Canadian Housing Price Indices: An Evaluation of Average Price with Robust Measures of Location

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ABSTRACT

The distribution of single family housing prices is not normal. The distribution of housing prices can be expected to be skewed to the right (positive skewness). Yet most research using housing price information is based on average prices which presumes a normal distribution of housing prices. Limited research has been undertaken to assess the stability of the average price data in comparison to other associated measures more commonly linked to non-normal distributions.

The literature review illustrates that investigation of the effects of distribution of housing prices on empirical research and market use has just begun. We learn from Mark and Goldberg [9] and Eger and Farrell [3] that even in annualized data series or in speculative markets from 1980-1983, significant differences of up to 15%-20% exist between reported mean and unreported median prices for a given market.

Data series were constructed from individual sales of housing for Dollard Des Ormeau (suburban city of metro Montreal); Toronto (M.L.S. Toronto Real Estate Board); N. W. Winnipeg (M.L.S. from Winnipeg Real Estate Board; Kerrisdale (neighbourhood in Vancouver) and Richmond (suburban city of metro Vancouver).

Prices were developed for each market based on the average, median, Hampel, trimmed mean and biweight (the latter four being classified as robust measures of location). A difference of means test, using a conservative test of population variance, was then undertaken for each segment of the above series on a monthly and quarterly basis.

The five data series have revealed that significant differences exist between the mean and robust measures of location. As it was not possible to measure any difference between the robust measures themselves (i.e., between the median Hampel, trimmed mean and biweight) the median was compared with the mean in this analysis.

The magnitude of the difference between the mean and median is significant. Even as illustrated in the literature review, with the annualized data, significant differences exist between mean and median. As might be expected, when the data are disaggregated to a quarterly and monthly series, the differences become more and more pronounced, ranging as high (not the extreme cases, but an upper level) as 20%. Most cities exhibited a continual difference of at least 5%-10%.

Finally, as observed in the one case, where outliers are most likely to affect the mean, significant variation is shown in the Kerrisdale segment - small neighbourhood, upper income market. Continual variation of at least 8% is noted, with highs of 20%-24% not uncommon - on a quarterly basis. It can be expected that the monthly series would show even greater fluctuation.

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Additional data were provided by the regional office of C.M.H.C. in Vancouver (Mr. Jim Walker) and in Montreal by Mr. David Hughes and Mr. Gerd Reise of David Hughes and Associates of Montreal.

Ms. Nancy Smith, Research Director for Royal Trust, Toronto, provided data series from their files and provided an insight into the bases of the sample standardization, for their housing price series.

The task of typing and editing the data base was undertaken by a number of individuals who joined in the spirit of cooperation in completing their tasks cheerfully and efficiently. In particular, I wish to thank Ms. Anne Der, Ms. Vija Eger and Ms. Heidi Good for their sustained efforts.

Finally, the University of British Columbia Faculty of Commerce provided excellent computer resources to allow me to complete this first version of a comprehensive housing price index for selected Canadian cities.

As is usual, the errors that remain after this effort are mine. Suggestions for improvements are welcomed.

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1.0 Statement of the Problem

The distribution of single family housing prices is not normal. The distribution of housing prices can be expected to be skewed to the right (positive skewness). Yet most research using housing price information is based on average prices which presumes a normal distribution of housing prices. Limited research has been undertaken to assess the stability of the average price data in comparison to other associated measures more commonly linked to non-normal distributions.

The positive skewness of the housing price distribution results from a number of factors, several of which are discussed briefly below. First, the ownership distribution does not represent the total distribution of housing (lower income households have a higher percentage of rental) than do other income groups. Consequently, the left hand side of the distribution, which would tend to make the distribution normal, is not measured. Second, upper income groups have higher price/income elasticities and spend proportionately more on housing than do other income groups.

Third, the use of the Multiple Listing Service data (a by-product of the sales system) may affect the stability of the price series. The M.L.S. real estate price indices have, until recently, been mean or average based price indices. The ease of collection has allowed this index to be used as a proxy for a market index in the residential real estate market. However, the use of the M.L.S. index is not without some risk of bias or instability.

The M.L.S. index tends to either over or underestimate this bias in relation to a quality adjusted (hedonic) index. This bias

while not constant over time, appears to be directly related to the type of sale mechanism being chosen by the vendors. During periods of economic expansion, the percentage of M.L.S. sales to total existing residential sales decreases. The shift in the reported sales from M.L.S. to non M.L.S. affects the reported price as most of the shift appears to be in the medium and upper priced housing. The reported M.L.S. average price can be expected to decrease because the reported sample is losing a percentage of medium and upper priced housing. Consequently, the reported price of existing housing, using this sample as a proxy for the market, tends to underestimate the actual market price of housing.

During recessionary times, then, the range of housing sold under M.L.S. can be expected to increase (housing normally sold in the exclusive market is placed in the M.L.S. for wider exposure). These additions of highly priced housing at the margin can be expected to strongly influence the central tendency measure, i.e., the average. The reported M.L.S. average will over-estimate the actual market price of housing during these recessionary periods.

Ideally, comparison of the M.L.S. price index with the market should allay such concerns. However, limited research has been undertaken because of the significant cost of obtaining data bases of both the M.L.S. and the market. Indeed, the problem is compounded because the recording areas for M.L.S. are not readily related to the same sample area of a particular housing market. Finally, historical M.L.S. sales data generally are kept at the whim or perseverance of each major board. These collection systems vary from bare essentials (monthly averages only) to a near complete form (individual sales data complete with qualitative data for location and physical attributes).

Another distribution problem is manifesting itself, particularly since the depression of 1981. The housing market is tending to segment. The entire housing market is moving neither up nor down/across all segments at the same time. It is not uncommon to talk to brokers and/or agents and find that upper income segments of the market are moving well (doing poorly) while middle and low income housing, which are more susceptible to expectations about higher (lower) interest rates, are indeed only moving slowly (more rapidly).

1.1 Purpose of the Study

These distributional problems then - that of positive skewness for single family housing as a market; the question of representativeness of the M.L.S. relative to the market; and, finally, the effect of segmentation on measures of central tendency - will form the basis of this study. The purpose of this study is straightforward and modest. First and foremost, the study is intended to derive a series of price indices based on alternative measures (such as the median, trimmed mean) and compare these figures with the average price for a selected number of Canadian cities. Having set the stage with these comparisons, the study then proceeds to analyze the desirability of these alternate measures. The question of M.L.S. representativeness to the market is addressed for one city, where availability of data made such a comparison possible.

In establishing this bench mark, the study then is intended to serve as a basis for future analysis which will look at the critical issues of sample size for segmented housing markets with the existing housing market. This study base can provide a much needed link with the literature on the comparative stability of hedonic based indices in contrast to the market indices as typified by the M.L.S. approach.

2.0 Background Research

2.1 Mean and Median Prices

Review of the literature revealed limited evidence of empirical comparison of averages and non-average measures. Mark and Goldberg [9] evaluate housing price indices for two suburbs of Vancouver on a yearly basis from 1959 to 1979. Their results are tabled below to show the percentage differences for Fraser (medium income neighbourhood) and Kerrisdale (upper income neighbourhood). Kerrisdale, the neighbourhood with the extremely large value sales, shows the greater variation in price when using the median in comparison to the mean. This effect on the index is particularly evident when the market escalates rapidly. Exhibit 2 demonstrates how, for brief periods, the medium varies significantly from the average. (1964-1967; 1974-75; and 1978 in Kerrisdale). The Fraser neighbourhood exhibits negligible differences during the 22 year (annual series) .

Further empirical evidence, based on the monthly frequency distribution of seven Real Estate Boards from 1980-1983 demonstrates the variation of mean and medium prices in exhibits 3 to 9 . Unlike the series of Mark and Goldberg [9], these series are based on monthly figures. As might be expected, seasonal variation, sample size and large value sales can be expected to produce a wider range of variation between the mean and the median than was shown by the Mark and Goldberg study.

The Real Estate Boards of Victoria, Vancouver, Edmonton, Calgary, Hamilton, Toronto and Halifax-Dartmouth (independently) started to report frequency distributions from 1980.

While it is helpful to derive the median prices from the frequency distribution, there are a number of drawbacks presented by this technique. First, not all boards present the distribution figures (in ranges of $10,000 generally). Whereas the aggregate figures are split into three parts, namely, single family residential, single family other, and residential other, the frequency distribution figures represent a total residential. The impact of large values is likely to be found in the residential other and single family residential, yet there is no way to control for these qualitative differences in the distribution provided.

The range of each frequency distribution has, in part, resulted from the escalation of housing prices. For example, at the lower end of the distribution, it is/was common to see intervals of $5,000 ($35,000 - $40,000) which was appropriate when prices were in that range; whereas at the upper end of the scale, intervals of $20,000 or more are recorded. These differences make accurate estimation of the median price, from the frequency distribution, more difficult.

Another common problem associated with these tables is that the statistician did not move quickly enough when the market escalated. In 1980-81, often figures showing more than 50% of the housing frequency were recorded in the uppermost interval and made the task of estimating the median difficult if not impossible. In extreme cases, this author did not calculate the median due to the wide range of possible results. Additionally, the lack of a definitive upper and lower price limit (for those intervals at margin) i.e., minimum and maximum, could cause the median price to vary significantly. This was particularly true when the majority of sales were clustered in the uppermost interval.

Fraser Neighbourhood (Vancouver)

Year	Mean	Median	Difference	% Difference
1957	100.00	100.00	0	0
1958	108.48	110.00	(1.52)	(1.4)
1959	110.01	111.11	(1.10)	(0.9)
1960	122.07	119.04	3.03	2.4
1961	110.67	105.56	5.11	4.6
1962	102.88	100.00	2.88	2.7
1963	102.74	100.00	2.74	2.6
1964	110.56	108.61	1.95	1.7
1965	106.94	105.56	1.38	1.2
1966	122.56	120.00	2.56	2.1
1967	146.66	145.09	1.57	0.7
1968	169.87	170.56	(0.69)	(0.4)
1969	198.67	194.44	4.23	2.1
1970	204.98	205.56	(0.58)	(0.3)
1971	217.88	222.22	(4.34)	(1.9)
1972	245.12	250.00	(4.88)	(1.9)
1973	319.49	316.67	2.82	0.9
1974	459.70	466.67	(6.97)	(1.5)
1975	505.26	500.00	5.26	1.0
1976	548.16	535.56	12.6	2.3
1977	559.88	550.00	9.88	1.8
1978	566.89	550.00	16.89	3.0
1979	605.36	588.89	16.47	2.7

Exhibit 1. Comparison of mean and median prices for Fraser (Vancouver). Source of mean and median data is Mark, J. and Goldberg, M. Alternative Housing Price Indices: An Evaluation. AREUEA Journal. Vol. 12, No. 1, 1984.

Kerrisdale Neighbourhood (Vancouver)

Year	Mean	Median	Difference	% Difference
1957	100.00	100.00	0	0
1958	99.07	98.62	0.45	0.5
1959	120.98	115.52	5.46	4.5
1960	113.21	106.90	6.31	5.6
1961	109.55	106.90	2.65	2.4
1962	108.58	100.00	8.58	7.9
1963	117.83	101.38	16.45	14.0
1964	128.80	103.45	25.35	19.7
1965	134.74	108.97	25.77	19.1
1966	137.21	116.55	20.66	15.0
1967	168.51	144.83	23.68	14.0
1968	205.63	182.76	22.87	11.1
1969	193.23	185.52	7.71	4.0
1970	217.20	200.00	17.20	7.9
1971	244.56	220.69	23.87	9.8
1972	269.73	242.76	26.97	10.0
1973	336.77	289.66	47.11	14.0
1974	453.95	406.90	47.05	16.3
1975	488.12	448.28	39.84	8.2
1976	567.24	517.24	50.00	8.8
1977	567.23	508.97	53.26	9.5
1978	620.11	537.93	82.18	13.2
1979	814.68	758.62	56.06	6.9

Exhibit 2. Comparison of mean and median prices for Kerrisdale (Vancouver). Source of mean and median data is Mark, J. and Goldberg, M. Alternative Housing Price Indices: An Evaluation. AREUEA Journal. Vol. 12, No. 1, 1984.

These measurement problems notwithstanding, exhibits 3 to 9 reveal a number of important results. Exhibit 3 (Victoria) is perhaps typical of medium size boards, where sample size cannot be expected to influence the difference between the mean and the median unduly. Percentage difference between mean and median ranges from .5% (the difference as a percentage of the mean) to 20.7%, with average yearly differences of 6.4% (1981), 8.2% (1982) and 11.0% (1983).

Edmonton tends to show little variation with the mean exceeding the median by 6%-7% for each of the three years 1981-1983. The difference in Calgary is most pronounced in 1980 and 1983, with the difference exceeding 10%.

Vancouver exhibits the most dramatic differences of all seven cities in that differences as large as 23.5% are reported, with the periods 1980-81 and 1983 showing a difference of 13% and 15% respectively.

The percentage difference between the mean and median for Toronto is nearly as high as that of Vancouver (12%-14%), but does not show the same fluctuation as was observed in Vancouver. There appears to be a constant difference in Toronto, whereas in Vancouver, this difference drops to a low base of 6%-8% during more regular markets.

Hamilton reveals some cyclical variance with higher percentage being observed in 1981 and 1983. The average difference is in the 8%-10% range.

Halifax-Dartmouth exhibits some of the problems associated with smaller sampling and non-normal distribution, as variance ranges from 1% - 20%. The average is approximately 8%. Significant variation is observed in 1983.

These exhibits, while not completely comparable, do note that differences between mean and median prices are significant. A host of

EXHIBIT 3 VICTORIA MLS PRICE RANGE 1981

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	203	107,193	n/a	n/a	n/a
Feb.	260	118,234	n/a	n/a	n/a
Mar.	246	126,793	120,491	6,302	4.9
Apr.	342	125,070	124,366	704	0.5
May	219	113,129	120,865	7,736	6.8
Jun.	164	118,887	116,561	2,310	1.9
Jul.	172	138,238	122,092	16,146	11.6
Aug.	143	124,752	123,870	882	0.7
Sep.	132	123,058	113,332	9,726	7.9
Oct.	146	127,684	114,240	10,444	8.1
Nov.	124	106,873	99,564	7,309	6.8
Dec.	158	113,837	96,153	17,684	15.5

EXHIBIT 3 VICTORIA MLS PRICE RANGE 1982

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	149	112,333	105,757	6,576	5.8
Feb.	186	108,618	100,467	8,151	7.5
Mar.	191	106,017	99,614	6,403	6.0
Apr.	116	101,214	88,999	12,215	12.0
May	161	105,039	99,165	5,874	5.5
Jun.	150	96,164	91,199	4,965	5.1
Jul.	208	99,102	87,173	11,929	12.0
Aug.	223	94,948	85,512	9,436	9.9
Sep.	326	96,997	84,582	12,415	12.7
Oct.	308	89,131	84,236	5,895	5.4
Nov.	353	89,643	81,370	8,273	9.2
Dec.	236	89,382	82,790	6,592	7.3

EXHIBIT 3 VICTORIA MLS PRICE RANGE 1983

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	269	95,966	87,699	8,267	8.6
Feb.	321	100,958	89,081	11,876	11.7
Mar.	333	110,943	87,964	22,979	20.7
Apr.	317	94,585	84,659	9,926	10.5
May	348	92,722	86,285	6,437	6.9
Jun.	377	98,161	86,745	11,416	11.6
Jul.	312	93,360	82,916	10,444	11.2
Aug.	326	97,216	84,565	12,650	13.0
Sep.	336	99,122	86,956	12,166	12.3
Oct.	228	89,746	84,516	5,229	5.8
Nov.	247	91,324	85,972	5,352	5.8
Dec.	225	99,071	84,891	14,180	14.3

EXHIBIT 4.1 VANCOUVER MLS PRICE RANGE 1979

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	498	70,676	64,022	6,654	9.4
Feb.	622	70,169	63,799	6,370	9.0
Mar.	887	77,864	62,617	5,247	7.7
Apr.	871	68,011	62,313	5,658	8.3
May	1,074	70,345	62,840	7,505	10.6
Jun.	1,057	70,650	62,954	7,696	10.8
Jul.	1,039	71,386	63,154	8,232	11.5
Aug.	2,019	74,256	63,423	10,833	14.5
Sep.	885	69,478	63,304	5,974	8.6
Oct.	905	75,639	63,422	12,217	16.1
Nov.	716	79,265	63,362	5,903	8.5
Dec.	487	73,636	63,385	10,251	13.9

EXHIBIT 4.1 VANCOUVER MLS PRICE RANGE 1980

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	750	75,501	66,105	9,296	12.4
Feb.	1,056	77,839	67,954	9,885	12.6
Mar.	828	78,709	68,701	10,008	12.7
Apr.	663	81,924	68,838	13,086	15.9
May	800	85,335	70,406	14,929	17.4
Jun.	1,096	92,567	73,268	19,299	20.8
Jul.	1,287	96,767	76,344	20,423	21.1
Aug.	1,169	103,132	78,883	24,249	23.5
Sep.	1,210	107,960	93,388	14,572	13.5
Oct.	1,065	123,018	118,818	9,200	7.4
Nov.	767	131,982	126,895	5,087	3.9
Dec.	578	152,870	141,100	11,770	7.7

EXHIBIT 4.2 VANCOUVER MLS PRICE RANGE 1981

DATE	SALES	MEAN	MEDIUM	$ DIFF.	% DIFF.
Jan.	589	157,441	n/a	n/a	n/a
Feb.	622	160,520	n/a	n/a	n/a
Mar.	647	151,834	n/a	n/a	n/a
Apr.	615	162,431	n/a	n/a	n/a
May	516	160,959	n/a	n/a	n/a
Jun.	470	159,546	n/a	n/a	n/a
Jul.	436	153,495	n/a	n/a	n/a
Aug.	332	137,792	n/a	n/a	n/a
Sep.	460	141,560	121,882	19,670	13.9
Oct.	432	130,789	117,234	13,554	10.4
Nov.	571	127,426	115,172	12,253	9.6
Dec.	585	133,834	119,444	14,389	10.8

EXHIBIT 4.2 VANCOUVER MLS PRICE RANGE 1982

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	515	122,700	112,375	10,325	8.4
Feb.	675	117,549	110,085	7,464	6.3
Mar.	689	119,738	109,418	10,320	8.6
Apr.	638	117,881	108,972	8,909	7.5
May	779	114,876	107,380	7,496	6.5
Jun.	785	110,184	108,757	1,427	1.2
Jul.	755	105,433	104,626	807	0.7
Aug.	875	101,815	102,450	635	0.6
Sep.	1,236	103,949	100,919	3,030	2.9
Oct.	1,572	102,511	99,218	3,293	3.2
Nov.	1,870	103,101	98,028	5,073	4.9
Dec.	1,285	103,086	97,317	5,769	5.5

EXHIBIT 4.2 VANCOUVER MLS PRICE RANGE 1983

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	830	110,531	95,697	14,833	13.5
Feb.	1,210	115,174	97,863	17,310	15.1
Mar.	1,580	111,943	98,588	13,355	11.9
Apr.	1,278	115,167	112,130	3,763	3.3
May	n/a	n/a	n/a	n/a	n/a
Jun.	1,339	121,430	102,067	19,363	16.0
Jul.	1,160	119,465	102,436	17,029	14.3
Aug.	1,190	118,289	96,917	21,371	18.1
Sep.	1,033	118,207	97,358	20,849	17.6
Oct.	1,020	116,110	97,521	18,589	16.0
Nov.	1,107	117,104	97,460	19,643	16.8
Dec.	943	110,705	97,737	n/a	n/a

EXHIBIT 5.1 CALGARY MLS PRICE RANGE 1980

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	866	88,081	78,341	9,740	11.0
Feb.	1,020	89,954	79,135	10,819	12.0
Mar.	1,000	87,588	75,573	12,015	13.7
Apr.	761	93,958	78,925	15,033	16.0
May	862	92,472	79,911	12,561	13.5
Jun.	967	95,526	n/a	n/a	n/a
Jul.	1,109	94,639	n/a	n/a	n/a
Aug.	1,077	96,451	n/a	n/a	n/a
Sep.	1,112	99,538	n/a	n/a	n/a
Oct.	1,255	97,160	n/a	n/a	n/a
Nov.	894	92,252	n/a	n/a	n/a
Dec.	676	98,964	n/a	n/a	n/a

EXHIBIT 5.1 CALGARY MLS PRICE RANGE 1981

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	954	99,295	83,703	3,703	4.2
Feb.	1,069	106,824	91,214	15,610	14.6
Mar.	1,041	106,273	97,310	8,963	8.4
Apr.	1,090	107,744	97,486	10,258	9.5
May	1,042	110,955	100,496	10,459	9.4
Jun.	910	109,065	99,571	9,494	8.7
Jul.	792	110,701	100,937	9,764	8.8
Aug.	614	112,344	100,030	12,314	10.9
Sep.	635	110,544	105,632	4,912	4.4
Oct.	567	106,921	99,990	6,931	6.4
Nov.	621	106,312	102,432	3,880	3.6
Dec.	589	105,523	100,384	5,139	4.8

EXHIBIT 5.2 CALGARY MLS PRICE RANGE 1982

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	513	110,188	107,142	3,046	2.8
Feb.	612	106,180	102,251	3,929	3.7
Mar.	643	106,799	112,486	5,687	5.3
Apr.	470	109,141	102,702	6,439	5.9
May	408	110,093	101,747	8,346	7.5
Jun.	290	108,955	103,438	5,517	5.1
Jul.	266	107,119	98,462	8,657	8.3
Aug.	301	107,090	102,950	4,140	3.9
Sep.	625	105,918	98,019	7,899	7.5
Oct.	540	102,108	94,111	7,997	7.8
Nov.	526	103,647	95,500	8,147	7.8
Dec.	383	99,119	91,521	7,598	7.6

EXHIBIT 5.2 CALGARY MLS PRICE RANGE 1983

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	487	104,450	91,599	12,851	14.0
Feb.	592	103,720	92,869	10,851	10.5
Mar.	674	102,947	92,337	10,610	10.3
Apr.	621	101,424	92,035	9,389	9.3
May	596	99,644	98,276	10,368	10.4
Jun.	696	101,838	90,949	10,889	10.7
Jul.	578	99,156	88,865	10,291	10.4
Aug.	672	97,668	90,102	7,566	7.7
Sep.	640	95,331	85,752	9,579	10.1
Oct.	519	95,511	87,465	8,046	8.4
Nov.	532	90,444	83,433	7,011	7.7
Dec.	358	88,102	79,602	8,500	9.6

EXHIBIT 6 EDMONTON MLS PRICE RANGE 1981

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	459	88,818	n/a	n/a	n/a
Feb.	555	91,476	n/a	n/a	n/a
Mar.	767	89,301	n/a	n/a	n/a
Apr.	806	94,222	n/a	n/a	n/a
May	804	90,429	n/a	n/a	n/a
Jun.	802	91,729	n/a	n/a	n/a
Jul.	608	92,677	85,052	7,625	8.2
Aug.	644	91,092	86,788	4,304	4.7
Sep.	621	91,805	86,530	5,275	5.7
Oct.	538	92,730	83,783	8,947	10.0
Nov.	522	89,052	83,333	5,719	6.4
Dec.	450	92,979	87,215	5,764	6.2

EXHIBIT 6 EDMONTON MLS PRICE RANGE 1982

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	358	90,947	86,000	4,947	5.4
Feb.	416	94,573	87,192	7,381	7.8
Mar.	502	95,505	86,941	4,564	8.9
Apr.	344	89,289	84,912	4,377	4.9
May	367	95,102	86,727	8,375	8.8
Jun.	412	95,435	87,647	7,788	8.2
Jul.	366	92,275	85,967	6,308	6.8
Aug.	373	90,931	84,393	6,538	7.2
Sep.	482	92,814	85,130	7,684	8.2
Oct.	489	89,046	83,608	5,438	6.1
Nov.	503	86,171	82,421	3,750	4.3
Dec.	387	88,936	82,982	5,954	6.7

EXHIBIT 6 EDMONTON MLS PRICE RANGE 1983

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	334	81,618	79,999	4,619	5.5
Feb.	396	87,733	81,492	6,241	7.1
Mar.	530	88,212	81,398	2,814	7.7
Apr.	471	89,406	82,573	6,833	7.6
May	563	86,068	80,573	5,495	6.4
Jun.	566	86,921	79,999	6,922	8.0
Jul.	469	85,587	81,436	4,151	4.9
Aug.	633	85,767	80,233	5,534	6.5
Sep.	533	84,226	79,426	4,800	5.7
Oct.	413	82,441	76,874	5,567	6.8
Nov.	487	85,901	78,258	7,643	8.9
Dec.	339	80,271	76,292	3,979	5.0

EXHIBIT 7.1 TORONTO MLS PRICE RANGE 1980

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	1,406	71,865	65,260	6,605	9.1
Feb.	2,088	83,950	65,725	8,225	11.1
Mar.	1,850	72,504	65,470	7,034	9.7
Apr.	1,789	73,923	65,587	8,336	11.2
May	2,005	77,104	68,357	8,747	11.3
Jun.	2,078	77,373	67,745	9,628	12.4
Jul.	2,398	76,793	67,852	8,941	11.6
Aug.	2,540	75,997	67,152	8,845	11.6
Sep.	2,670	76,049	66,643	9,406	12.3
Oct.	2,805	76,125	66,949	9,176	12.0
Nov.	2,423	77,275	67,226	10,049	13.0
Dec.	1,964	75,930	65,283	10,647	14.0

EXHIBIT 7.1 TORONTO MLS PRICE RANGE 1981

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	2,148	77,288	67,986	9,302	12.0
Feb.	2,300	78,877	66,913	11,964	15.1
Mar.	3,504	81,217	70,377	10,840	13.3
Apr.	4,737	87,534	75,896	11,638	13.2
May	2,951	93,175	78,978	14,197	15.2
Jun.	1,621	100,323	83,566	16,757	16.7
Jul.	1,841	103,946	n/a	n/a	n/a
Aug.	1,553	100,005	85,168	14,837	14.8
Sep.	1,571	96,551	n/a	n/a	n/a
Oct.	1,801	97,536	84,274	13,262	13.5
Nov.	1,762	100,080	86,799	13,281	13.2
Dec.	1,599	98,554	85,570	12,984	13.1

