	151831	13	.612	.80	15.37	40.40	44.22
	151967	37	.350	.31	2.23	80.98	16.79
	151968	24	.499	.35	0.47	97.18	2.35
	151971	36	.438	.34	1.85	89.89	8.27
	151974	13	.621	.49	6.36	85.42	8.22
	151978	8	.844	.52	0.78	98.11	1.10
	151984	14	.843	.52	0.29	98.50	1.21
	151986	7	.919	.55	1.86	94.71	3.43
al	151990	15	.568	.64	11.87	62.60	25.53
	151998	37	.350	.31	2.23	80.98	16.79
	151999	24	.499	.35	0.47	97.18	2.35
	152005*	24	.442	.45	3.31	88.58	7.60
	152009*	12	.741	.52	0.64	98.29	1.04
	152013*	9	.716	.57	4.41	91.12	4.18
	152015	14	.843	.52	0.29	98.50	1.21
	152019	9	.815	.59	2.45	94.66	2.89
	152024	36	.438	.34	1.85	89.89	8.27

Appendix C

Series to be Seasonally Adjusted Starting in

1979

tor	CANSIM NUMBERS	F Statistics	Identifiable Seasonality	Total Quality	I	C	S
	150088*	18	.585	0.51	5.31	83.87	10.55
	150580*	10	.650	0.59	14.25	55.71	26.11
	151339*	14	.631	0.55	2.69	93.08	4.23
al	152021*	25	.426	0.55	8.22	59.44	30.89

1980

I	150062	326	.107	0.14	1.00	18.77	80.23
	150546*	13	.551	0.40	1.97	88.82	8.44
	150537	19	.453	0.59	15.62	37.77	46.61
	150577*	11	.679	0.51	11.26	51.52	27.62
	151326*	21	.522	0.59	13.31	34.44	46.78
	151537	19	.548	0.76	21.77	18.80	59.43
	151550	15	.810	0.46	3.97	85.02	11.01
	151559	35	.736	0.58	6.63	12.26	81.11
I	151819	618	.803	0.94	30.00	33.71	38.60
al	151976	21	.488	0.35	2.90	80.34	16.76
al	151980	80	.375	0.31	3.08	41.36	55.56
al	152007	22	.488	0.35	2.00	80.34	16.76
al	150895	59	.306	0.49	9.18	17.04	73.78

1981

	150157*	63	.253	0.60	6.46	3.75	45.41
	150529*	16	.564	0.76	14.95	39.84	45.21
	151338	26	.455	0.48	4.73	4.40	90.86
	151505	89	.382	0.31	1.63	53.71	44.67
al	152011	92	.336	0.34	1.70	53.12	45.17
	150892	11	.621	0.64	4.14	74.58	21.28