EXHIBIT 7.2 TORONTO MLS PRICE RANGE 1982

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	1,508	97,235	84,062	13,173	13.5
Feb.	1,941	96,624	84,136	12,488	12.9
Mar.	2,124	95,032	82,682	12,350	13.0
Apr.	2,034	94,050	82,350	11,700	12.4
May	1,897	96,354	82,957	13,427	13.9
Jun.	1,985	98,347	84,613	13,734	13.9
Jul.	1,793	94,436	82,063	12,373	13.1
Aug.	1,956	95,060	82,292	12,768	13.4
Sep.	2,456	92,470	80,508	11,962	12.9
Oct.	2,546	94,689	81,423	•13,266	14.0
Nov.	2,720	97,817	82,824	14,992	15.3
Dec.	2,376	94,523	80,861	13,662	14.4

EXHIBIT 7.2 TORONTO MLS PRICE RANGE 1983

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	1,902	96,924	83,429	13,495	13.9
Feb.	2,203	106,191	88,983	17,208	16.2
Mar.	3,236	102,806	86,949	15,857	15.4
Apr.	2,990	101,686	87,918	13,768	13.5
May	2,856	104,644	88,793	15,851	15.1
Jun.	2,917	102,639	87,413	15,226	14.8
Jul.	2,367	104,683	87,835	17,028	16.3
Aug.	2,308	99,667	85,643	14,024	14.1
Sep.	2,453	99,112	84,843	14,269	14.4
Oct.	2,328	100,470	85,502	14,969	14.9
Nov.	2,436	101,176	86,286	14,890	14.7
Dec.	2,049	100,102	86,307	13,795	13.8

EXHIBIT 8.1 HAMILTON MLS PRICE RANGE 1980

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	319	55,800	n/a	n/a	n/a
Feb.	488	54,607	50,526	4,081	7.4
Mar.	509	54,516	51,893	2,623	4.8
Apr.	542	55,524	52,040	3,484	6.2
May	462	58,577	55,171	3,406	5.8
Jun.	565	52,638	50,690	1,948	3.7
Jul.	626	54,255	50,725	3,530	6.5
Aug.	508	55,191	50,943	4,248	7.6
Sep.	555	55,018	52,333	2,685	4.8
Oct.	582	56,272	52,135	4,157	7.3
Nov.	514	53,791	52,181	1,610	2.9
Dec.	368	51,549	48,713	2,836	5.5

EXHIBIT 8.1 HAMILTON MLS PRICE RANGE 1981

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	317	53,930	50,660	3,270	6.0
Feb.	530	57,779	53,488	4,291	7.4
Mar.	729	56,427	52,261	4,166	7.3
Apr.	995	60,017	56,027	3,990	6.6
May	947	58,655	52,909	5,746	9.7
Jun.	602	57,363	49,999	7,364	12.8
Jul.	509	59,070	54,224	4,846	8.2
Aug.	432	58,627	52,384	6,243	10.6
Sep.	424	58,108	56,031	2,077	3.5
Oct.	416	61,371	57,114	4,257	6.9
Nov.	322	62,639	53,749	8,890	14.2
Dec.	352	63,834	53,957	9,877	15.4

EXHIBIT 8.2 HAMILTON MLS PRICE RANGE 1982

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	329	57,366	53,408	3,958	6.8
Feb.	460	59,118	53,484	5,634	9.5
Mar.	529	58,869	52,697	6,172	10.4
Apr.	609	58,193	54,119	4,074	7.0
May	545	56,871	54,201	2,670	4.6
Jun.	518	58,451	53,610	4,841	8.2
Jul.	473	57,859	53,388	4,471	7.7
Aug.	469	57,081	53,966	3,115	5.4
Sep.	508	62,418	58,394	4,024	6.4
Oct.	530	57,608	54,148	3,460	6.0
Nov.	522	59,936	55,566	4,370	7.2
Dec.	556	59,727	53,194	6,533	10.9

EXHIBIT 8.2 HAMILTON MLS PRICE RANGE 1983

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	415	61,734	55,642	6,092	9.9
Feb.	450	67,966	n/a	n/a	n/a
Mar.	857	64,316	n/a	n/a	n/a
Apr.	749	65,232	58,795	6,437	9.9
May	834	66,024	59,926	6,098	9.3
Jun.	908	63,508	57,866	5,642	8.9
Jul.	694	64,245	58,287	5,958	9.3
Aug.	777	63,101	57,731	5,370	8.5
Sep.	n/a	n/a	n/a	n/a	n/a
Oct.	651	61,530	55,144	6,386	10.4
Nov.	688	65,735	59,090	6,645	10.1
Dec.	430	62,373	56,164	6,209	10.0

EXHIBIT 9.1 HALIFAX-DARTMOUTH MLS PRICE RANGE 1980

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	45	46,512	45,416	1,096	2.3
Feb.	123	56,354	49,837	6,517	11.5
Mar.	133	55,886	44,658	11,228	20.0
Apr.	160	56,553	47,799	8,754	15.4
May	75	60,713	57,352	3,361	5.5
Jun.	45	50,410	49,499	911	1.8
Jul.	188	54,744	53,599	1,145	2.0
Aug.	265	54,910	51,271	3,639	6.6
Sep.	194	41,821	47,399	n/a	n/a
Oct.	139	54,618	49,837	4,781	11.4
Nov.	110	51,406	50,689	717	1.3
Dec.	127	53,092	47,926	5,166	9.7

EXHIBIT 9.1 HALIFAX-DARTMOUTH MLS PRICE RANGE 1981

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	79	54,585	48,808	5,777	10.5
Feb.	77	52,777	48,599	4,178	7.9
Mar.	96	54,774	52,777	1,997	3.6
Apr.	111	55,966	52,031	3,875	6.9
May	125	53,603	49,633	3,970	7.4
Jun.	239	59,499	55,299	4,200	7.0
Jul.	218	60,802	56,363	5,539	7.3
Aug.	186	65,645	58,936	6,710	10.2
Sep.	183	66,413	58,749	7,664	11.5
Oct.	145	61,815	58,808	3,007	4.8
Nov.	133	54,942	52,419	2,523	4.5
Dec.	113	58,127	55,399	2,728	4.6

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EXHIBIT 9.2 HALIFAX-DARTMOUTH MLS PRICE RANGE 1982

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	92	60,108	54,999	5,109	8.5
Feb.	72	68,596	57,499	11,097	16.1
Mar.	107	64,579	58,249	6,330	9.8
Apr.	129	51,817	52,407	n/a	n/a
May	130	59,476	54,999	4,477	7.5
Jun.	201	62,562	58,368	4,194	6.7
Jul.	210	64,190	58,022	6,168	9.6
Aug.	197	61,047	57,244	3,803	6.2
Sep.	185	64,960	59,867	5,093	7.8
Oct.	128	61,272	56,128	5,144	8.3
Nov.	272	59,744	57,114	2,630	4.4
Dec.	201	64,061	60,121	3,940	6.1

EXHIBIT 9.2 HALIFAX-DARTMOUTH MLS PRICE RANGE 1983

DATE	SALES	MEAN	MEDIAN	$ DIFF.	% DIFF.
Jan.	162	66,065	60,400	5,665	8.6
Feb.	96	63,863	60,556	3,307	5.2
Mar.	198	67,147	61,515	5,632	8.4
Apr.	181	66,342	58,242	8,100	12.2
May	26	71,679	66,666	5,013	7.0
Jun.	42	67,679	62,989	4,690	6.9
Jul.	329	73,416	67,318	6,098	8.3
Aug.	311	75,921	67,765	8,156	10.7
Sep.	305	72,893	66,489	6,404	8.8
Oct.	243	69,698	66,416	3,282	4.7
Nov.	160	69,970	67,666	4,303	6.2
Dec.	216	71,560	65,714	5,847	8.2

sampling factors may affect these differences. At the basic measurement level, designation of upper and lower limits of frequency distribution, changes of the frequency distribution within a given city's series, and changes in the proportion of single family residence relative to the total residential, are the most ~~most~~ likely reasons.

Second, sample problems due to seasonal variation in sales of housing, and shifts to and from the M.L.S. market account for another set of differences. Finally, shifts within the M.L.S., i.e., strong sales for upper income housing while other ranges remain less active, account for other variations.

Given these variations, the creation of housing prices from individual sales seemed most realistic (and is reported in the body of this study) as the problems of changes in frequency distribution within a time series, market shifts within an area could be identified and seasonality could be examined. Problems of classification of unique single family housing series remain unresolved - other than identification of neighbourhood which will serve as a proxy for housing type in future studies.

2.2 Market Mean and M.L.S. Mean

Direct studies of a residential index and M.L.S. index has been undertaken for selected or quarterly data in the city of Vancouver from 1970 to 1975 by Hamilton [6]. In using both the mean and median measures, Hamilton found that the market mean and M.L.S. mean varied as much as 18.2% whereas there was a difference of as much as 19.3% between the market median and the M.L.S. median.

Table X
Mean $ MLS/Mean $ Market by Area by Period

Period/ Area	3rd Quarter 1970	1st Quarter 1971	3rd Quarter 1971	2nd Quarter 1972	3rd Quarter 1973	3rd Quarter 1974	3rd Quarter 1975
Vancouver West	29,954/32,048 93.5%	30,250/30,786 98.3%	32,319/34,330 94.1%	45,016/43,509 103.5%	48,500/53,900 89.9%	68,000/69,600 97.6%	72,600/68,200 106.5%
Vancouver East	19,560/20,256 96.6%	20,156/20,796 96.9%	21,769/21,390 101.8%	30,378/30,380 100%	35,100/39,100 89.7%	46,700/47,300 98.7%	51,100/52,100 98.3%
West Vancouver	43,551/42,346 102.8%	43,871/39,535 111.0%	41,909/41,335 101.4%	60,036/52,302 114.8%	61,000/66,300 92.2%	93,400/86,800 107.6%	98,000/92,000 106.5%
North Vancouver	28,352/27,084 104.7%	26,888/27,482 97.8%	28,658/29,634 96.7%	30,818/38,326 80.4%	47,700/46,700 102.2%	60,000/61,400 97.8%	65,200/60,400 107.9%
Overall	25,835/27,252 94.8%	26,088/26,327 99.1%	27,110/28,440 95.3%	34,511/37,914 91.0%	41,900/47,800 87.7%	58,700/61,100 96.2%	64,900/62600 103.6%

Median $ MLS/Median $ Market by Area by Period

Period/ Area	3rd Quarter 1970	1st Quarter 1971	3rd Quarter 1971	2nd Quarter 1972	3rd Quarter 1973	3rd Quarter 1974	3rd Quarter 1975
Vancouver West	28,500/28,500 100.0%	26,900/27,500 97.8%	29,000/31,000 93.5%	43,000/40,000 107.5%	45,000/46,500 96.8%	60,000/62,000 96.8%	65,000/62,900 103.3%
Vancouver East	18,500/18,500 100.0%	19,500/19,000 102.6%	21,000/20,000 105.0%	29,250/28,500 102.6%	33,300/35,000 95%	43,000/43,900 97.9%	49,000/48,400 101.2%
West Vancouver	40,000/40,000 100.0%	40,000/36,000 111.1%	41,350/40,000 103.4%	61,000/49,900 122.2%	57,000/61,500 92.7%	84,000/75,000 112%	91,000/85,000 107.1%
North Vancouver	26,500/26,600 99.6%	26,650/28,000 95.2%	27,500/29,000 94.8%	41,500/38,000 109.2%	47,000/44,500 105.6%	60,500/57,000 106.1%	64,500/58,500 110.3%

Exhibit 10. Mean and Medium Housing Prices for Vancouver 1970-1975. Source of data is from Hamilton, S. Housing Price Indices: Theory and Practice, Vol. II. Technical Report, Vancouver, B.C. Faculty of Commerce, University of British Columbia. 1976, pp. 383-417.

Indirect evidence of the representativeness of the median as opposed to the mean price can be found by analyzing the above exhibit. Strength to this statement can be seen if we examine the relationship of the median M.L.S. to the median market price. In the seven quarters reported, the median M.L.S. was 102.5% representative of the median market price (but with a range from 93.5% to 122.2%), whereas the mean M.L.S. was 95.4% representative of the mean market and has a much wider range of variation (from 80.4% to 114%). The mean M.L.S. price appears to underestimate the mean market price whereas the median M.L.S. price approximates the median market price (and has less variability).

For purposes of comparison to the finding of Mark and Goldberg, a comparison of mean and median M.L.S. prices was derived from the Hamilton survey. Exhibit 11 demonstrates that the higher valued areas have greater variability (between the mean and median). These results are similar to Mark and Goldberg. Vancouver West and West Vancouver show the greater differences of 7% - 11%. However, the differences are not constant. This suggests that all segments of housing prices do not move in conjunction with each other.

	3rd quarter 1970	1st quarter 1971	3rd quarter 1971	2nd quarter 1972	3rd quarter 1973	3rd quarter 1974	3rd quarter 1975
Vancouver West							
Mean	29,954	30,250	32,319	45,016	48,500	68,000	72,600
Median	28,500	26,900	29,000	43,000	45,000	60,000	65,000
Difference	1,454	3,350	3,319	2,016	3,500	8,000	7,600
% Difference	4.8	11.1	10.3	4.5	7.2	11.8	10.5
Vancouver East							
Mean	19,560	20,156	21,769	30,378	35,100	46,700	51,100
Median	18,500	19,500	21,000	29,250	33,300	43,000	49,000
Difference	1,060	656	769	1,128	1,800	3,700	2,100
% Difference	5.4	3.3	3.5	3.7	5.1	7.9	4.1
West Vancouver							
Mean	43,551	43,871	41,909	60,036	61,000	93,400	98,000
Median	40,000	40,000	41,350	61,000	57,000	84,000	91,000
Difference	3,551	3,871	559	(964)	4,000	9,400	7,000
% Difference	8.2	8.8	1.3	(1.6)	6.6	0.06	7.1
North Vancouver							
Mean	28,352	26,888	28,658	N.A.	47,700	60,000	62,500
Median	26,500	26,650	27,500	N.A.	47,000	60,500	64,500
Difference	1,852	230	1,158	N.A.	700	(500)	(2,000)
% Difference	6.5	0.9	4.0	N.A.	1.5	(0.8)	(3.2)

Exhibit 11. Comparison of mean and median prices for Vancouver 1970-75.

2.3 Measurement Problems of Previous Research

If, in this era of restricted research funds, a choice has to be made between the inexpensive, broadly based M.L.S. and the expensive, characteristic specific hedonic price approach, it is appropriate to try and identify the source of bias and the magnitude of that bias, between the two measurement techniques. The problem is not one merely of academic interest, from a measurement viewpoint, but has scientific ramification for conclusions and methodology of studies previously undertaken [4], [3].

For example, when the M.L.S. is used as a proxy for a mean based price index, and then compared to a hedonic approach, conflicting results are observed. Palmquist [12] concludes that the rate of increase in housing prices was substantially lower using the hedonic and repeat sale techniques, in comparison to the mean based or non quality adjusted rate of change in the average selling price. Ferri [4] demonstrated conflicting results. During the late 1960's, the mean based index underestimated the hedonic index, whereas in 1971 and again by 1974, the mean based approach over-estimated the hedonic index.

Secondly, Ferri [4] noted that the mean based index is much more volatile, whereas the hedonic price index preserves the trend and moderates the sharp increases of the M.L.S. (mean based index).

Aside from the fact that this volatility not only creates measurement problems, unnecessary uncertainty is possibly thrust on the end users of this price series. Many home purchasers are uncertain about the nuances of real estate financing. With the volatility of a mean based index, undue speculation may occur by these purchasers, who are investing in the largest purchase of their lifetime.

Testing the alternate forms of hedonic equations can be complicated by the presence of biased M.L.S. indices. Palmquist [12] had difficulty in selecting the correct functional form of the interacting demand and supply characteristics of his hedonic equations. Choosing his functional form, based on empirical results, may have been complicated by the use of the (Seattle) M.L.S. price index (1962-1976). Observed housing prices did not reflect the high percentage of vendor sales and mortgage discount prevalent in the Seattle housing market in the mid 1970's. This upward bias in the M.L.S. index could have consequently affected the empirical results of the hedonic equations. The final selection of the correct (hedonic) functional form could be jeopardized by the M.L.S. index itself.

2.4 Comparative Price Indices

Two broad approaches exist in recording prices of Canadian housing. Statistics Canada produces a new home price index for major metropolitan areas (and national). These figures are obtained by consulting with developers as to market prices for existing housing. Price indices do not include the value of land.

This series is based on new housing, which can be qualitatively and locationally different from existing housing. Additionally, turnover in the existing market generally surpasses that of the new housing. Consequently, this index has a use for the type of the market from which it was derived. It must also be noted that this price is an average price.

The existing market is measured currently by several techniques. The M.L.S. price index, which originally was based on all types of property sold under M.L.S., had been refined to the point that residential property is

Two approaches are used by Royal Trust: an appraiser is asked to identify a particular house and quote the monthly changes in the price of that house; or the appraiser (or sometimes the local trust agent) is asked to determine the average price of a mythical house in the neighbourhood. These approaches are valuable in that location, size of house, size of lot, (which are important determinants of housing prices) are held constant. Housing is appraised as if free and clear of mortgages (this would contrast sharply with the M.L.S./Teela approaches where the prices would reflect the financing).

The qualitative trust approach has an additional advantage in that the market is segmented into several types, depending on the local type of construction - a 1 storey 3 bedroom, a 2 storey 3 bedroom, a mid-range condominium, and a luxury condominium.

The significant differences between the four indices are outlined below. In the market price indices there are three main series: Statistics Canada - new housing; M.L.S. existing residential; and Teela (all real estate, new and existing). In the appraised value price index approach, Royal Trust survey, with the longest and most complete series, measures the segmented housing market. The following exhibit (12) is meant to be a general guide only, showing data sources, degree of coverage (by region and time), market segment and availability to end uses as well as location estimate of price. Reference is made to the treatment of financing, because of the special impact financing has on price. No attempt is made to document the current computerized systems in use in the major boards since 1982, as this is far beyond the scope of this study.

	Data Source	Data Base	Market Segment in each C.M.A.	Treatment of financing	Availability to users	Location Measure of price
Market derived price index	Statistics Canada	Monthly for all CMA's in Canada since 1960's.	NHA single family; new housing series.	Included in price (land price excluded).	Readily available from Stats. Can. on a monthly basis.	Average
	M.L.S. boards & national bureau.	Monthly since 1960's but segmented on residential/ non res. since early 1970's. All major CMAs in Canada.	Residential/ non residential in aggregated; existing housing series.	Included in price.	Published monthly on an aggregated CMA basis. (Internal figures with greater local precision available to members).	Average reported nationally. Some boards now use quartiles and median.
	Teela	Monthly since 1960's Montreal Toronto Vancouver	All real estate transactions; new & existing on an individual street address.	Included in price but able to distinguish financing.	Available generally only to subscribers, i.e., appraisers, brokers, etc.	Individual prices can be aggregated. Rarely done.
Appraised Value Price Index	Royal Trust national bureau	Quarterly, since 1975 to present for selected Canadian cities.	Segmented by 2 or 4 types of housing by selected neighbourhood; existing housing series.	Appraised as if free and clear of financing.	Available from published monthly financial statements.	Average price.

Exhibit 12. Overview of Comparative Price Indices in Canada (1984).

split into 3 categories - single family house, single family other, and residential other (on an aggregated C.M.A. basis). Distribution of housing as reported by the 6-8 larger boards remains a distribution of the total residential. A few boards have refined their market segments on a very precise basis so that it would be possible to use some of these segmented markets as comparable data bases to those of the constant quality indices (as developed by the trust companies). However, many segments of a given city area need to be refined to the point that they are more representative of given neighbourhoods. Additionally, boards are encouraged, once their data base is computerized, to keep historical records of their sales. A major deficiency in this study of developing historical series is that only summary figures were available. In some cases prices had to be reconstructed from the given frequency distributions.

In comparison to the M.L.S. index, Teela records exist for several Candian C.M.A.'s (notably Montreal, Toronto and Vancouver). While this information covers the entire market in real estate transactions, it is not possible to qualitatively deduce whether or not a particular transaction is a house, office, or residential building. Consequently, while the Teela records may be more representative, they suffer in that it is not possible to delineate type of real estate. Given a computerized index of street addresses, it would be possible to create a segmented index for real estate and, with some classification system as to type of property, this index could be used to compare to a segmented M.L.S. index.

The qualitative housing index used by the trust companies - notably Royal Trust since 1975 and recently (1982) Canada Permanent Trust, identifies particular housing in a given neighbourhood for the bases of market prices.

2.5 Research Overview

The literature review has illustrated a number of salient facts. First, investigation of the nature of the distribution of housing prices has only begun. We learn from Mark and Goldberg [9] and Eger and Farrell [3], as well as from the limited empirical evidence available, that there are significant differences between the mean and the median, even on annualized data (Mark and Goldberg); and on the evidence of the monthly data collected by a number of the major boards from 1980 to 1983.

We learn that the M.L.S. may be representative of the market, in some areas (Hamilton [6]). But these are not precise enough indices or answers.

We must begin to determine how M.L.S. can best be applied either as a representative index of the market (as it is now used) or as a series of segmented indices, comparable to those used by the Trust companies or the more quality controlled hedonic indices.

The demand for accurate housing statistics is increasing. No longer can we expect to rely on specialized housing price indices (N.H.A. new single family) as a proxy for the existing market. No longer is the homeowner satisfied with such average figures as the very fabric of our cities is changing. The market is becoming more and more segmented as buyers try to capitalize on location. The agent/broker in the market must be prepared to meet this demand. A segmented price index will meet this demand. Indeed accurate measurement of the sales price of existing housing may help create a more accurate Consumer Price Index for housing.

3.0 Robust and Resistant Measures of Scale

> "Resistance is a property we like summary statistics to have. If changing a small part of a body of data, perhaps drastically, can change the value of the summary substantially, the summary is not resistant.
>
> Conversely, if a change of a small part of the data, no matter what part or how substantially, fails to change the summary substantially, the summary is said to be resistant."

3.1 Arithmetic Mean and Median

The arithmetic mean is an example of a non-resistant summary. It is known that the population mean is not always a good measure of the centre of a frequency distribution because it can be pulled away from the main concentration of frequency (the intuitively reasonable region for the distributional centre) by a small amount of frequency that is attached to large values. A purely statistical criticism of the population mean in such cases is that the statistical properties of its best estimator, the sample mean $\bar{X}$, deteriorate disastrously in the presence of outliers. The usual confidence interval for based on $\bar{X}$ and Student's t distribution is extremely conservative.

If there is a series of housing prices with the following frequencies:

Set A		Set B	
frequency	price	frequency	price
2	30,000	2	30,000
3	50,000	3	50,000
2	70,000	2	70,000
		2	90,000

the average for set A is \$50,000 and the median is \$50,000. However, if two additional higher priced houses are added to the sample as in set B, the average is influenced strongly by the new housing values. Set B now has a mean of \$58,888 and the median remains at \$50,000.

The mean is non-resistant and the median is a prototype of a simple resistant measure. Changes do not affect the median. Clearly the median is resistant.

3.2 Robust and Efficient Measures: Hampel and Biweight

Other kinds of summaries are also resistant (those used in this study) namely, the Hampel, the trimmed mean and the biweight, in addition to the previously mentioned median. The Hampel and biweight are calculated by iteration as in the following example of the definition of the biweight (y^*). Iteration is required because we must know the w's before computing y^* and it is not possible to compute the w's until we know y^*.

Mosteller and Tukey [11] note the formula for the biweight as follows:

$$y^* = \frac{\Sigma w_i y_i}{\Sigma w_i}$$

where

$$w_i = \begin{cases} \left(1 - \left(\frac{y_i - y^*}{cS}\right)^2\right)^2 & \text{when } \left(\frac{y_i - y^*}{cS}\right)^2 < 1, \\ 0 & \text{otherwise,} \end{cases}$$

and $S = \text{median}\{|y_i - y^*|\}$

or, perhaps, $S = \frac{1}{2}(\text{spread between hinges})$,

and $C = \text{constant (either 6 or 9)}$

> "It may help to think of S as estimating roughly $2/3\,\sigma$, so that, with C = 6, we allow the residuals to count up to about $4\,\sigma$, where the spread is being measured more by the middle observations, than by the large ones." [4]

3.3 Trimmed Mean

If the statistical difficulties with the estimation of the population mean can be used to guide the selection of a different parameter to measure location, why not choose an estimator for the projected good statistical properties, and then use the mean of its sampling distribution as the location parameter? This procedure should not only solve the estimation problem but should also lead to a location measure closer to the intuitive centre of the distribution. (One such estimator is the sample median, which estimates the corresponding population median. Unfortunately, its small-sample statistical properties are not well understood.) A promising alternative is the trimmed mean.

The trimmed mean $\bar{X}_T$ defines the population trimmed mean μ_T as the location measure. The 10% population trimmed mean, for example, would be obtained by trimming the upper and lower 10% of the measurements in the population and forming the ordinary mean of the rest. For a long-tailed distribution this parameter will be a reasonable measure of location and will also be a good parameter for measuring shifts in location for comparison problems. The following discussion of the trimmed mean is drawn from Koopmans [8].

3.4 Descriptive Comparison of Biweight, Hampel

Descriptively, the distribution of the three robust measures of location - the Hampel, biweight and (for purposes of comparison at this time) the trimmed mean - will be shown below.

> "These measures estimate with less variability the location (mean) of a symmetric distribution, than does the mean or median when the data come from a long-tailed symmetric distribution, or when the data have outliers or extreme values."[2]

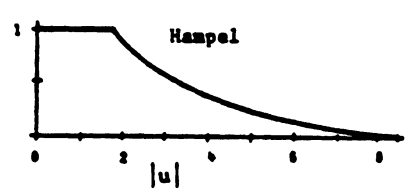
The mean is an estimate of location in which each location is given the same weight. The above measures of robust location do not weight observations equally. The estreme values receive less weight.

For purposes of this study, the trimmed mean omits the largest 15 percent of the acceptable values as well as 15 percent of the smallest acceptable values. The mean is then computed using the remaining observations - the central 70 percent. Each observation in the central 70 percent has a weight of one and the extreme observations (both sides of the central group) have a weight of zero.

The Hampel and the biweight assign higher weights to the observation near the estimate than those far from the estimate. Basically, the weights are a function of

$$u = \frac{\text{observed value - estimate of location}}{\text{estimate of dispersion}}$$

where the estimate of dispersion is the median of the absolute deviations from the sample median.



3.5 Robust Measures and Housing Price Distribution

Mosteller and Tukey [11] summarize the effect of using the arithmetic mean, median in comparison to the biweight. They conclude that

> "... except for quite small samples, the biweight has all the desired properties. ... the smallest samples, say those of count three, four, and five, we might do better with the median."[3]

The following exhibit (13) notes the resistance and robustness of efficiency of some location estimators.

Resistance and robustness of efficiency of some location estimators

Estimator	Sample size	Resistant?	Gaussian efficiency	Stretched-tail efficiency	Robustness of efficiency
Arithmetic mean	Small	No	100%	Poor	Poor
	Large	No	100%	Very poor	Very poor
Median	Small	Yes	High	Higher	High
	Large	Yes	62%	Higher	Moderate
Biweight with $c = 6$ or 9	Small	Reasonably	Highish	Higher	Highish
	Large	Yes	>90%	>90%	High

Exhibit 13. Resistance and robustness of efficiency of some location estimators. Source of table is Mosteller and Tukey [11] p. 206.

Finally, Mosteller and Tukey note that in practice we tend to use the median in exploration (and other circumstances where moderate efficiency is sufficient). Second, the biweight, or related measures such as the Hampel,

is useful when high performance measure is needed. The arithmetic mean should be used after careful study: when traditions or meaningfulness require it; when the cost of redoing data bases is exhorbitant; when convenience of linearity is required or when the data have short tails and no outliers.

Since the distribution of housing prices is (generally) positively skewed, i.e., skewed to the right, it is therefore necessary to examine these distributions of data and determine which of these robust and resistant measures of location will perform the best for the housing price distribution.

Footnotes

1. Mosteller, F. and Tukey, J. Data Analysis and Regression. 1977. Addison-Wesley. Don Mills, Ontario. p. 203.

2. B.M.D.P. Statistical Software. 1983. University of California Press. Berkeley, California. p. 82.

3. Mosteller, F. and Tukey, J. Op. cit. p. 206.

4. Ibid., p. 205.

4.0 Data Bases/Sampling

The sampling for the housing price indices reflect three major concerns. First, the base should be as regional as possible to reflect the differences in market activity. Montreal, Toronto, Winnipeg, Calgary, and Vancouver were selected as possible C.M.A.'s. Second, the series was designed to be used in comparison to the Royal Trust Survey of housing prices. Third, the series had to reflect upper, medium and low income groupings. Consequently, the following samples, together with their sample size (per quarter, per month) are noted for Dollard Des Ormeau (Montreal); Toronto (Toronto Real Estate Board); N.W. Winnipeg (Winnipeg); Richmond (Vancouver) and Kerrisdale (Vancouver).

Segment	Time Series	Total for Time Series	Average Number of Sales per qtr.	per mo.	Remarks
Dollard Des Ormeau (Montreal)	Jan. 1974 to Dec. 1983	11,433	285	95	Based on Teela records.
Toronto	Jan. 1976 to Apr. 1984	205,863	2,122	6,238	Based on M.L.S. sales frequency distributions.
N.W. Winnipeg	Jan. 1975 to Nov. 1983	4,014	115	38	Based on M.L.S. sales records
Richmond (Vancouver)	Mar. 1975 to Oct. 1983	19,859	584	194	Based on Teela records.
Kerrisdale (Vancouver)	Mar. 1975 to Dec. 1983	1,210	35	11	Based on Teela records.

Exhibit 14. Sample size, parameters for housing price study.

Housing prices were derived on a quarterly and monthly basis (except for Kerrisdale) based on mean, median, Hampel, trimmed mean and biweight. Appendix 1 details the actual series. Comparatively the average is plotted with the median; then the average with the Hampel; then the average with the trimmed mean; and finally, the average with the biweight is plotted. Percentage differences of each of these sets is also plotted.

Kerrisdale was plotted on a quarterly basis, due only to the low level of sales activity. Future studies will examine the implications of sample size on measures of price location.

5.0 Empirical Findings

5.1 Comparison of Series

In analyzing the stability of the mean and associated measures of robustness (median, Hampel, biweight and trimmed mean) t-tests were used to compare the series. The results of these t-tests are summarized in the following exhibit. As might be expected, the most likely series to demonstrate significant differences are the monthly series with small samples and those market segments having the greatest possibility of outliers affecting the sample. For purposes of brevity, the actual graphs for Toronto and Kerrisdale (Vancouver) are found in the report proper. Appendix 1 contains the comparative series for Dollard Des Ormeau, N. W. Winnipeg and Richmond (Vancouver).

Results of T-test

Series	Characteristics	Series Compared	T Value	D.F.	T Prob.	F Prob.	Formula
Toronto monthly	Large sample Total M.L.S.	Average & median	4.08	198	.000	.032	(3)
		Average & Hampel	3.45	198	.001	.134	(3)
		Average & trimmed mean	2.88	198	.004	.196	(3)
		Average & biweight	3.87	198	.000	.098	(3)
Toronto quarterly	Large sample Total M.L.S.	Average & median	2.63	50	.011	.345	(3)
		Average & Hampel	2.20	50	.033	.553	(3)
		Average & trimmed mean	1.83	50	.073	.604	(3)
		Average & biweight	2.44	50	.018	.484	(3)
Kerrisdale quarterly	Neighbourhood Small sample affected by outliers	Average & median	1.81	48	.077	.794	(3)
		Average & Hampel	1.61	48	.113	.977	(3)
		Average & trimmed mean	1.25	48	.217	.894	(3)
		Average & biweight	1.64	48	.107	.994	(3)

Exhibit 15. Comparison of difference of means for (Toronto) large sample, CMA data base, and (Kerrisdale) small sample neighbourhood base.

Results of T-test

Series	Characteristics	Series Compared	T Value	D.F.	T Prob.	F Prob.	Formula
Dollard Des Ormeau monthly	Large sample Total municipality	Average & median	.67	236	.485	.405	(3)
		Average & Hampel	1.54	236	.125	.052	(3)
		Average & trimmed mean	1.48	236	.140	.043	(1)
		Average & biweight	1.62	236	.108	.053	(3)
Dollard Des Ormeau quarterly	Large sample Total municipality	Average & median	.13	46	.896	.780	(3)
		Average & Hampel	.79	46	.428	.524	(3)
		Average & trimmed mean	.76	46	.447	.484	(3)
		Average & biweight	.81	46	.421	.556	(3)
N.W. Winnipeg monthly	Medium sample Large neighbor-hood M.L.S. base	Average & median	2.67	212	.008	.496	(3)
		Average & Hampel	2.45	212	.015	.658	(3)
		Average & trimmed mean	2.23	212	.027	.939	(3)
		Average & biweight	2.48	212	.014	.679	(3)
N.W. Winnipeg quarterly	Medium sample Large neighbor-hood M.L.S. base	Average & median	3.02	46	.004	.667	(3)
		Average & Hamepl	3.04	46	.004	.876	(3)
		Average & trimmed mean	2.89	46	.006	.624	(3)
		Average & biweight	3.14	46	.003	.762	(3)
Richmond monthly	Large sample Total municipality	Average & median	2.31	190	.022	.155	(3)
		Average & Hampel	2.39	190	.018	.164	(3)
		Average & trimmed mean	2.01	190	.046	.284	(3)
		Average & biweight	2.50	190	.013	.143	(3)
Richmond quarterly	Large sample Total municipality	Average & biweight	1.27	46	.208	.318	(3)
		Average & Hampel	1.35	46	.183	.296	(3)
		Average & trimmed mean	1.14	46	.257	.387	(3)
		Average & biweight	1.40	46	.166	.282	(3)

Exhibit 16. Comparison of difference of means for Dollard Des Ormeau, N.W. Winnipeg and Richmond.

First a word about the difference of means T-test. The monthly and average series both were tested by cross matching the average with the median; the average with the Hampel; the average with the trimmed mean and finally, the average with the biweight. The robust measures of location (Hampel, biweight, median and trimmed mean) were also cross matched together. Since none of these robust measures showed any difference statistically between themselves, the reporting is limited solely to the differences between the average and the robust measures of location.

Second, in testing the differences of means, a test of population variances was undertaken. All series (except Dollard Des Ormeau monthly - average and trimmed mean) resulted in the use of a more conservative test. The more sensitive T-test in which population variance is first tested for equality (type 3) was used. The T-test subroutine performs F tests to determine whether the assumption of equality of population variances is valid; if yes, type 3 T-tests are performed; if not, type 1 tests are carried out. Appendix 2 notes the type 1, 2, and 3 tests for population differences.

Finally, the quarterly series were tested for differences of means from 1975 and 1978 (but reported only from 1978); whereas the monthly series are tested from 1975. In all cases the series terminated in 1983.

The general consensus of the testing is that there is a significant difference over time (1975 to 1983) of the average and related robust measures of location. This statement is particularly valid in all the monthly series - except Dollard Des Ormeau. There was no significant difference between the average and the median, etc., for Dollard Des Ormeau. However, significant differences in the Toronto, N.W. Winnipeg and Richmond series exist, between the average and the robust measures of location.

At the quarterly level, this consistency of difference is lost as only Toronto and Winnipeg exhibit significant statistic differences using the T-test. The small sample set of Kerrisdale, the stable Dollard Des Ormeau market and the homogenous Richmond market exhibit no difference.

The reader is cautioned that these results for the latter three cities could result from three major reasons. First, that indeed there is no difference between the average and the robust measures of location; or that the use of a non-M.L.S. data base obscures the shifts found in the M.L.S. markets. The Toronto and Winnipeg data is based on M.L.S. data sets.

Finally, as can be seen from the data series in the following exhibits (and was observed even in the annual data series) the differences between the mean and the median, for example, are erratic - probably linked to sub-economic cycles - so that measurement of a series during a particularly normal market will exhibit little or no difference, but as soon as the market segments shift significantly - particularly in the upper priced housing - then the outlier problem appears again. It is the latter explanation that is noted in deciding upon the appropriate measure of location.

The reader is now requested to view the Toronto and Kerrisdale data series. The mean and median will only be described because of the strong similarity between the robust measures of location. But the other series are included for reader inspection. The reader will note that in spite of the fact that there is a strong correlation between the median, Hampel, trimmed mean average and biweight, descriptive comparison of the quarterly series, in particular, reveals that the median is a more stable measure than any of the alternative robust measures of location. This is particularly true of Winnipeg, Richmond and Dollard Des Ormeau. Reference to Appendix 1 and the

appropriate percentage difference series will clearly indicate that the median/average difference is more stable than the Hampel/average, or the biweight/average differences. Graphs can be found for Dollard Des Ormeau in exhibits 2.2, 2.4, 2.6, and 2.8; for N. W. Winnipeg in 4.2, 4.4, 4.6 and 4.8; and for Richmond (Vancouver) in tables 6.2, 6.4, 6.6 and 6.8. (Appendix 1).

These results leave the statement that the biweight should be a preferable measure to median (except in small samples) open to further investigation.

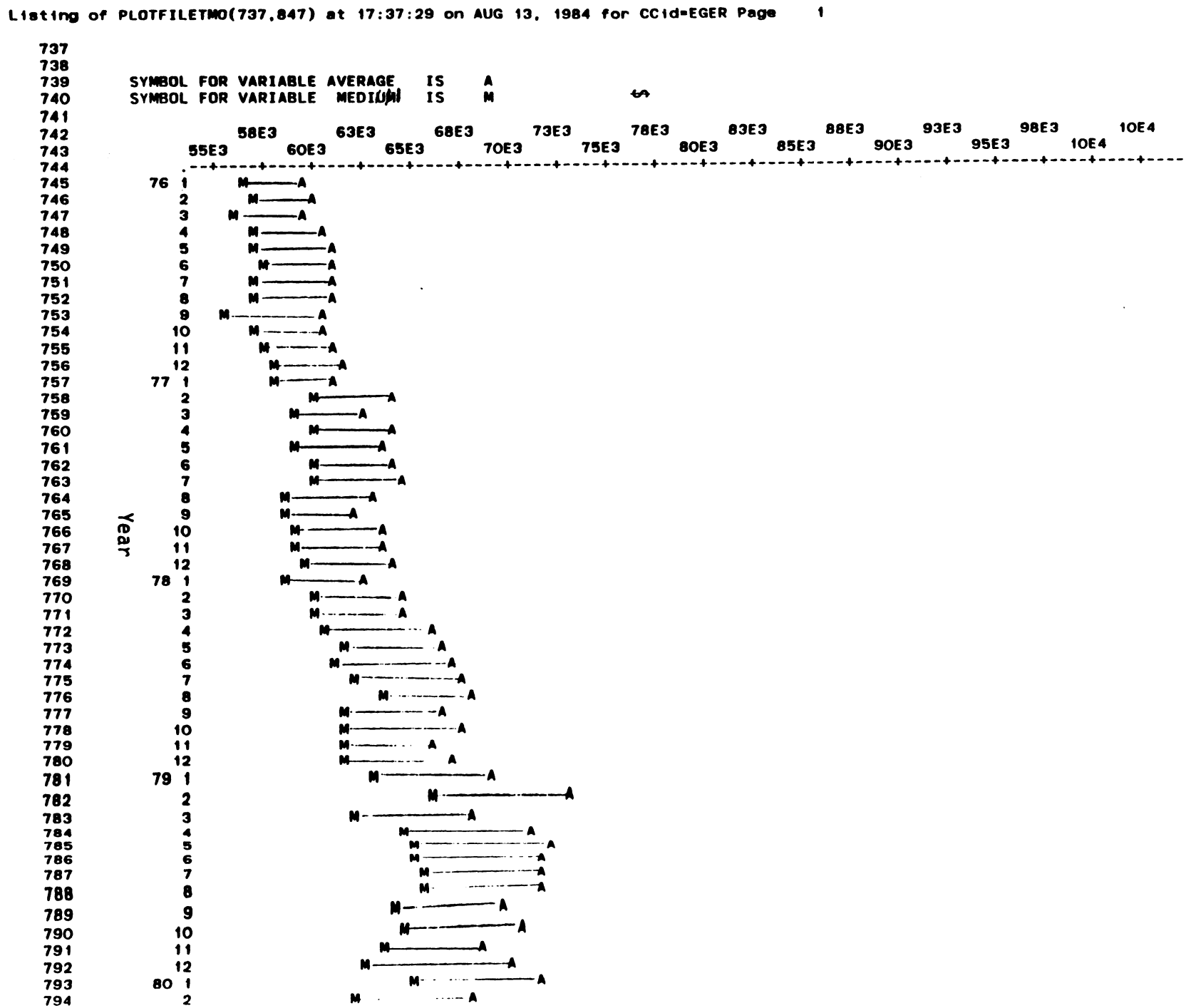
5.2 Descriptive Overview of the Average and Robust Measure of Location

The following exhibits (17, 18, 19) for Toronto and Kerrisdale, both monthly and quarterly series, give the reader an understanding of the percentage differences between two polar cases (total Toronto Real Estate Board and neighbourhood of Kerrisdale (Vancouver)).

The Toronto M.L.S. market consistently (both quarterly and monthly) shows and upward trend in difference between the mean and the median - from a low of 5.6% in 1976 to 11.2% in 1984. As can be seen from the Toronto monthly series (exhibit 17.2) there is significant monthly variation ranging from 5.0% to 8.0% in 1975; whereas by 1983 the difference ranges from 10.5% to 14.0%.

Kerrisdale, meanwhile, shows extreme fluctuation, even in the quarterly series, of the difference between the mean and median - from a low of 8.0% in 1975 to a high of 32% in 1978 (exhibit 19.2). As the data base was judged too small for comparable analysis, no monthly figures are exhibited. But the differences (between mean and median) could be expected to be even greater.

Exhibit 17.1 Toronto M.L.S. average and median housing price series monthly. Note E3 is 000's of dollars



```
795          3
796          4
797          5
798          6
799          7
800          8
801          9
802         10
803         11
804         12
805     81   1
806          2
807          3
808          4
809          5
810          6
811          7
812          8
813          9
814         10
815         11
816         12
817     82   1
818          2
819          3
820          4
821          5
822          6
823          7
824          8
825          9
826         10
827         11
828         12
829     83   1
830          2
831          3
832          4
833          5
834          6
835          7
836          8
837          9
838         10
839         11
840         12
841     84   1
842          2
843          3
844          4
845  1PAGE   8  BMDP2T TORONTO AVER        ,HAMPEL,TRIMAVER,BIWEIGHT
846
847
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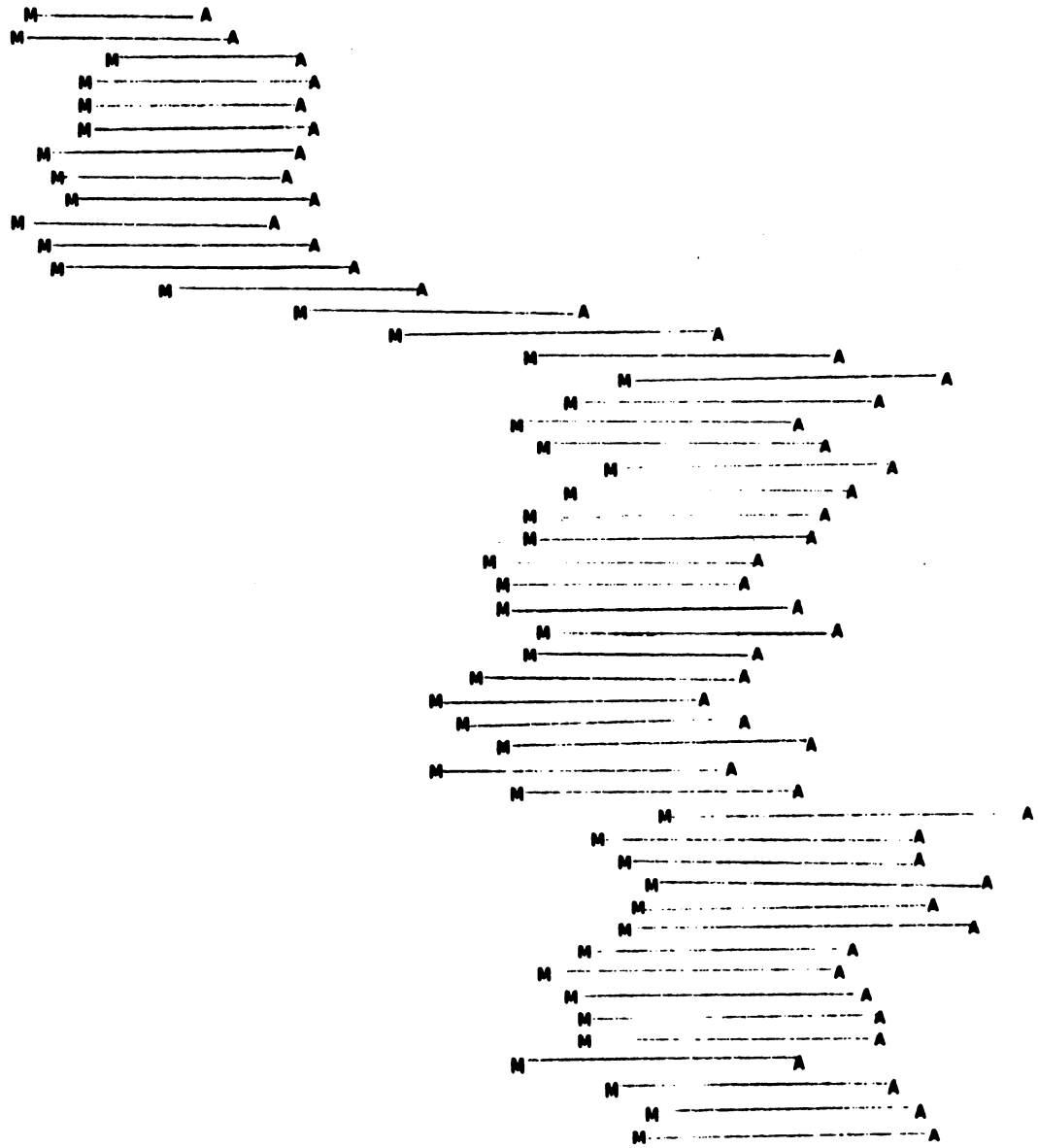
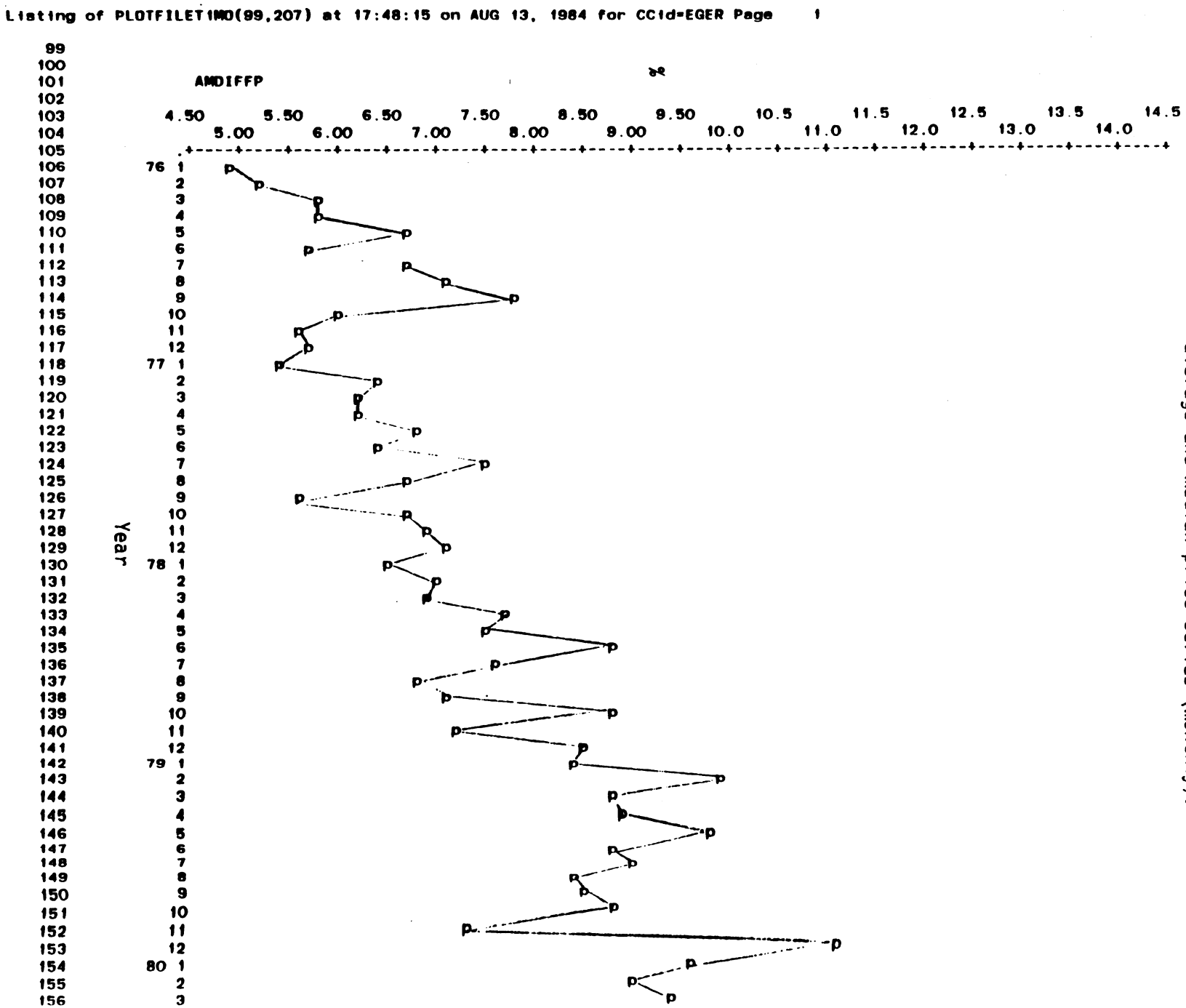


$L PLOTFILETMO(867,977)

Exhibit 17.2. Toronto M.L.S. percentage difference between average and median price series (monthly).



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157          4
158          5
159          6
160          7
161          8
162          9
163         10
164         11
165         12
166     81   1
167          2
168          3
169          4
170          5
171          6
172          7
173          8
174          9
175         10
176         11
177         12
178     82   1
179          2
180          3
181          4
182          5
183          6
184          7
185     80   8
186          9
187         10
188         11
189         12
190     83   1
191          2
192          3
193          4
194          5
195          6
196          7
197          8
198          9
199         10
200         11
201         12
202     84   1
203          2
204          3
205          4
206   1PAGE   3  BMDP2T TORONTO AVER,.  ..    .,HAMPEL,TRIMAVER,BIWEIGHT
207
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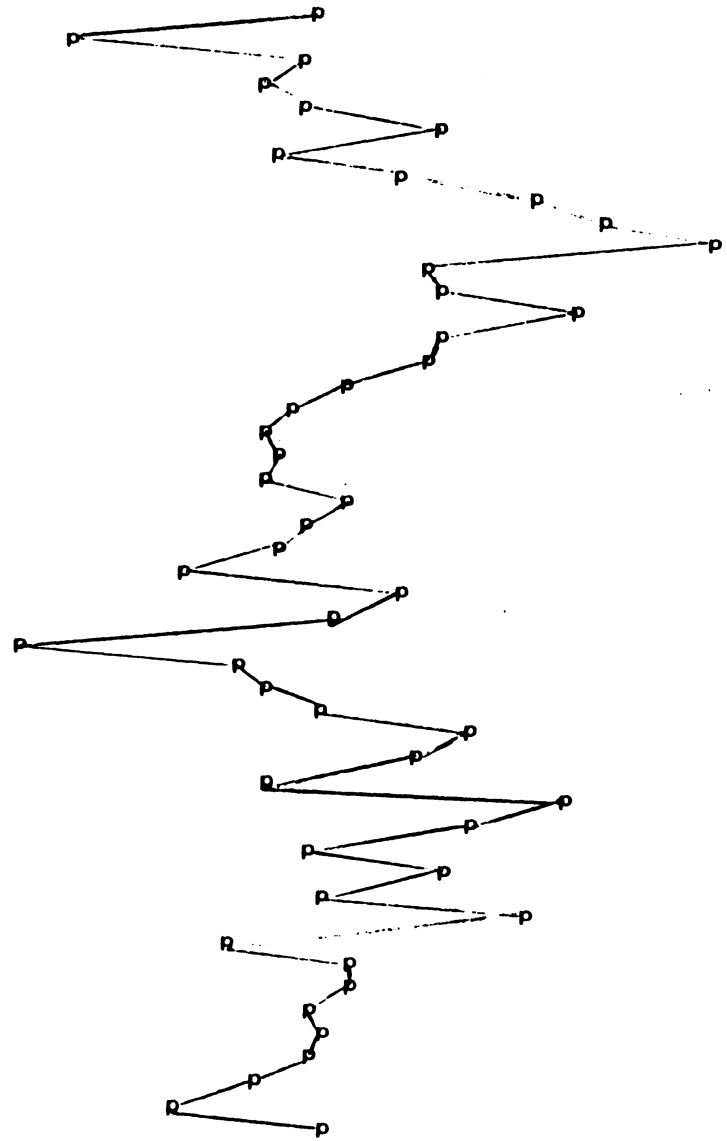
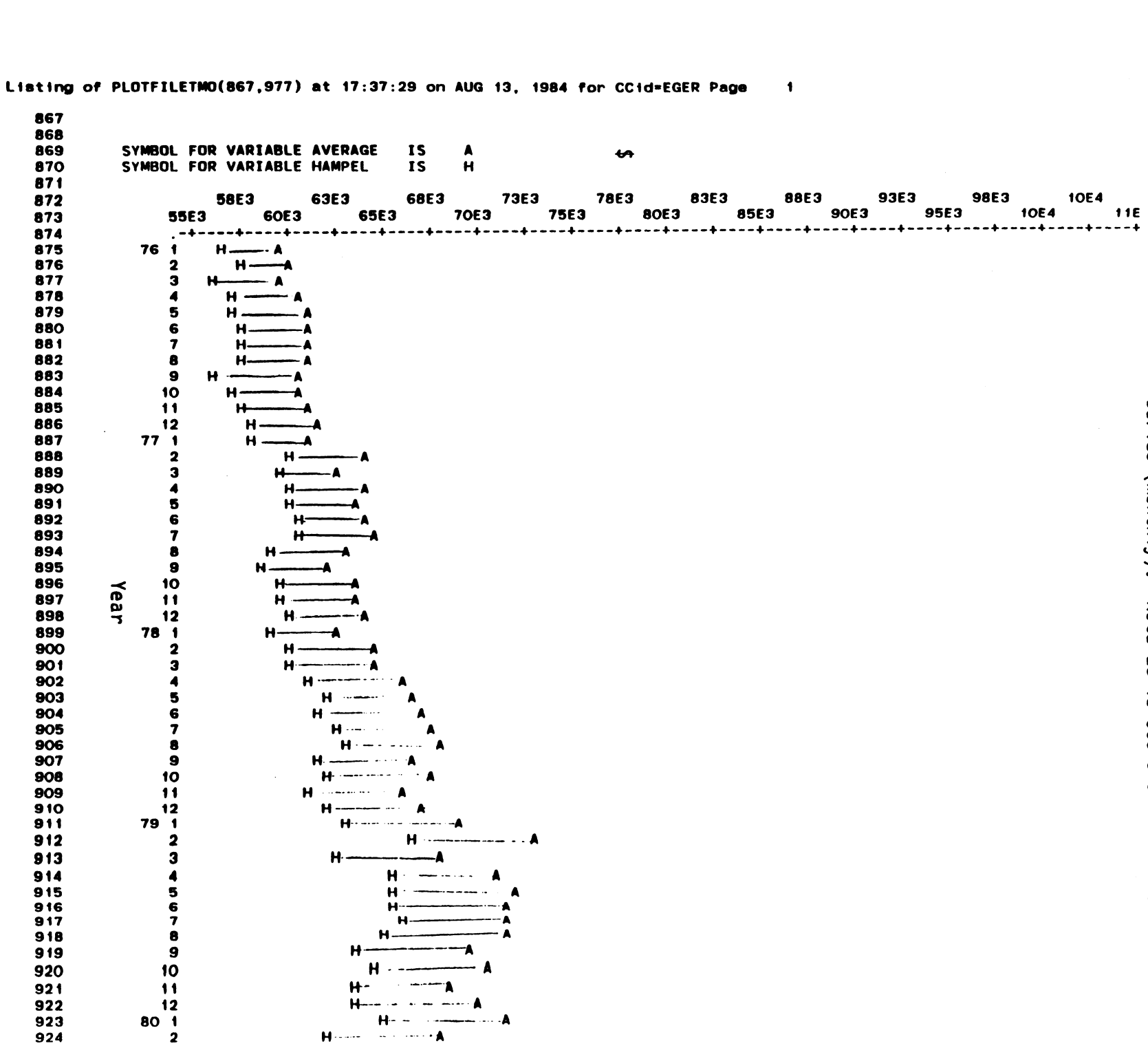


$L PLOTFILET1mo(227,335)

Exhibit 17.3. Toronto M.L.S. average and Hampel housing price series (monthly). Note E3 is 000's of dollars.



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927          5
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931          9
932         10
933         11
934         12
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936          2
937          3
938          4
939          5
940          6
941          7
942          8
943          9
944         10
945         11
946         12
947      82  1
948          2
949          3
950          4
951          5
952          6
953          7
954          8
955          9
956         10
957         11
958         12
959      83  1
960          2
961          3
962          4
963          5
964          6
965          7
966          8
967          9
968         10
969         11
970         12
971      84  1
972          2
973          3
974          4
975   1PAGE   9  BMDP2T TORONTO AVER,        ;,HAMPEL,TRIMAVER,BIWEIGHT
976
977
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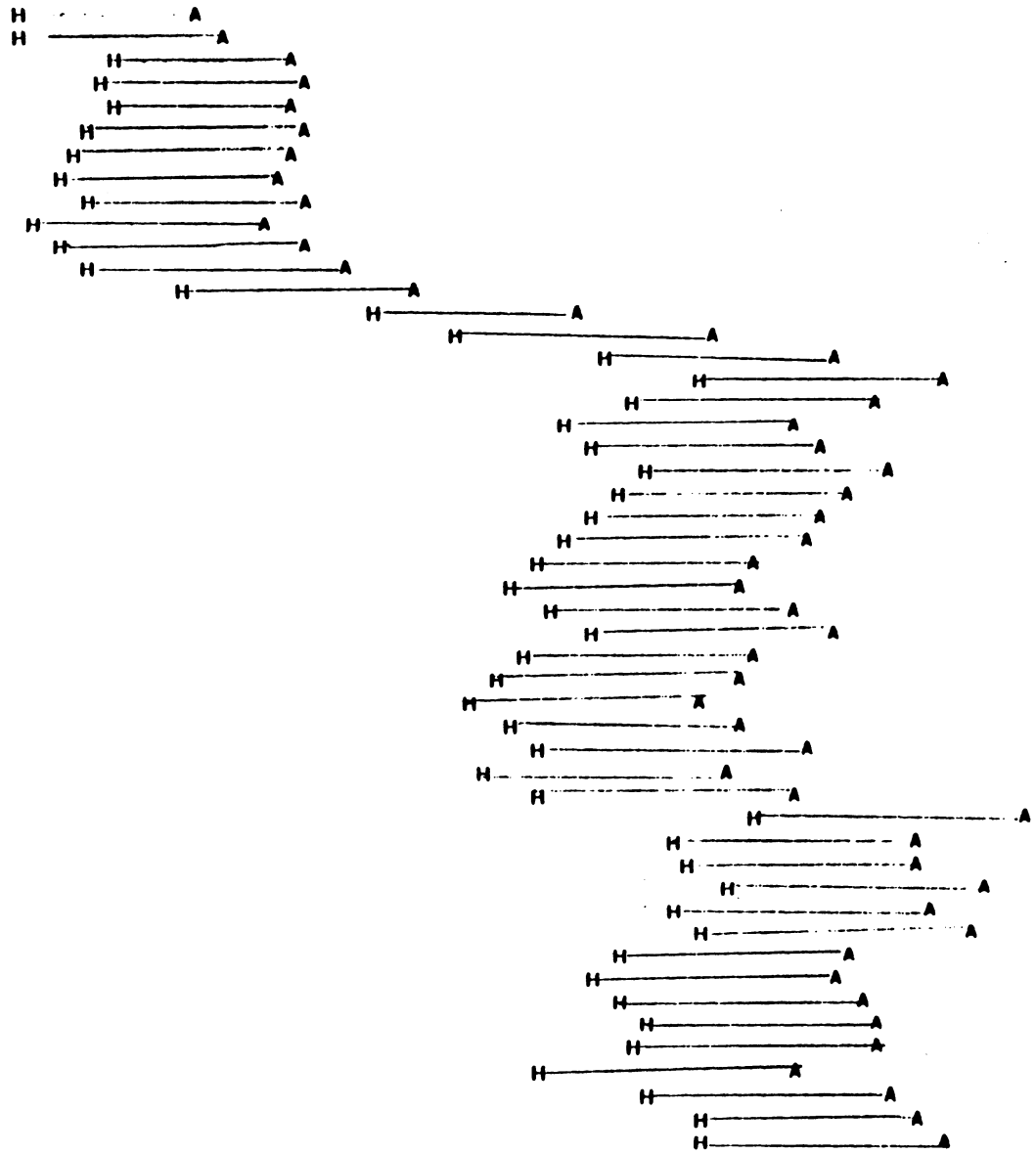
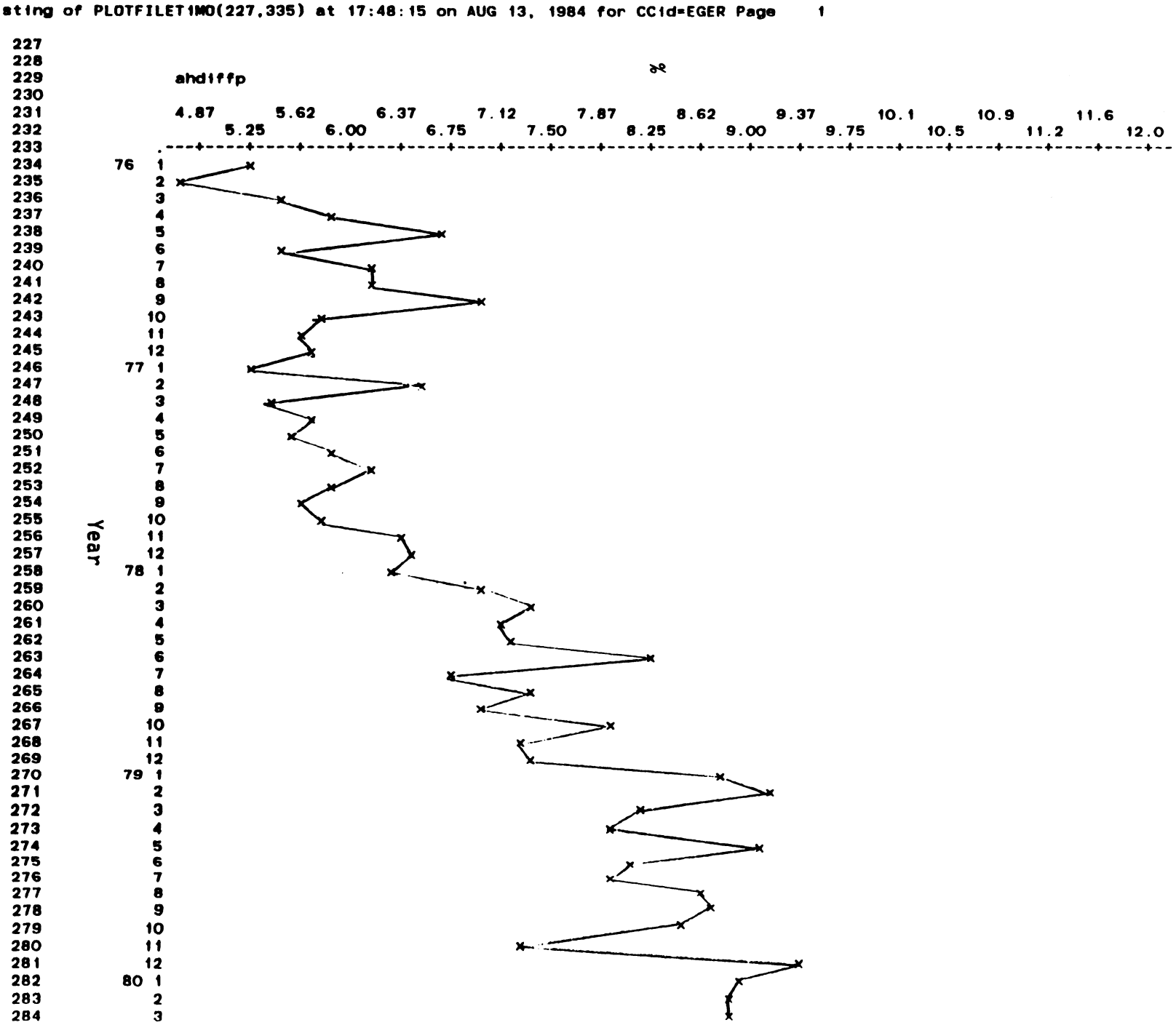


Exhibit 17.4. Toronto M.L.S. percentage difference between average and Hampel price series (monthly).



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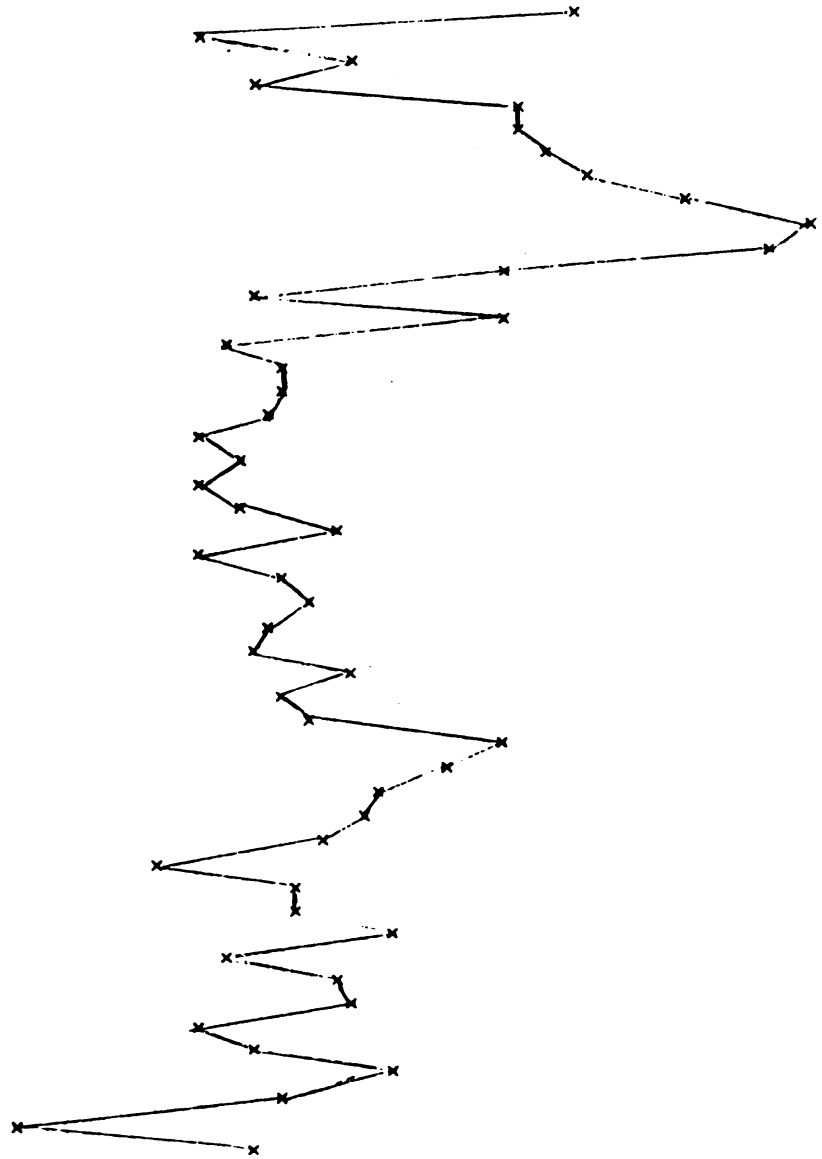
286          5
287          6
288          7
289          8
290          9
291         10
292         11
293         12
294       81 1
295          2
296          3
297          4
298          5
299          6
300          7
301          8
302          9
303         10
304         11
305         12
306       82 1
307          2
308          3
309          4
310          5
311          6
312          7
313          8
314          9
315         10
316         11
317         12
318       83 1
319          2
320          3
321          4
322          5
323          6
324          7
325          8
326          9
327         10
328         11
329         12
330       84 1
331          2
332          3
333          4
334     1PAGE   4  BMDP2T TORONTO AVER,.       ,HAMPEL,TRIMAVER,BIWEIGHT
335
```



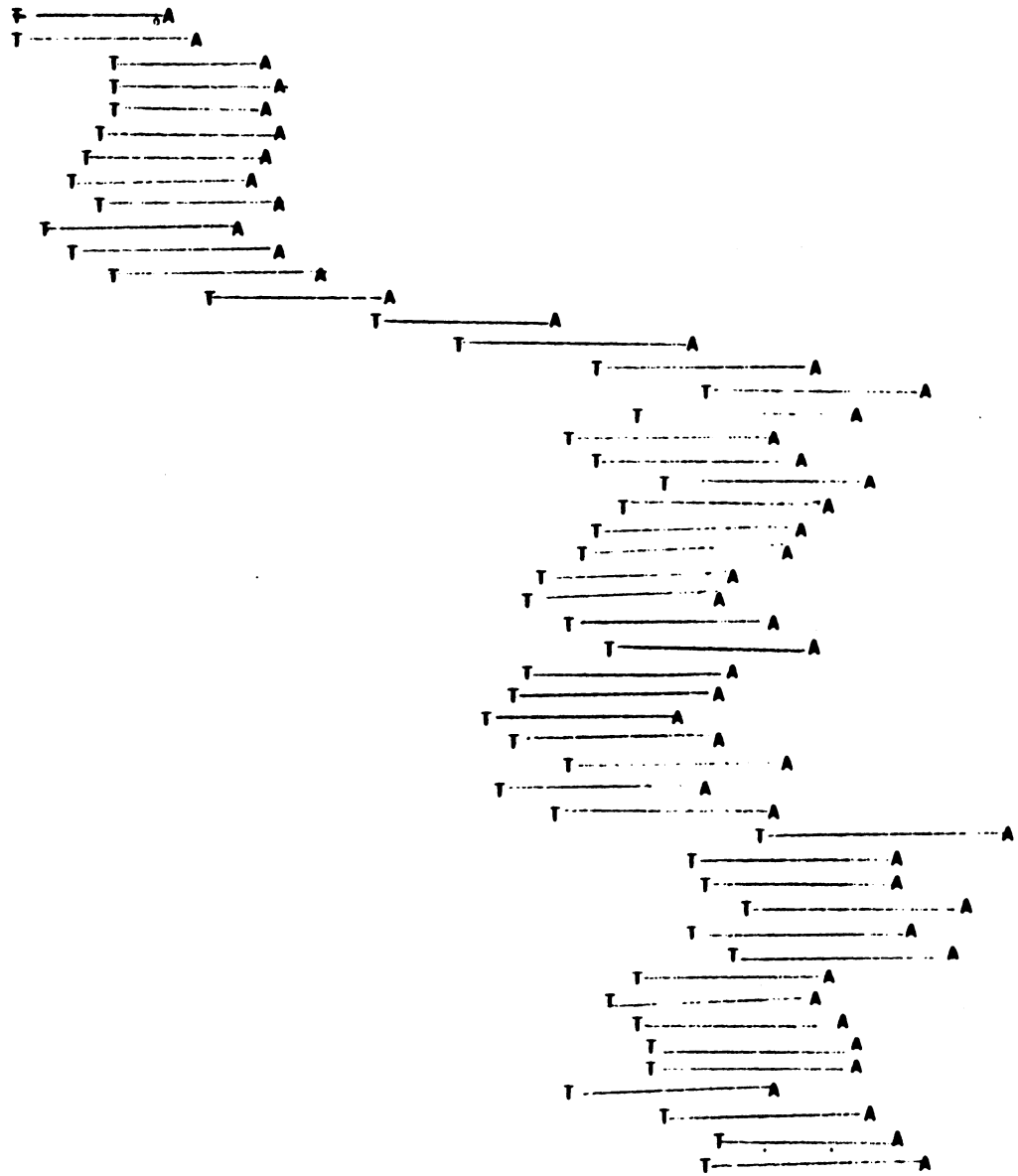
$L PLOTFILET1mo(355,464)

Exhibit 17.5. Toronto M.L.S. average and trimmed mean housing price series (monthly). Note E3 is 000's of dollars.


```
997
998
999      SYMBOL FOR VARIABLE AVERAGE   IS    A
1000     SYMBOL FOR VARIABLE TRIMAVER  IS    T
1001
1002                 58E3      63E3      68E3      73E3      78E3      83E3      88E3      93E3      98E3      10E4
1003          55E3      60E3      65E3      70E3      75E3      80E3      85E3      90E3      95E3      10E4      11E
1004          .-+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
1005      76 1    T----A
1006         2      T---A
1007         3    T----A
1008         4      T----A
1009         5      T-----A
1010         6       T----A
1011         7       T----A
1012         8       T----A
1013         9     T-----A
1014        10      T-----A
1015        11       T----A
1016        12        T---A
1017      77 1        T---A
1018         2           T-----A
1019         3          T----A
1020         4            T-----A
1021         5           T-----A
1022         6            T-----A
1023         7            T-----A
1024         8         T-----A
1025         9        T----A
1026        10          T-----A
1027        11          T-----A
1028        12           T-----A
1029      78 1         T----A
1030         2           T-----A
1031         3            T-----A
1032         4              T-----A
1033         5              T-----A
1034         6              T-----A
1035         7                T-----A
1036         8                 T-----A
1037         9              T-----A
1038        10               T-----A
1039        11             T-----A
1040        12               T-----A
1041      79 1                 T-----A
1042         2                      T-----A
1043         3                T-----A
1044         4                  T-----A
1045         5                   T-----A
1046         6                   T-----A
1047         7                    T-----A
1048         8                  T-----A
1049         9                 T-----A
1050        10                  T-----A
1051        11                T-----A
1052        12                 T-----A
1053      80 1                  T-----A
1054         2               T-----A
```

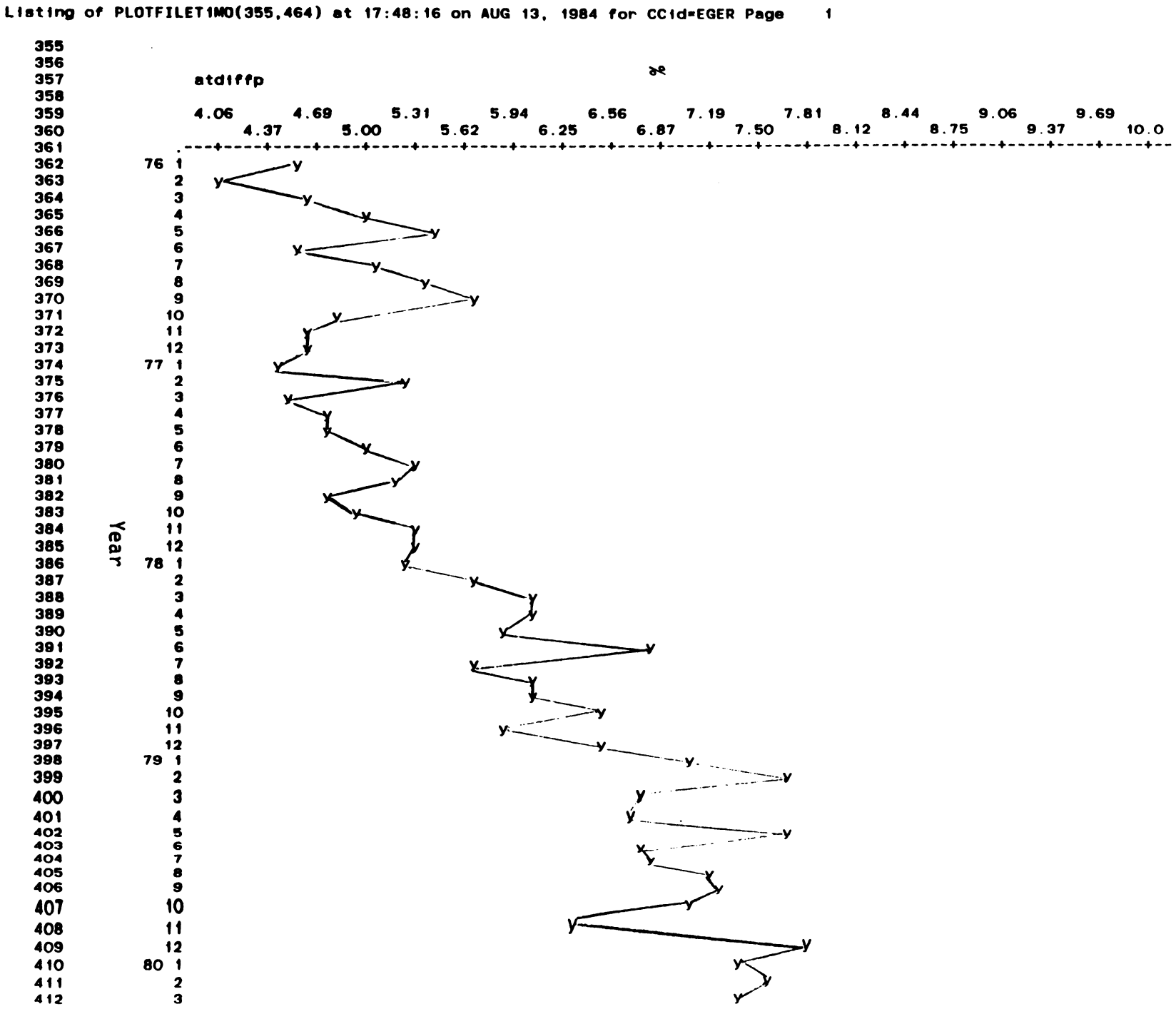
Year

```
1055          3
1056          4
1057          5
1058          6
1059          7
1060          8
1061          9
1062         10
1063         11
1064         12
1065      81  1
1066          2
1067          3
1068          4
1069          5
1070          6
1071          7
1072          8
1073          9
1074         10
1075         11
1076         12
1077      82  1
1078          2
1079          3
1080          4
1081          5
1082          6
1083          7
1084          8
1085          9
1086         10
1087         11
1088         12
1089      83  1
1090          2
1091          3
1092          4
1093          5
1094          6
1095          7
1096          8
1097          9
1098         10
1099         11
1100         12
1101      84  1
1102          2
1103          3
1104          4
1105    1PAGE  10  BMDP2T TORONTO AVER.        ,HAMPEL,TRIMAVER,BIWEIGHT
1106
1107
```

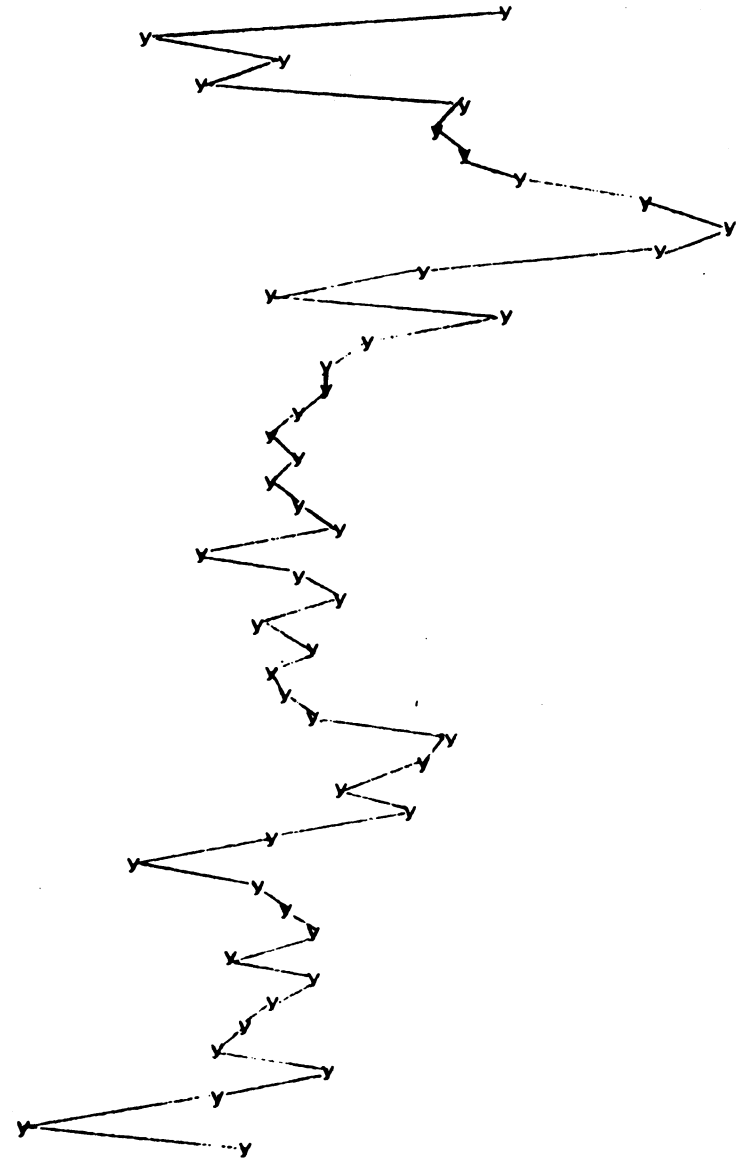


$1 PLOTFILETMO(1127,1237)

Exhibit 17.6. Toronto M.L.S. percentage difference between average and trimmed mean price series (monthly).

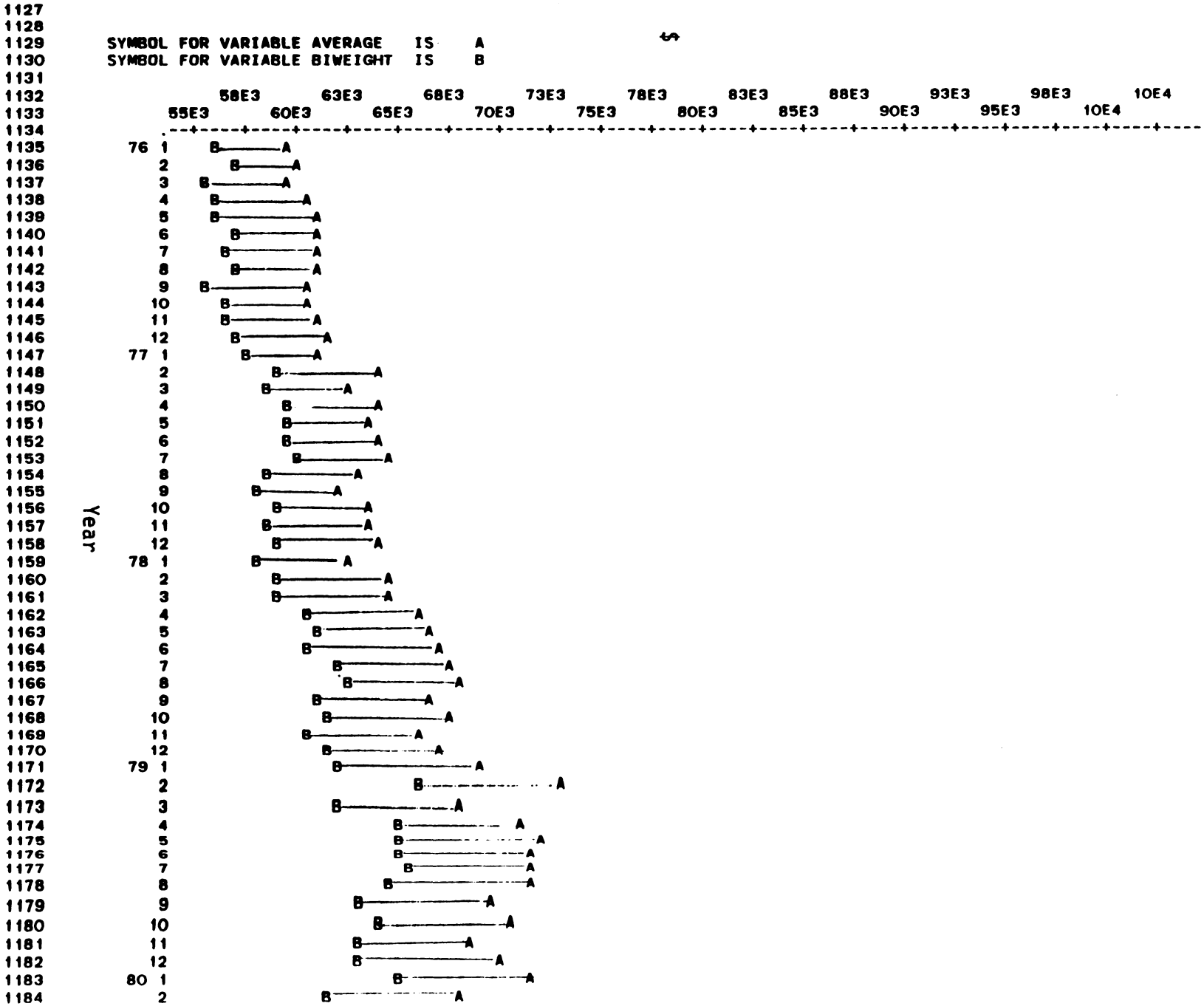


```
413          4
414          5
415          6
416          7
417          8
418          9
419         10
420         11
421         12
422      81  1
423          2
424          3
425          4
426          5
427          6
428          7
429          8
430          9
431         10
432         11
433         12
434      82  1
435          2
436          3
437          4
438          5
439          6
440          7
441          8
442          9
443         10
444         11
445         12
446      83  1
447          2
448          3
449          4
450          5
451          6
452          7
453          8
454          9
455         10
456         11
457         12
458      84  1
459          2
460          3
461          4
462    1PAGE   5  BMDP2T TORONTO AVER.        .HAMPEL.TRIMAVER.BIWEIGHT
463
464
```



$L PLOTFILET1mo(483,592)

Exhibit 17.7 . Toronto M.L.S. average and biweight housing price series (monthly). Note E3 is in 000's of dollars.



```
1185          3
1186          4
1187          5
1188          6
1189          7
1190          8
1191          9
1192         10
1193         11
1194         12
1195     81   1
1196          2
1197          3
1198          4
1199          5
1200          6
1201          7
1202          8
1203          9
1204         10
1205         11
1206         12
1207     82   1
1208          2
1209          3
1210          4
1211          5
1212          6
1213          7
1214          8
1215          9
1216         10
1217         11
1218         12
1219     83   1
1220          2
1221          3
1222          4
1223          5
1224          6
1225          7
1226          8
1227          9
1228         10
1229         11
1230         12
1231     84   1
1232          2
1233          3
1234          4
1235  1PAGE  11  BMDP2T TORONTO AVER,        ,HAMPEL,TRIMAVER,BIWEIGHT
1236
1237
```

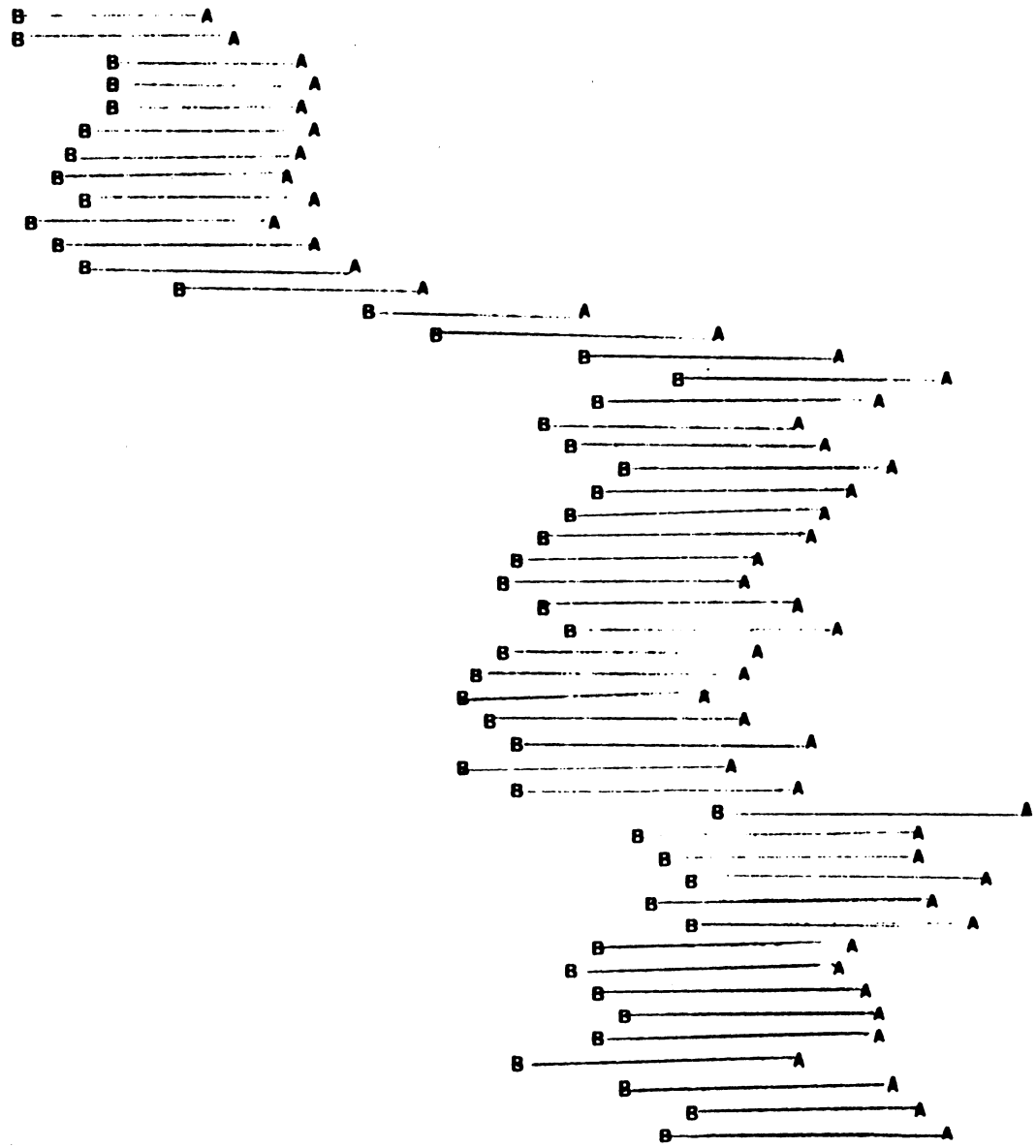
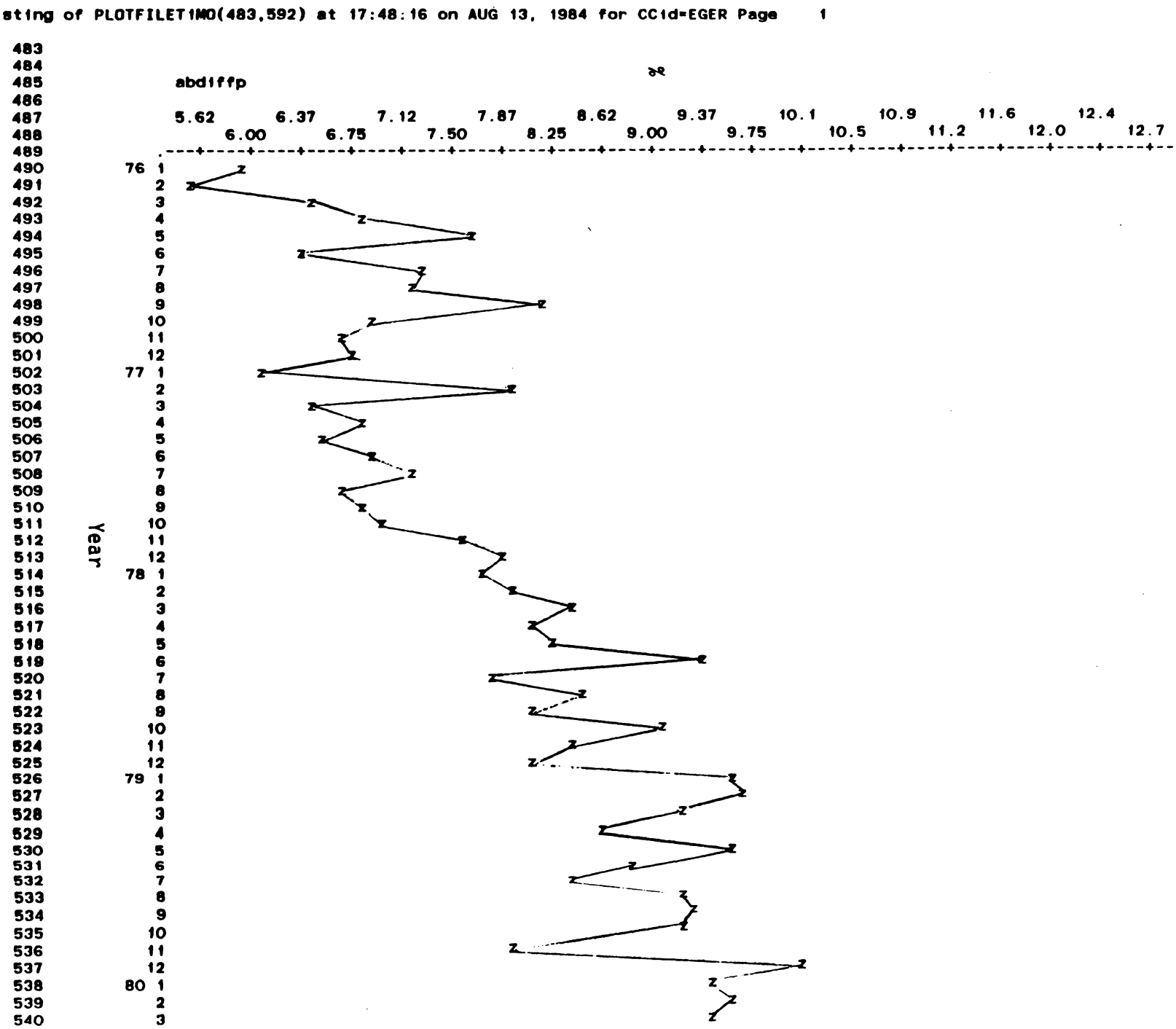
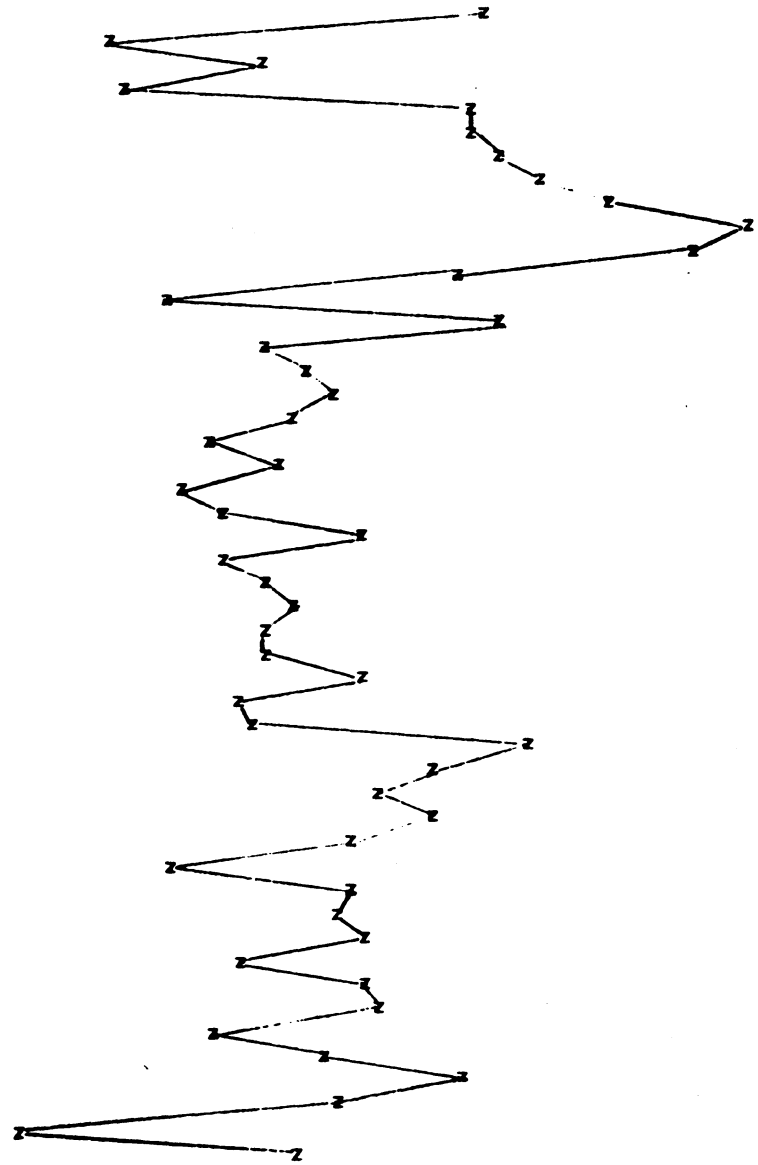


Exhibit 17. 8. Toronto M.L.S. percentage differences between average and biweight price series (monthly).



```
541          4
542          5
543          6
544          7
545          8
546          9
547         10
548         11
549         12
550      81  1
551          2
552          3
553          4
554          5
555          6
556          7
557          8
558          9
559         10
560         11
561         12
562      82  1
563          2
564          3
565          4
566          5
567          6
568          7
569          8
570          9
571         10
572         11
573         12
574      83  1
575          2
576          3
577          4
578          5
579          6
580          7
581          8
582          9
583         10
584         11
585         12
586      84  1
587          2
588          3
589          4
590    1PAGE   6  BMDP2T TORONTO AVER,      1,HAMPEL,TRIMAVER,BIWEIGHT
591
592
```



$L PLOTFILET1mo(612,721)

Exhibit 18.1. Toronto M.L.S. average and median housing price series (quarterly). Note E3 is in 000's of dollars.


```
407
408
409      SYMBOL FOR VARIABLE AVERAGE   IS    A
410      SYMBOL FOR VARIABLE  MEDIAN   IS    M
411
412                 58E3      63E3      68E3      73E3      78E3      83E3      88E3      93E3      98E3      10E4
413            55E3      60E3      65E3      70E3      75E3      80E3      85E3      90E3      95E3      10E4
414          .----+----+----+----+----+----+----+----+----+----+- --+----+----+----+----+----+----+----+----+--
415          I       M-----A
416          I        M-----A
417          I       M -----A
418          I         M-----A
419        5 +           M-----.A
420          I            M -----A
421          I           M -----A
422          I           M-----A
423          I            M-----A
424       10 +               M-----------A
425          I                 M-------A
426          I                M-----------A
427          I                   M -----------A
428          I                      M -----------.A
429       15 +                      M -----------A
430          I                   M-----------A
431          I                    M -----------A
432          I                         M-----------.A
433          I                        M-----------A
434       20 +                       M -----------A
435          I                          M -----------A
436          I                                      M-----------A
437          I                                                M-----------A
438          I                                                 M -----------A
439       25 +                                            M-----------A
440          I                                            M-----------A
441          I                                      M -----------A
442          I                                      M-----------A
443          I                                                 M -----------A
444       30 +                                                  M-----------A
445          I                                                 M-----------A
446          I                                                 M -----------A
447          I                                                  M-----------A
448          I                                                   M-----------A
```

Year

Exhibit 18.2. Toronto M.L.S. percentage difference between average and median price series (quarterly).

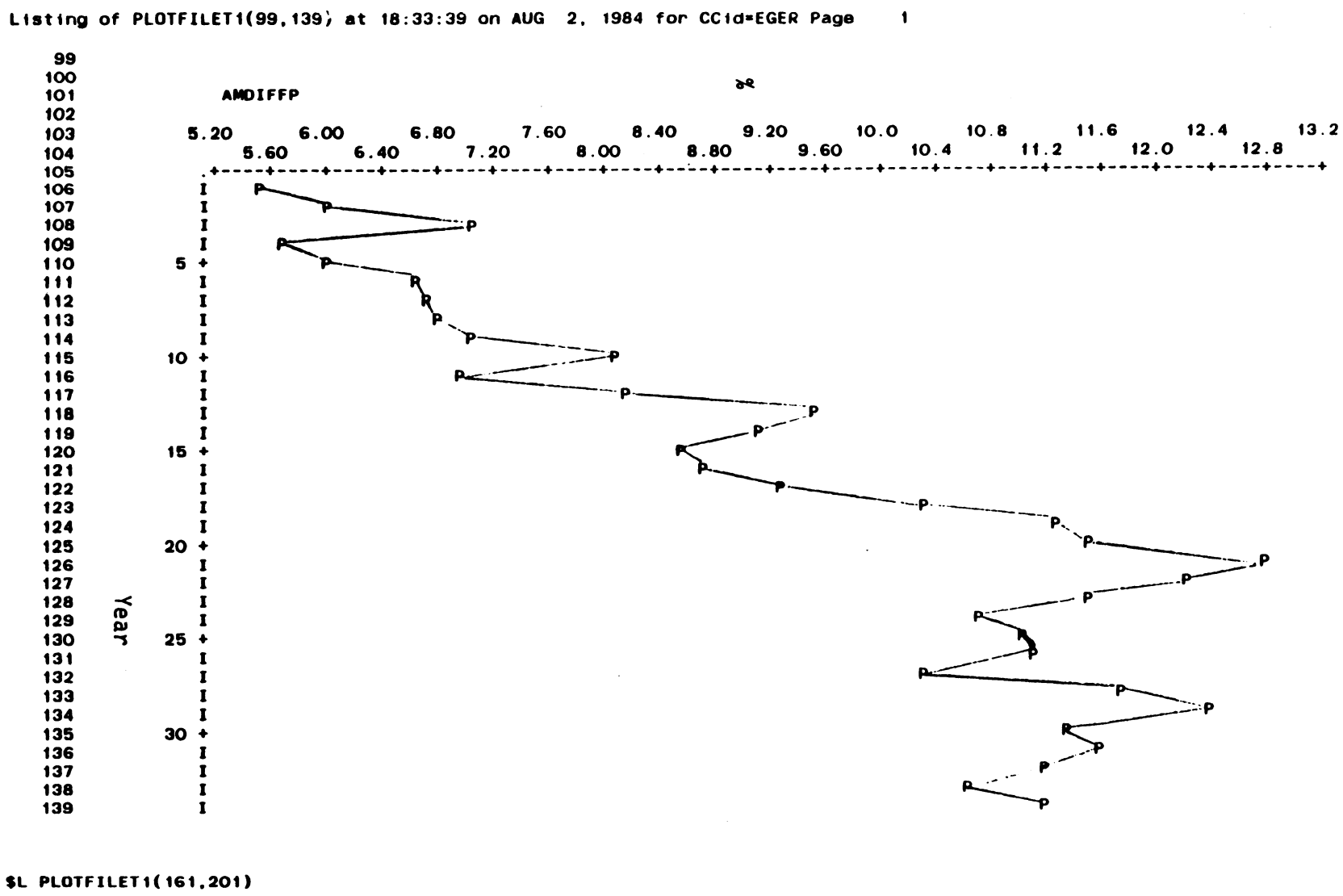


Exhibit 18.3. Toronto M.L.S. average and Hampel housing price series (quarterly). Note E3 is 000's of dollars.

```
Listing of PLOTFILET(470,512) at 18:30:08 on AUG  2, 1984 for CCid=EGER Page    1

470
471
472                                                  $
473      SYMBOL FOR VARIABLE AVERAGE   IS    A
474      SYMBOL FOR VARIABLE HAMPEL    IS    H
475
476                  58E3      63E3      68E3      73E3      78E3      83E3      88E3      93E3      98E3      10E4
477            55E3      60E3      65E3      70E3      75E3      80E3      85E3      90E3      95E3      10E4
478          .----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+--
479          I      H---A
480          I       H-----A
481          I       H------A
482          I        H-----A
483        5 +          H-----A
484          I            H------A
485          I           H-----A
486          I           H-----A
487          I           H------A
488       10 +               H-------A
489          I                H-------A
490          I               H-------A
491          I                  H-----------A
492          I                    H----------A
493       15 +                   H----------A
494          I                  H----------A
495          I                   H----------A
496          I                        H-----------A
497          I                         H----------A
498       20 +                       H----------A
499          I                            H----------A
500          I                                      H----------A
501          I                                                 H----------A
502          I                                                 H----------A
503       25 +                                            H----------A
504          I                                            H----------A
505          I                                       H----------A
506          I                                       H----------A
507          I                                                 H----------A
508       30 +                                                   H----------A
509          I                                                 H----------A
510          I                                                 H----------A
511          I                                                 H----------A
512          I                                                   H----------A

$L PLOTFILET(535,576)
```

Exhibit 18.4. Toronto M.L.S. percentage difference between average and Hampel price series (quarterly).

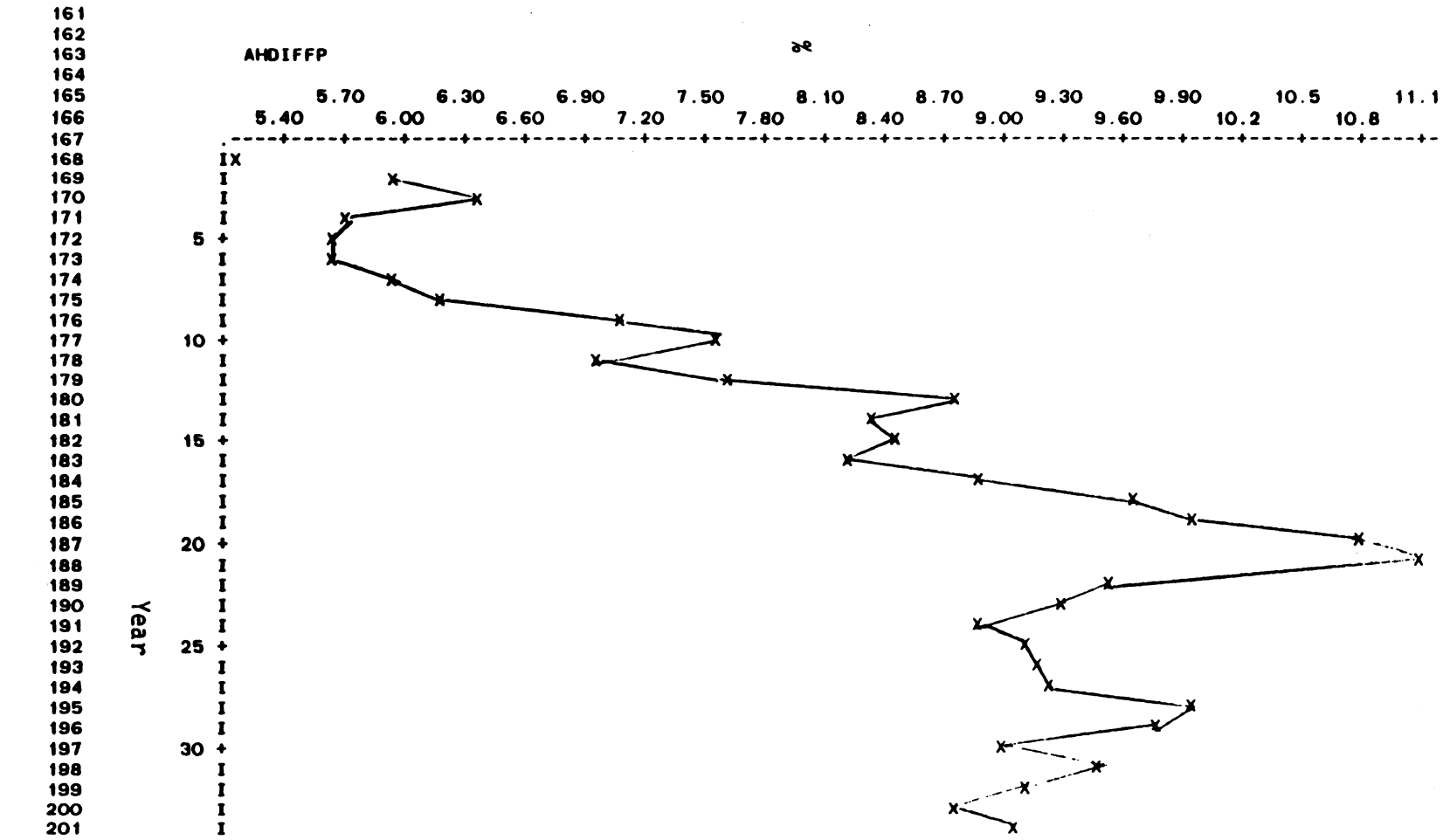


Exhibit 18.5. Toronto M.L.S. average and trimmed mean housing price series (quarterly). Note E3 is 000's of dollars.

```
Listing of PLOTFILET(535,576) at 18:30:12 on AUG  2, 1984 for CCid=EGER Page    1

535
536
537      SYMBOL FOR VARIABLE AVERAGE   IS    A
538      SYMBOL FOR VARIABLE TRIMAVER  IS    T
539
540                 58E3      63E3      68E3      73E3      78E3      83E3      88E3      93E3      98E3      10E4
541            55E3      60E3      65E3      70E3      75E3      80E3      85E3      90E3      95E3      10E4
542            .---+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+---
543            I       T---A
544            I        T---A
545            I        T----A
546            I         T---A
547         5 +            T---A
548            I             T----A
549            I            T----A
550            I            T----A
551            I             T----A
552        10 +                T----A
553            I                T----A
554            I               T----A
555            I                  T----A
556            I                    T----A
557        15 +                   T----A
558            I                  T----A
559            I                   T----A
560            I                      T----A
561            I                       T----A
562        20 +                      T----A
563            I                         T----A
564            I                                  T----A
565            I                                    T----A
566            I                                   T----A
567        25 +                                 T----A
568            I                                 T----A
569            I                              T----A
570            I                               T----A
571            I                                  T----A
572        30 +                                  T----A
573            I                                 T----A
574            I                                 T----A
575            I                                  T----A
576            I                                   T----A
Year

$L PLOTFILET(599,640)
```

Exhibit 18.6. Toronto M.L.S. percentage difference between average and trimmed mean price series (quarterly).

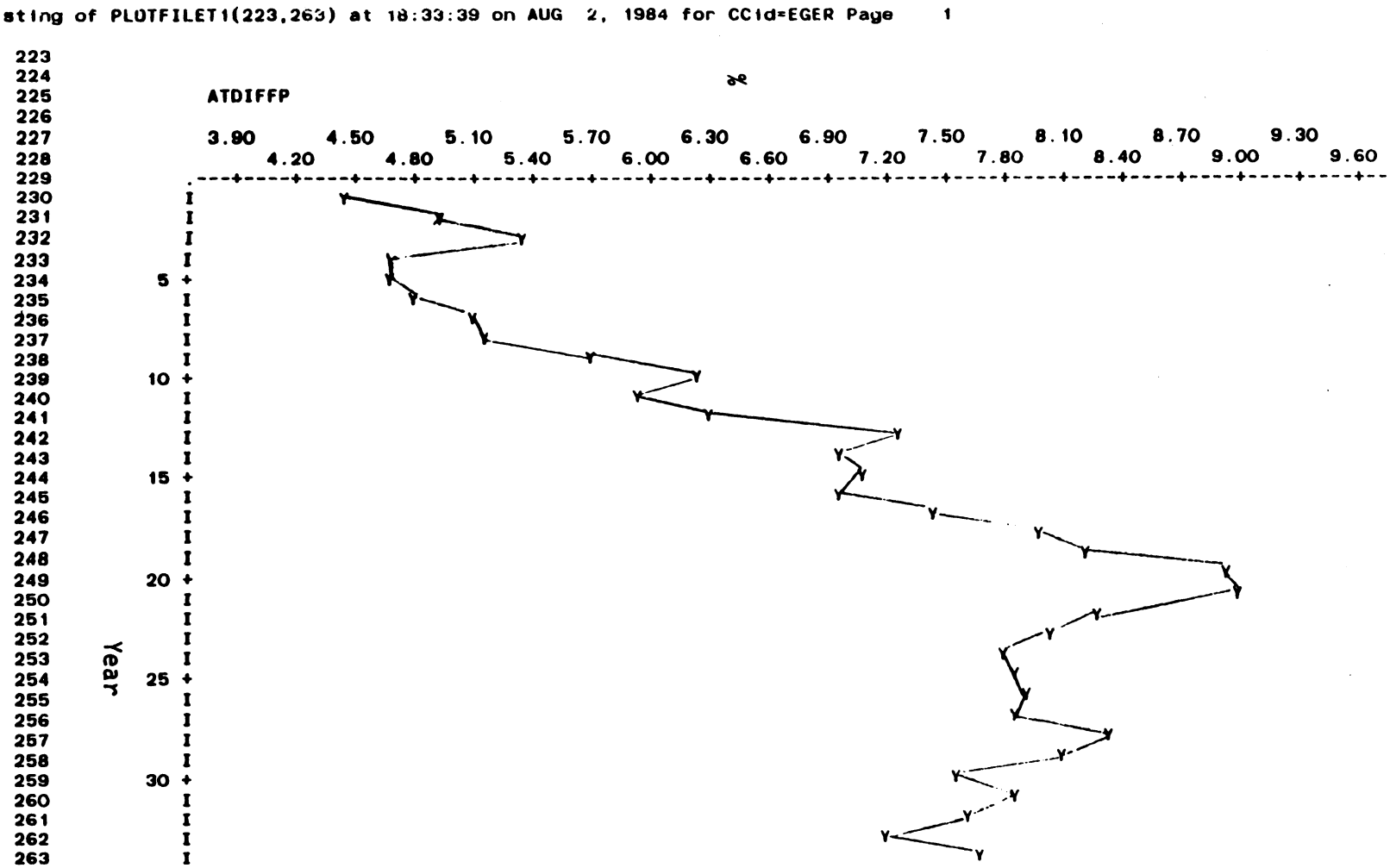


Exhibit 18.8. Toronto M.L.S. average and biweight housing price series (quarterly). Note E3 is 000's of dollars.

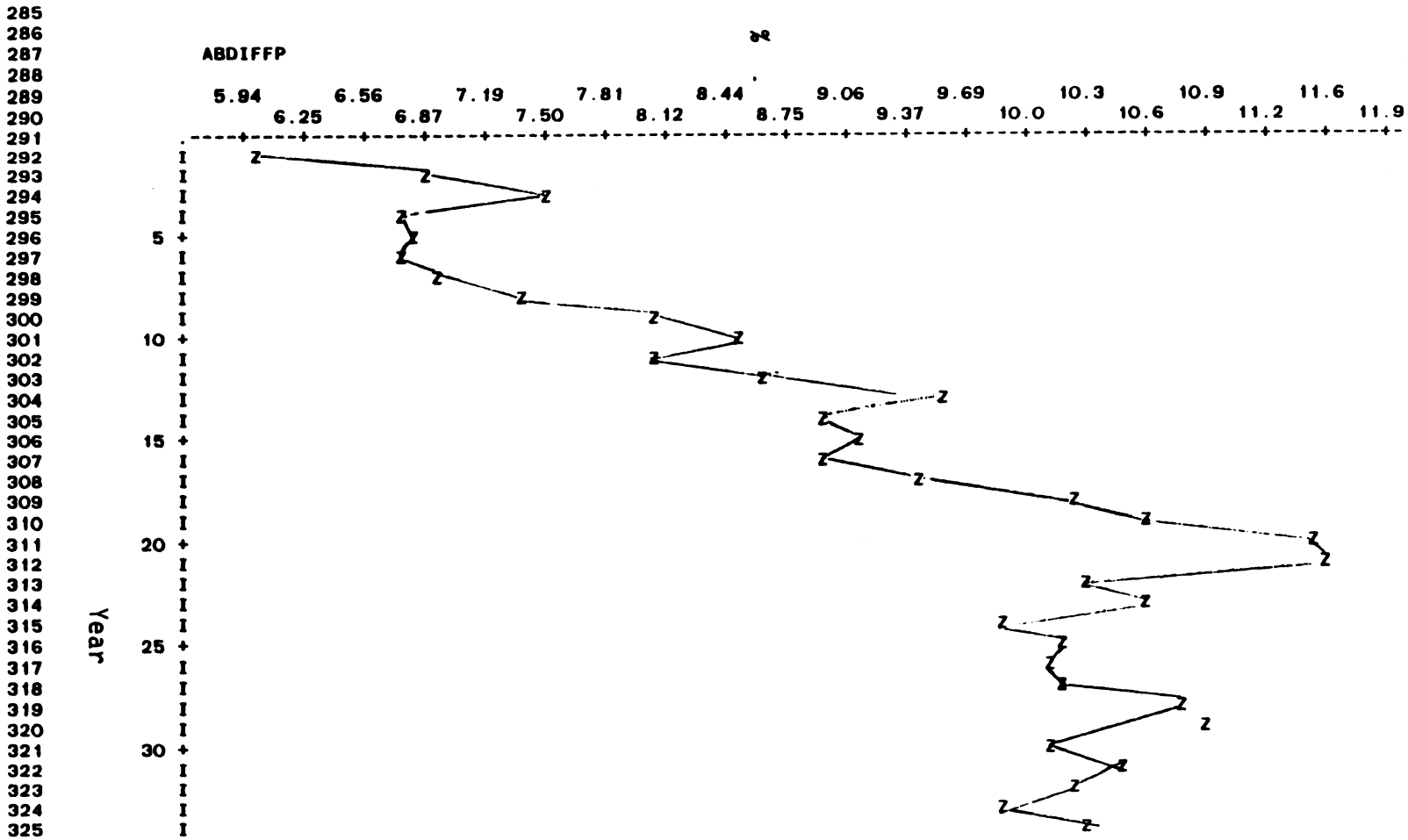
```
Listing of PLOTFILET(599,640) at 18:30:13 on AUG  2, 1984 for CCid=EGER Page    1

599
600
601      SYMBOL FOR VARIABLE AVERAGE   IS    A
602      SYMBOL FOR VARIABLE BIWEIGHT  IS    B
603
604                  58E3      63E3      68E3      73E3      78E3      83E3      88E3      93E3      98E3      10E4
605            55E3      60E3      65E3      70E3      75E3      80E3      85E3      90E3      95E3      10E4
606          .----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+--
607          I      B-——— A
608          I      B———— A
609          I      B————A
610          I       B———A
611        5 +          B ——— A
612          I           B———— A
613          I          B———— A
614          I          B———— A
615          I          B———— A
616       10 +              B ———— A
617          I               B ———— A
618          I              B———— A
619          I                  B ———— A
620          I                     B———————A
621       15 +                    B ———— A
622          I                  B ———— A
623          I                   B ———— A
624          I                        B ———— A
625          I                        B ———————A
626       20 +                       B ———————A
627          I                           B ———————— A
628          I                                    B ———————— A
629          I                                          B———————— A
630          I                                          B ———————— A
631       25 +                                       B ———————— A
632          I                                       B ———————— A
633          I                                   B———————— A
634          I                                   B ———————— A
635          I                                          B ———————— A
636       30 +                                             B ———————— A
637          I                                          B ———————— A
638          I                                          B———————— A
639          I                                          B ———————— A
640          I                                             B ———————— A

$L PLOTFILET(663,704)
```

Year

Exhibit 18.9. Toronto M.L.S. and percentage difference between average and biweight price series (quarterly).

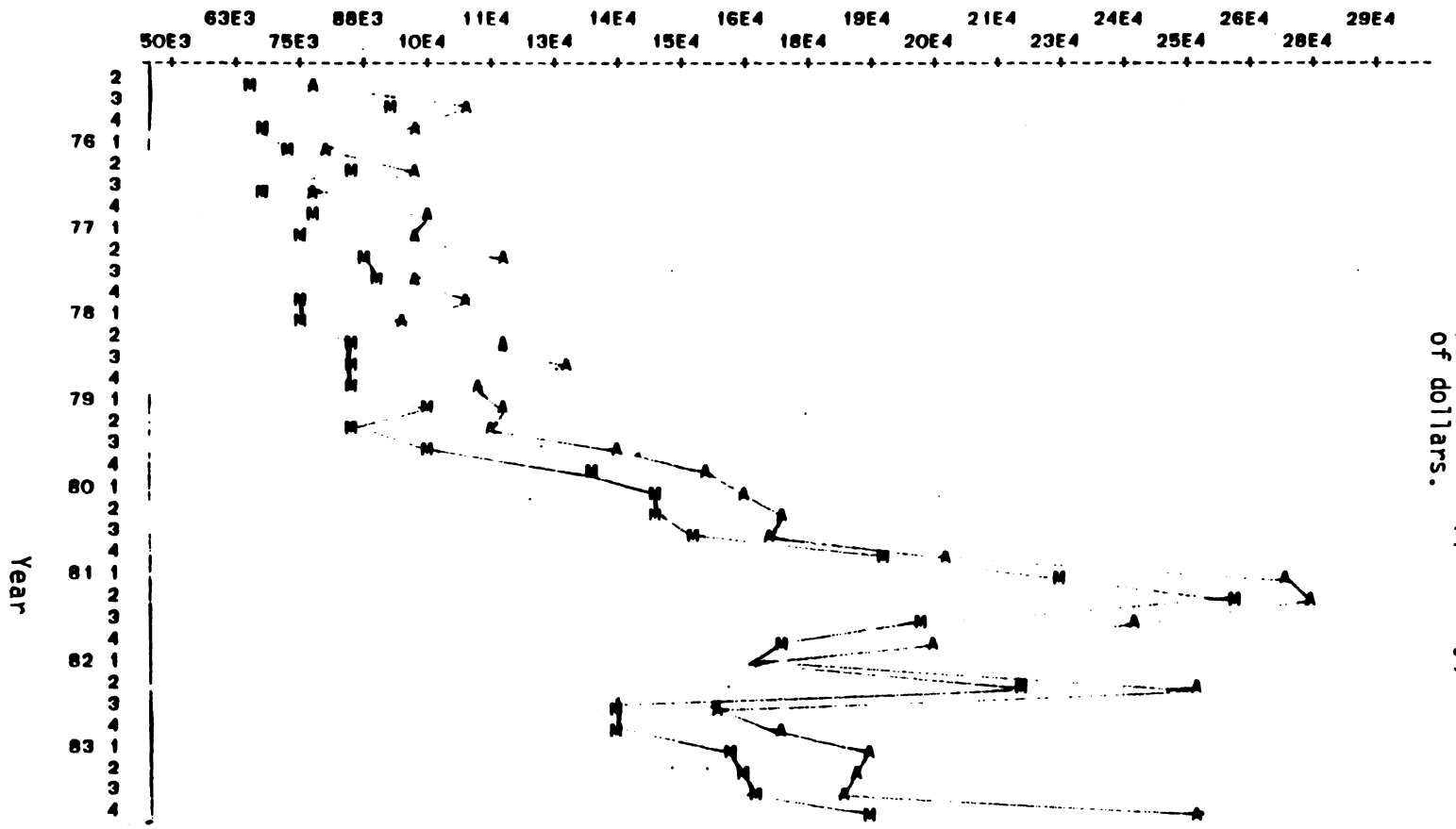


$L PLOTFILET1(348,389)

Exhibit 19.1. Kerrisdale M.L.S. average and median housing price series (quarterly). Note E3 is 000's of dollars.

```
Listing of PLOTFILEK(413,454) at 12:28:03 on JUL 31, 1984 for CCId=EGER Page    1

413
414      SYMBOL FOR VARIABLE AVERAGE   IS    A
415      SYMBOL FOR VARIABLE MEDIUM    IS    M
416
417                 63E3      88E3      11E4      14E4      16E4      19E4      21E4      24E4      26E4      29E4
418          50E3      75E3      10E4      13E4      15E4      18E4      20E4      23E4      25E4      28E4
419
420        2
421        3
422        4
423   76   1
424        2
425        3
426        4
427   77   1
428        2
429        3
430        4
431   78   1
432        2
433        3
434        4
435   79   1
436        2
437        3
438        4
439   80   1
440        2
441        3
442        4
443   81   1
444        2
445        3
446        4
447   82   1
448        2
449        3
450        4
451   83   1
452        2
453        3
454        4
```




```
$L PLOTFILEk(478,519)
```

Exhibit 19.2. Kerrisdale M.L.S. percentage difference between average and median price series (quarterly).

```
 *PRINT* assigned job number 95581
$sig eger landscape
Last signon was at 09:16:41, Mon Aug 13/84
User EGER signed on at 10:12:58, Mon Aug 13/84

Message for mailbox EGER: 1 old.  Use $MESSAGE to retrieve it.

$c PLOTFILEK1(99,143)
```

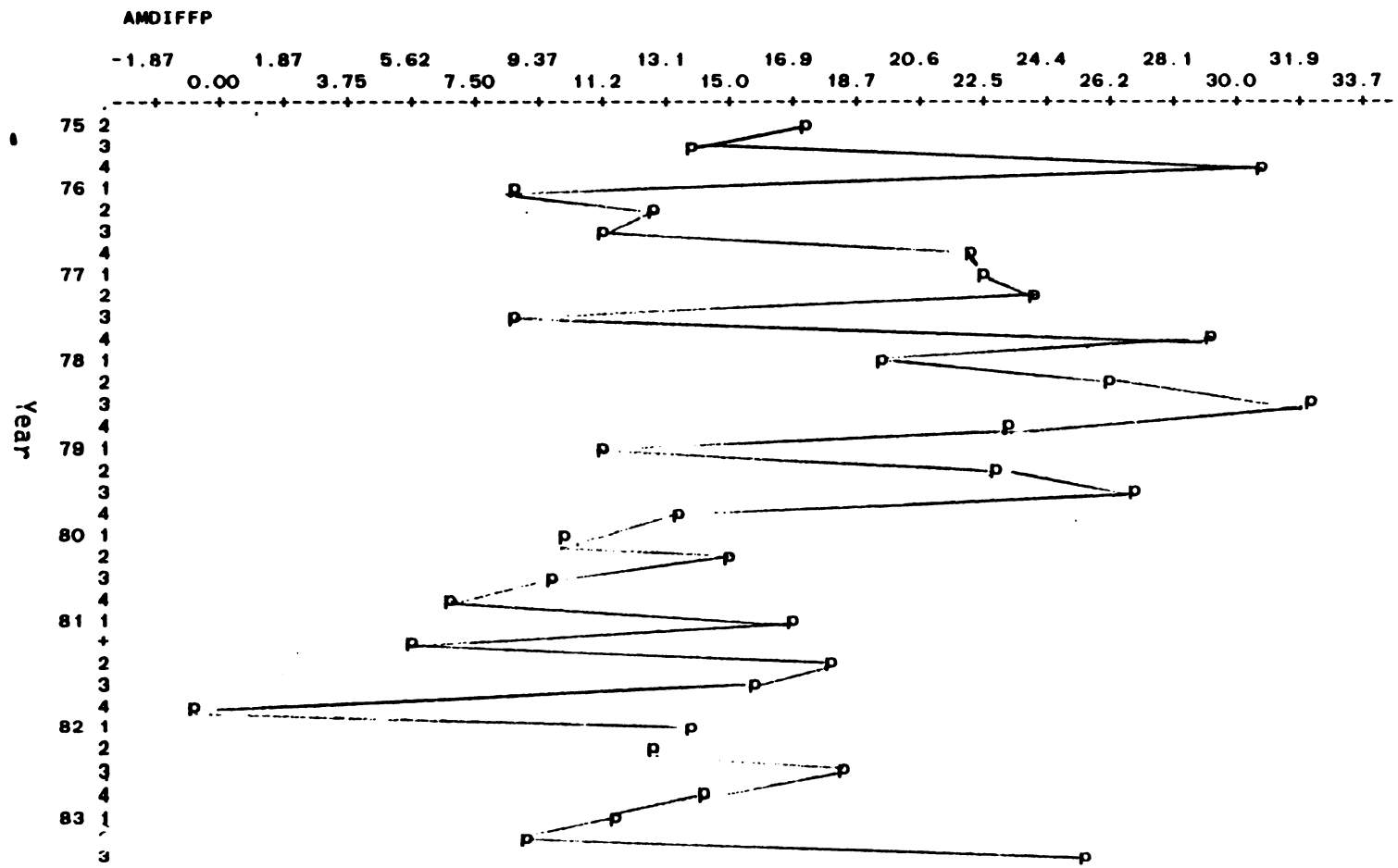


Exhibit 19.3. Kerrisdale M.L.S. average and Hampel housing price series (quarterly). Note E3 is 000's of dollars.


```
478
479     SYMBOL FOR VARIABLE AVERAGE   IS   .A
480     SYMBOL FOR VARIABLE HAMPEL    IS   H
481
482                 63E3      88E3      11E4      14E4      16E4      19E4      21E4      24E4      26E4      29E4
483          50E3      75E3      10E4      13E4      15E4      18E4      20E4      23E4      25E4      28E4
484
485        2
486        3
487        4
488   76   1
489        2
490        3
491        4
492   77   1
493        2
494        3
495        4
496   78   1
497        2
498        3
499        4
500   79   1
501        2
502        3
503        4
504   80   1
505        2
506        3
507        4
508   81   1
509        2
510        3
511        4
512   82   1
513        2
514        3
515        4
516   83   1
517        2
518        3
519        4
```

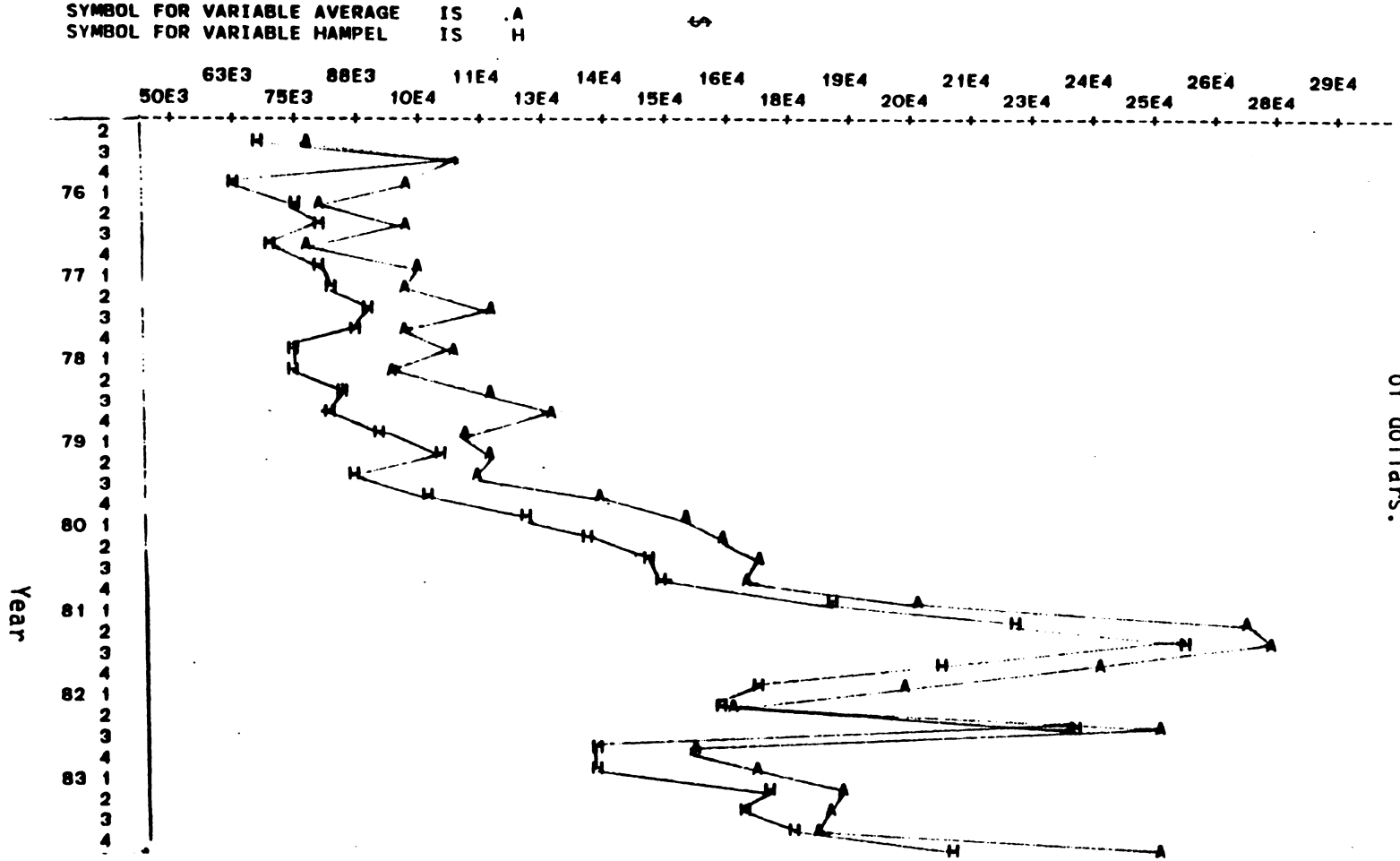


Exhibit 19.5. Kerrisdale M.L.S. average and trimmed mean housing price series (quarterly). Note E3 is 000's of dollars.

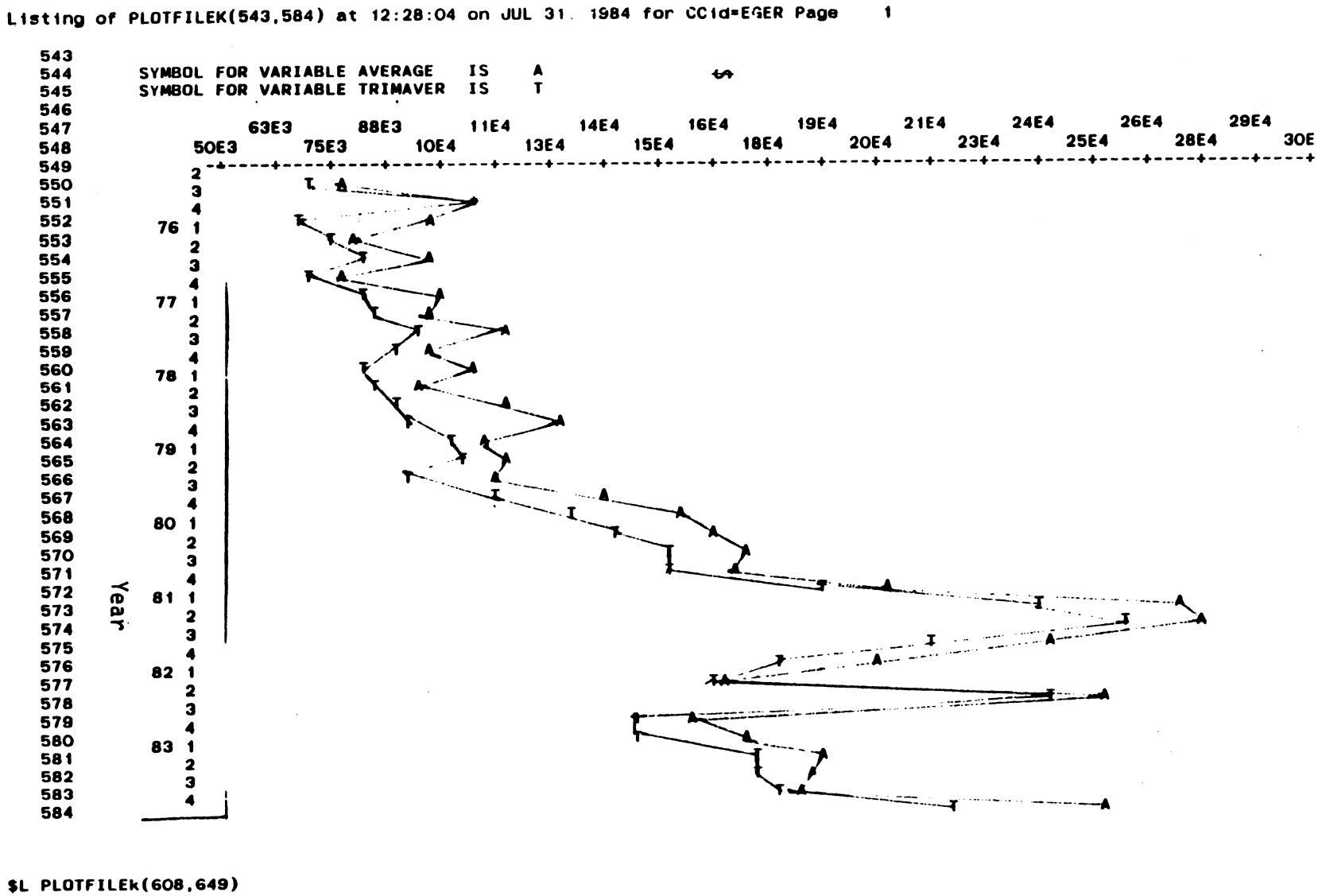


Exhibit 19.6. Kerrisdale M.L.S. percentage difference between average and trimmed mean price series (quarterly).

$c PLOTFILEK1(225,269)

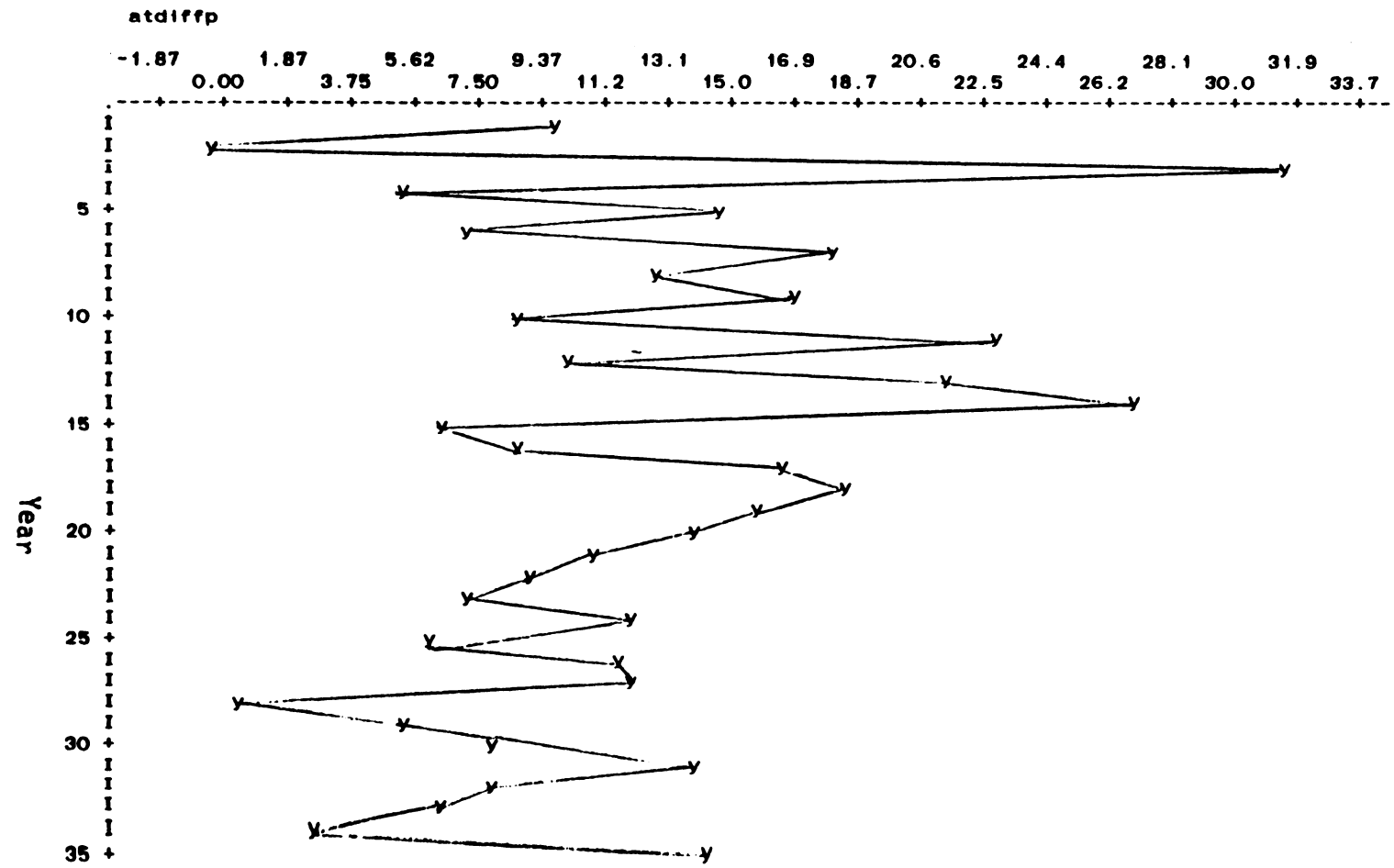


Exhibit 19.7. Kerrisdale M.L.S. average and biweight housing price series (quarterly). Note E3 is 000's of dollars.


```
608
609     SYMBOL FOR VARIABLE AVERAGE   IS    A
610     SYMBOL FOR VARIABLE BIWEIGHT  IS    B
611
612                 63E3      88E3      11E4      14E4      16E4      19E4      21E4      24E4      26E4      29E4
613          50E3      75E3      10E4      13E4      15E4      18E4      20E4      23E4      25E4      28E4
614
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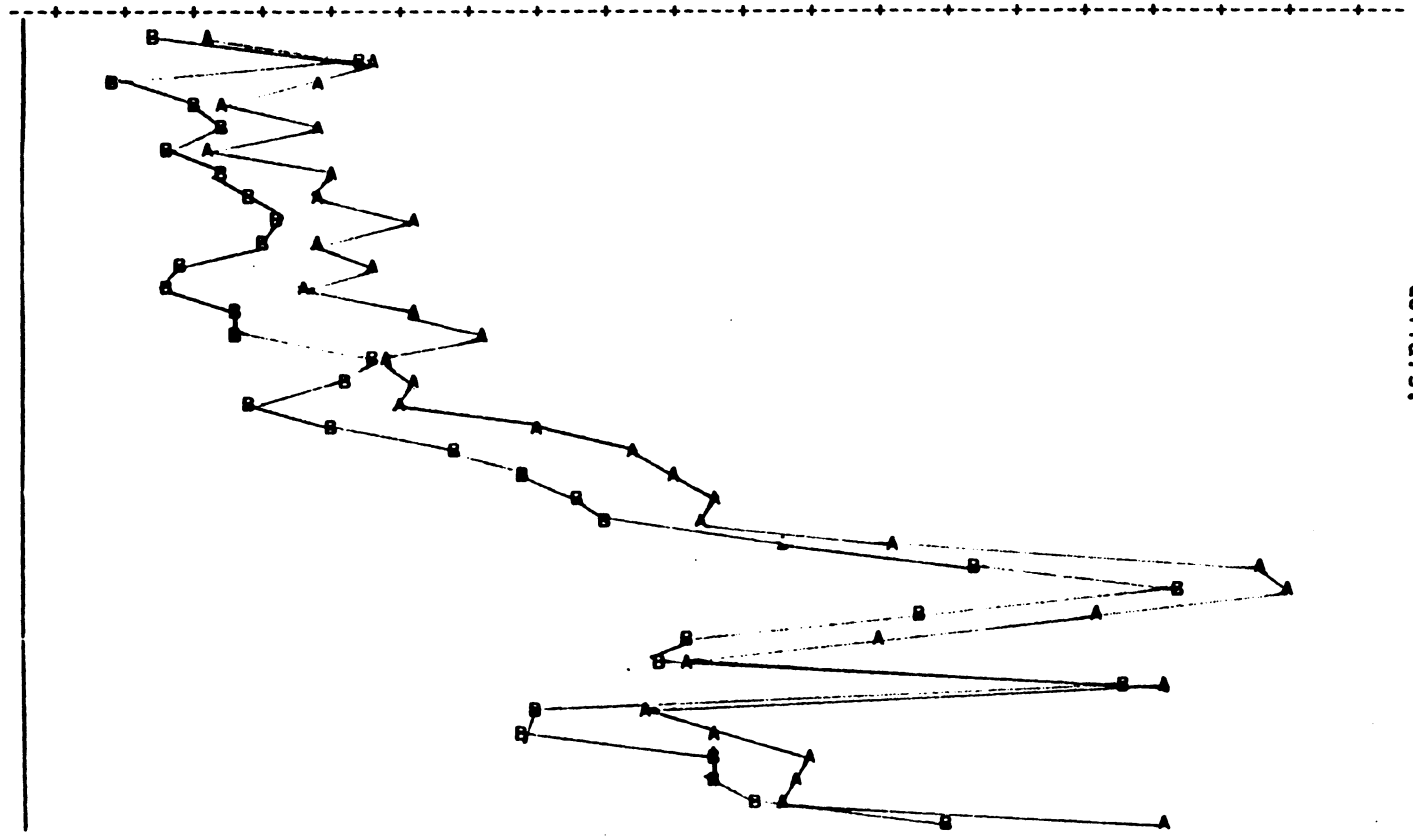


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$L PLOTFILEk(672,714)
```

Turning briefly now to the series in Appendix 1, and first reviewing the quarterly (the more conservative series), we find that variation in Dollard Des Ormeau mean and median can be 7%. (Appendix 2.2) Richmond demonstrates a continual difference of at least 8% and in the peak of the 1981 market had differences of 14%-16% (Appendix 5.2).

Winnipeg, in spite of the less speculative nature of that market, records a continual difference of at least 5%, and has some differences as large as 23%. (Appendix 6.2).

The monthly series for the Dollard market only shows volatility in late 1982 and 1983. (Appendix 1.2). Richmond, as noted in Appendix 5.2, demonstrates high percentage difference (15%-22%) in late 1976 and early 1977, in late 1978 and again in 1981. A continual bias of 8% exists for the mean as opposed to the median.

Winnipeg (Appendix 3.2) consistently reveals a difference of 6.5% of the mean over the median, with almost a cyclical and/or seasonal effect starting in 1975, peaking again in 1978, 1980, and 1981.

As it is far beyond the scope of this original study to determine factors causing these differences, a number of possibilities are noted in the conclusions.

6.0 Conclusions

The five data series have revealed that significant differences exist between the mean and robust measures of location. As it was not possible to measure any difference between the robust measures themselves (i.e., between the median Hampel, trimmed mean and biweight) the median was compared with the mean in this analysis. Further analysis of the robust measures, under varying sample size and/or differing neighbourhood definitions may cause this statement to be modified.

But given the fact that the median tended to be a more stable measure of location - in comparison to the biweight, Hampel and the trimmed mean - it (the median) was chosen for an appropriate measure of housing prices.

The magnitude of the difference between the mean and median is significant. Even as illustrated in the literature review, with the annualized data, significant differences exist between mean and median. As might be expected, when the data are disaggregated to a quarterly and monthly series, the differences become more and more pronounced, ranging as high (not the extreme cases, but an upper level) as 20%. Most cities exhibited a continual difference of at least 5%-10%.

Statements on upward trend and seasonal effects would be premature, although we do observe an upward drift of the differences between the mean and the median, particularly since 1980. Seasonal differences appear occasionally, as in the N.W. Winnipeg series.

Finally, as observed in the one case, where outliers are most likely to affect the mean, significant variation is shown in the Kerrisdale segment - small neighbourhood, upper income market. Continual variation of at least 8% is noted, with highs of 20%-24% not uncommon - on a quarterly basis.

It can be expected that the monthly series would show even greater fluctuation.

Future research can be expected to take a major direction. First, the implications of small sample size and robust measures of location can easily be studied, now that the data base has been assembled. Second, a direct link of the price based indices to the hedonic or quality adjusted price indices must be undertaken for comparable regions. Sufficient methodology and statistical techniques exist to make this latter step an operational one for municipal assessment boards, producers of housing price series, as well as those interested in academic pursuits.

6.1 Policy Implications for M.L.S. Boards

Several basic steps are recommended for M.L.S. boards at this time. In view of the fact that major boards are already running computerized data bases, the recommendations for data collection are considered quite realistic.

First, it is recommended that data bases of M.L.S. listing and sales be maintained and preserved on a monthly basis, for all boards. The word here is maintained, as in interviews, this author found that once the summary statistics were published by the local boards, often there was no perceived need to keep the original record of sale. It was therefore not possible to create different measures of location without the raw data.

The individual records could then be used by a central (or local) agency to compile the appropriate statistics. Notwithstanding the desire of each board to maintain individual regional and local records, a central agency, working with computerized data, could begin to publish a set of significant housing price indices. Errors of transposition, copying, etc., would be minimized. Delays in obtaining data would be eliminated.

As it is at the moment, we are neither certain whether the M.L.S. represents the market in a particular region, nor are we certain that it represents a segment (i.e., a neighbourhood). If this disparity is to be realistically resolved, attention must be given to designing neighbourhood segments for each C.M.A. and using the information to work toward a market index.

A word of caution should be noted. It may never be possible to use the M.L.S. as a basis for a complete market index, by the very nature of the segment of the market that M.L.S. represents. M.L.S. excludes some low and high income housing; is subject to withdrawal by major contributors

(as in Montreal and Quebec City) and is subject to competition from private organizations and market pressures. However, with proper sampling, the M.L.S. index can be used to cover a majority of the existing housing market.

Samples of M.L.S. data, from appropriately designed neighbourhood sets could be used to contrast market derived housing price indices with the appraised value series. Both series are necessary, if measurement is taken objectively and independently. It is only with these two approaches, particularly with the extreme problem of small sample size that exists, that the measurement of housing prices is going to be accurate and effective.

Finally, several significant steps have already been undertaken by the major boards - computerization considerations aside. The Vancouver Real Estate Board publishes median prices together with quartile price ranges. The Winnipeg Board maintains an excellent file of housing characteristics as well as the normal price, date, information published for the regular statistics. This approach allows further refinement of the price derived approach, with an adjusted (or hedonic) quality approach. The Toronto Board has maintained for years a significant breakdown of prices by very small regions.

These steps individually, if coordinated and used by all boards, could result in meaningful housing price data being available for end users. The cost is unlikely to be significant, as these recommendations are essential to meet increased competition. Consumers will demand more complete information about the product that requires the largest expenditure of their lifetime.

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APPENDIX I

Comparative Series of Housing Prices by mean, median, Hampel, trimmed mean and biweight for:

Dollard Des Ormeau (Montreal)

N. W. Winnipeg

Richmond (Vancouver)

ALBERT F. EGER, Ph.D.
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Faculty of Management
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1001 Sherbrooke Street West
Montreal, PQ, H3A 1G5
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Exhibit 1.1 Dollard Des Ormeau monthly average and median housing price series in $'000's.

```
Listing of PLOTFILEDMO(833,839)+... at 11:11:48 on AUG 13, 1984 for CCid=EGER Page    1

833
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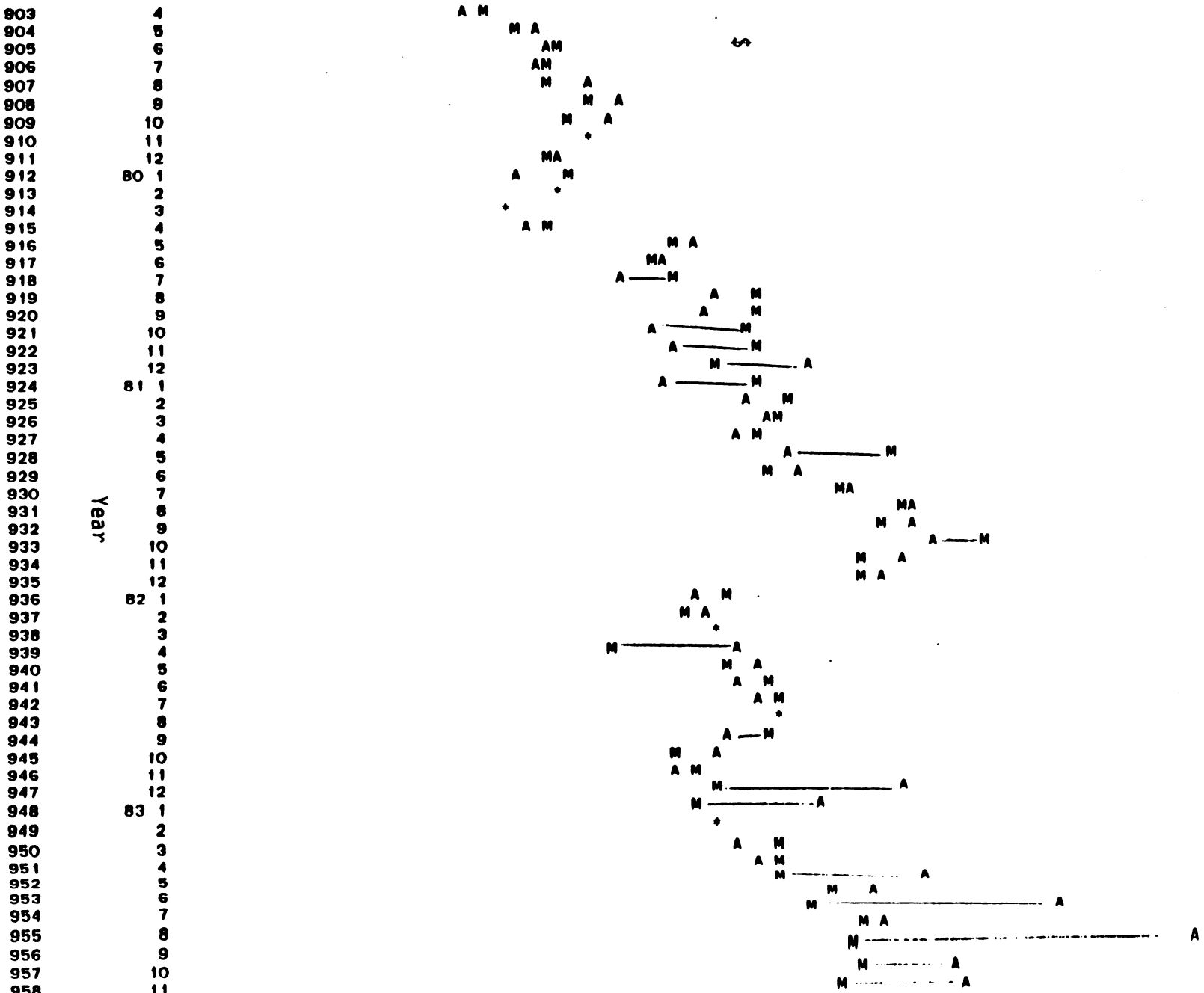
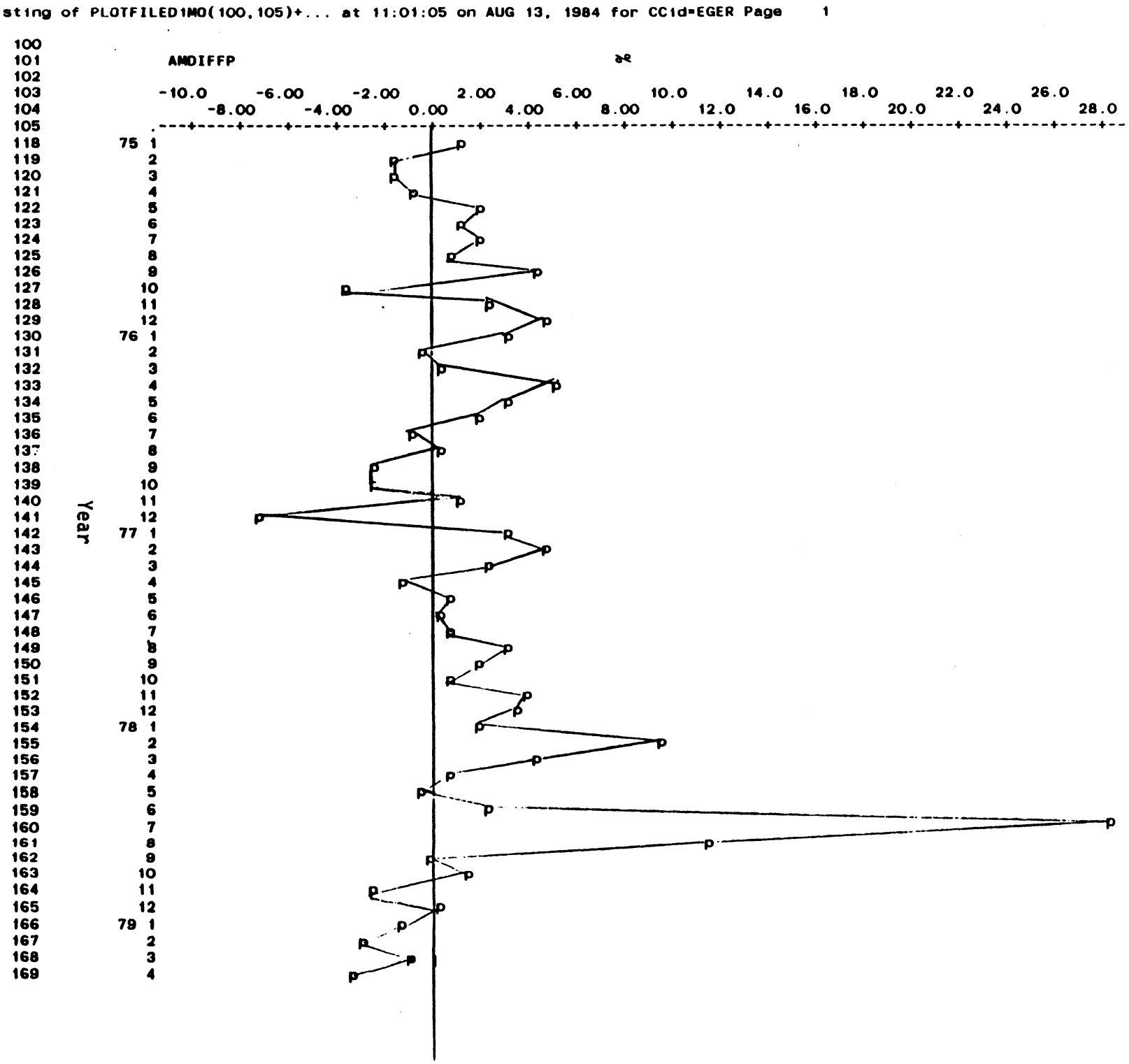
835      SYMBOL FOR VARIABLE  MEDIAN   IS    M
836
837                 28E3      34E3      41E3      47E3      53E3      59E3      66E3      72E3      78E3      84E3
838            25E3      31E3      38E3      44E3      50E3      56E3      63E3      69E3      75E3      81E3
839          .--+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----
852       75 1                          *
853          2                          AM
854          3                          AM
855          4                          *
856          5                               M A
857          6                          MA
858          7                            MA
859          8                              MA
860          9                               M  A
861         10                            A M
862         11                              MA
863         12                               M   A
864       76 1                            M A
865          2                            *
866          3                             *
867          4                            M  A
868          5                              M A
869          6                            M A
870          7                             AM
871          8                             *
872          9                            A M
873         10                              A M
874         11                             MA
875         12                          A——M
876       77 1                              M A
877          2                             M  A
878          3                           M A
879          4                       *
880          5                      *
881          6                          MA
882          7                          *
883          8                          M A
884          9                        M A
885         10                        *
886         11                          M A
887         12                     M A
888       78 1                       MA
889          2                        M ——— A
890          3                       M  A
891          4                      MA
892          5                        *
893          6                          MA
894          7                          M ———————————————— A
895          8                          M———— A
896          9                           *
897         10                             MA
898         11                          AM
899         12                           MA
900       79 1                               AM
901          2                            A M
902          3                             AM
```



1PAGE 8 BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Exhibit 1.1 Dollard Des Ormeau monthly average and median housing price series in $'000's.

Exhibit 1.2 Dollard Des Ormeau monthly percentage difference between average and median.



Listing of PLOTFILED1MO(100,105)+... at 11:01:05 on AUG 13, 1984 for CCid=EGER Page 2

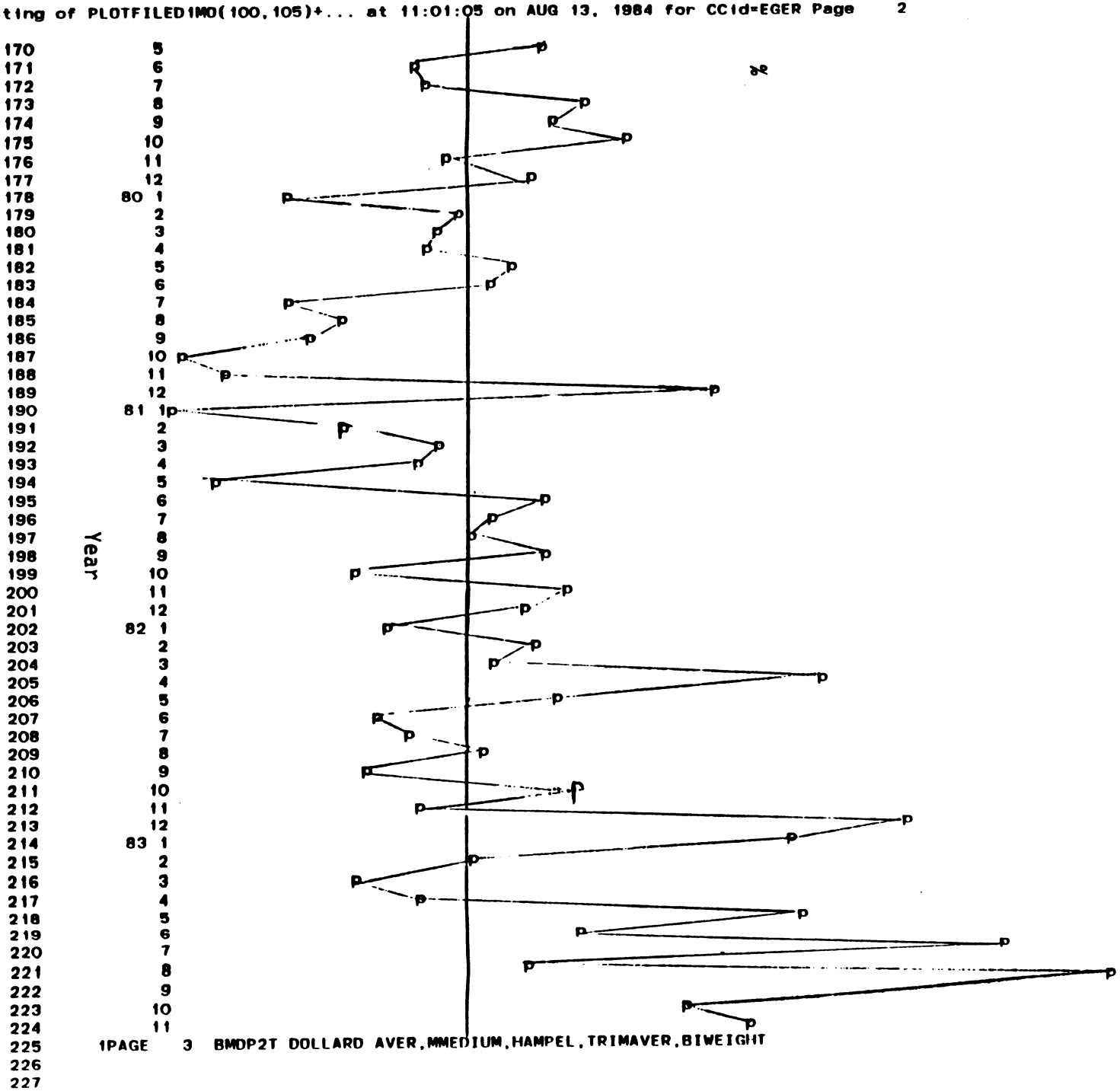
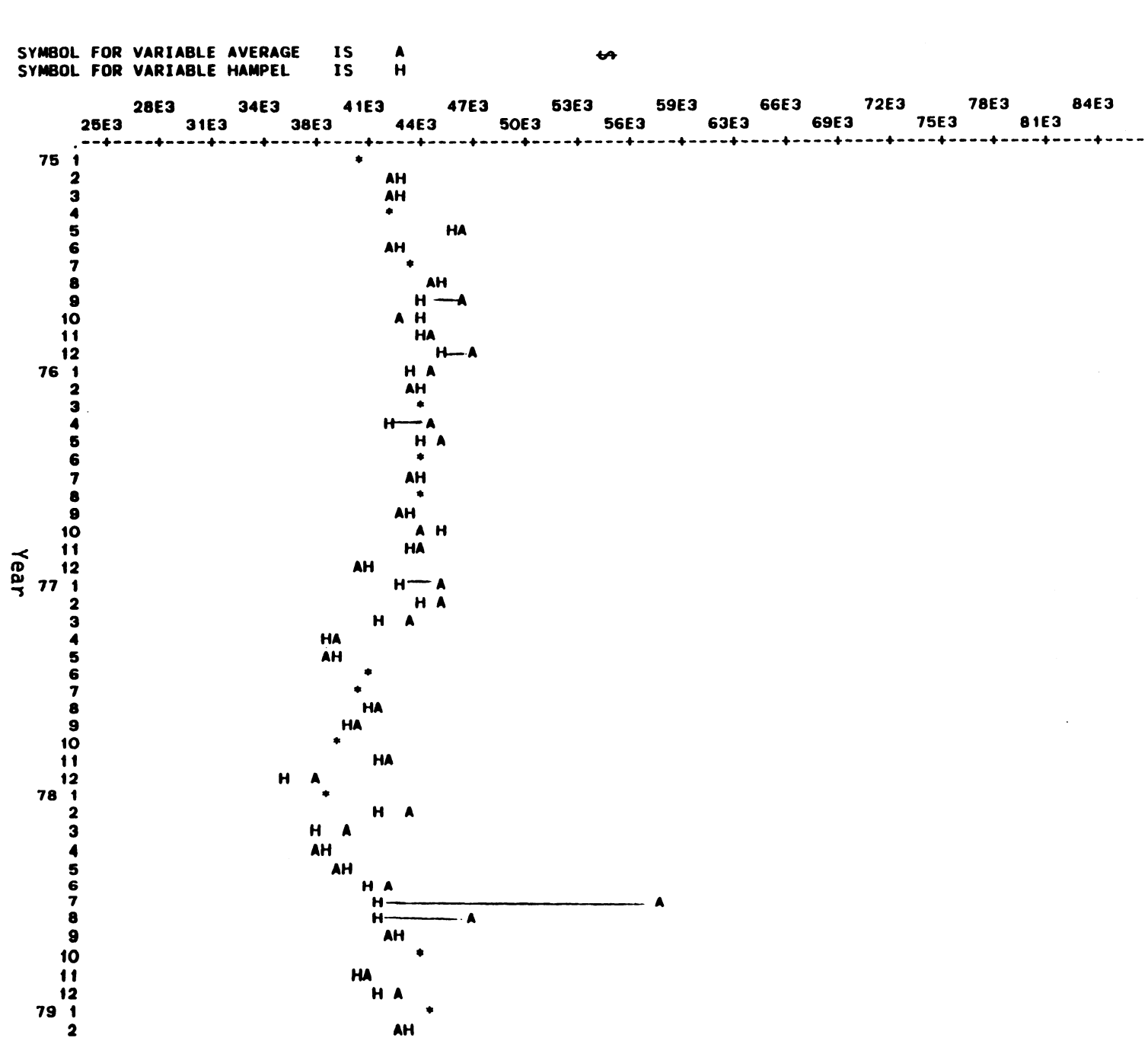


Exhibit 1.2 Dollard Des Ormeau monthly percentage difference between average and median.

Exhibit 1.3 Dollard Des Ormeau monthly average and Hampel housing price series in $'000's.



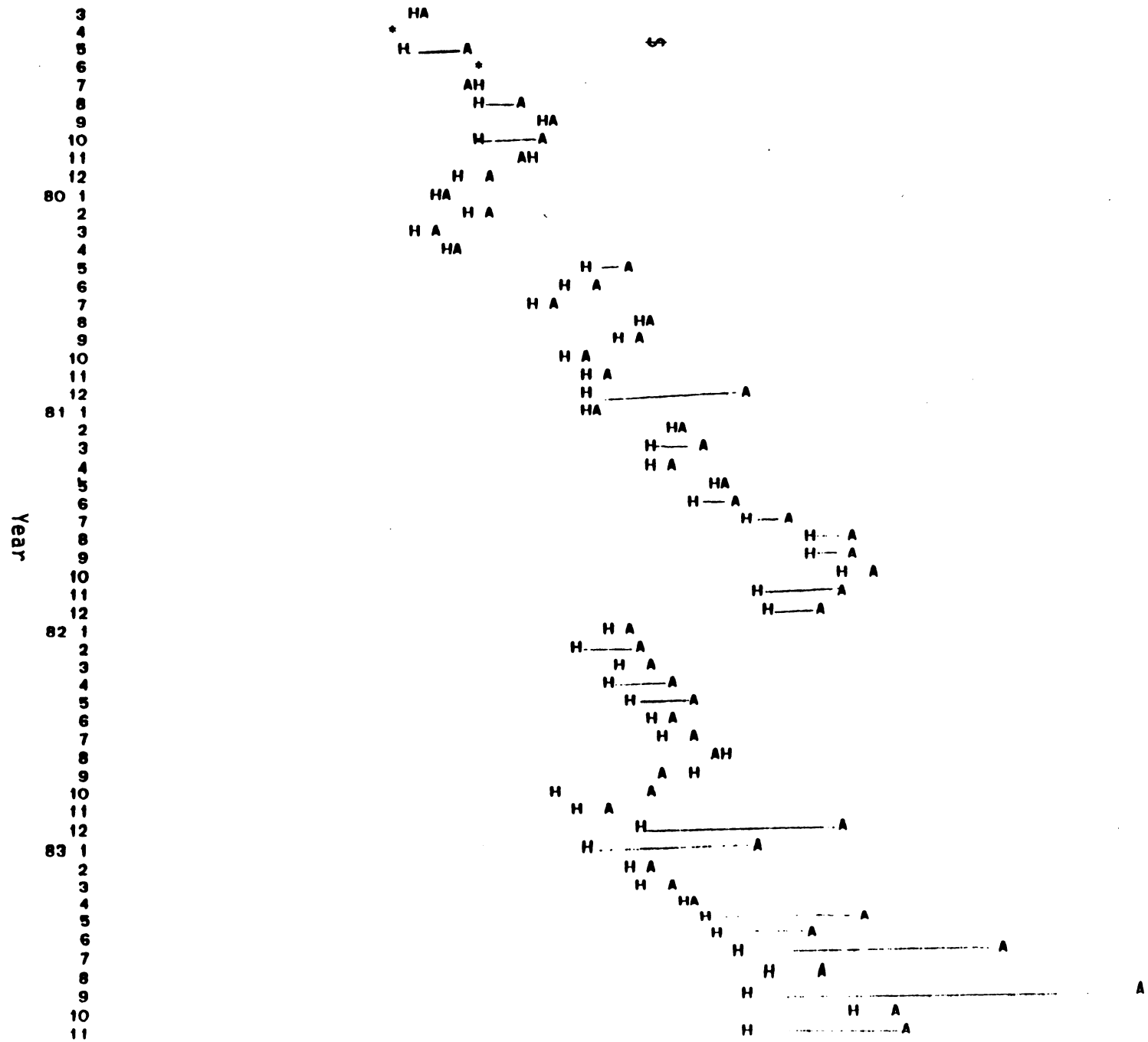
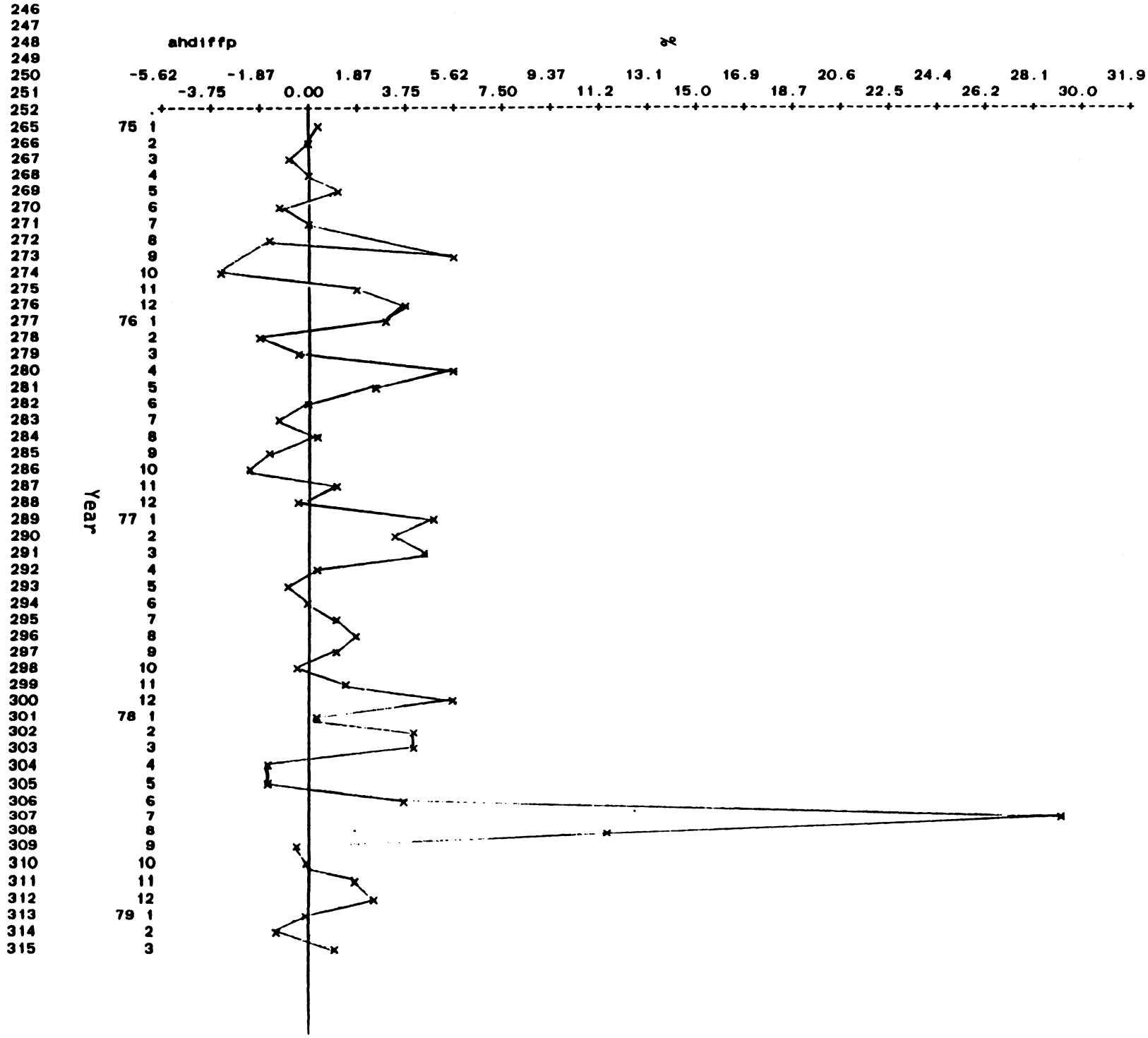
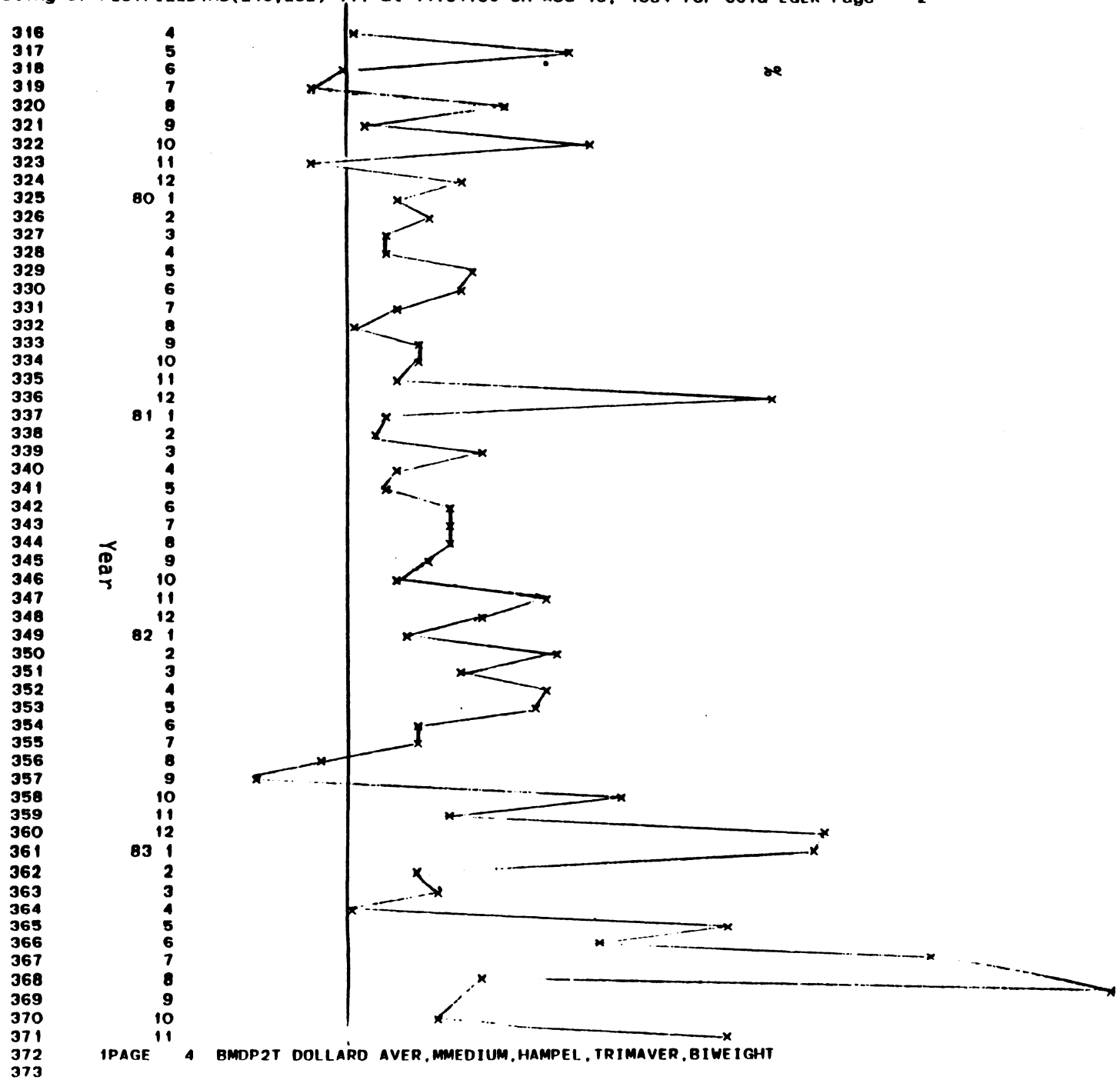


Exhibit 1.3 Dollard Des Ormeau monthly average and Hampel housing price series in $'000's.

Exhibit 1.4 Dollard Des Ormeau monthly percentage difference between average and Hampel.



Listing of PLOTFILED1MO(246,252)+... at 11:01:06 on AUG 13, 1984 for CCid=EGER Page 2



372 1PAGE 4 BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

373

Exhibit 1.4 Dollard Des Ormeau monthly percentage difference between average and Hampel.

Exhibit 1.5 Dollard Des Ormeau monthly average and trimmed mean housing price series in $'000's.

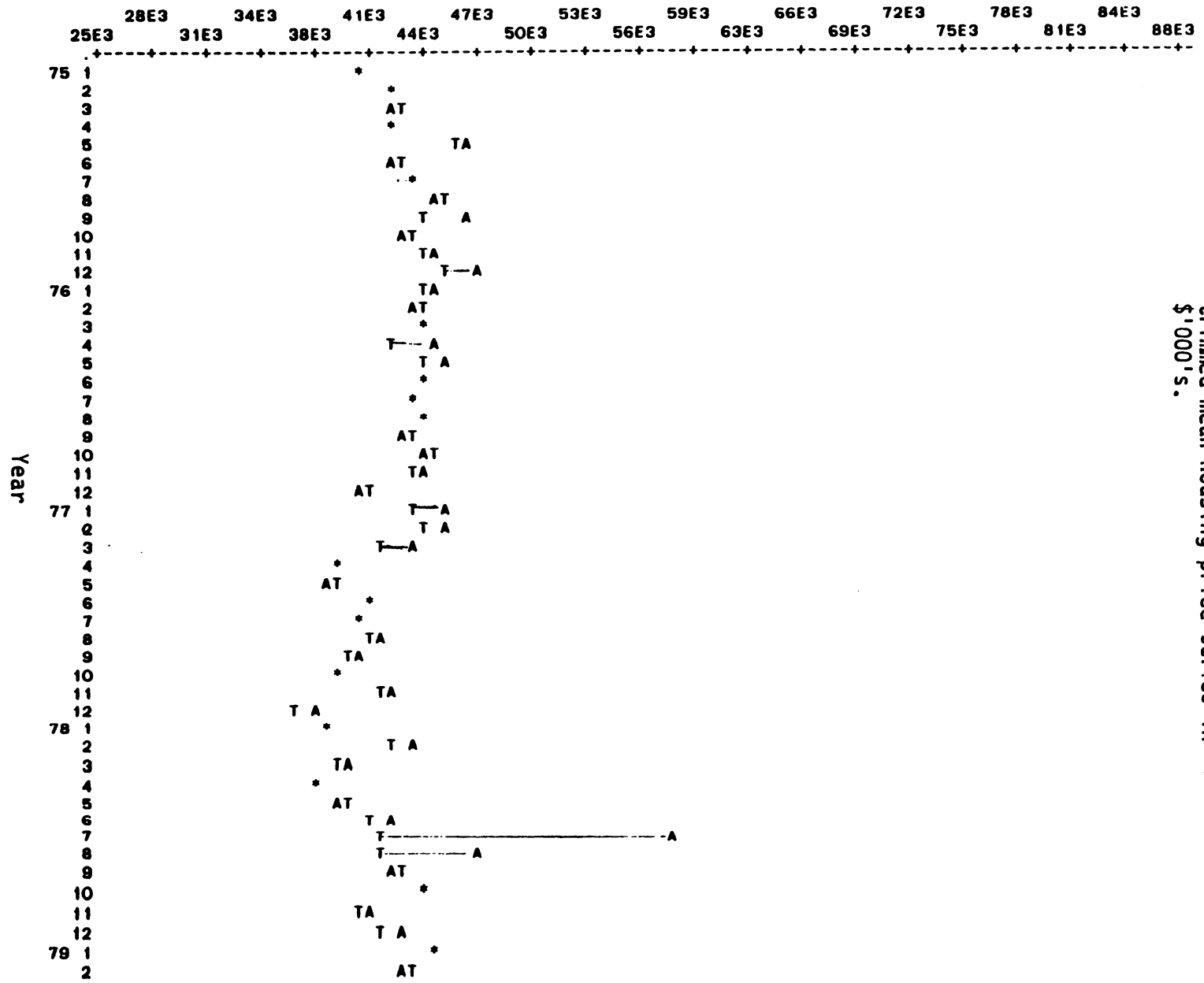


Exhibit 1.5 Dollard Des Ormeau monthly average and trimmed mean housing price series in $'000's.

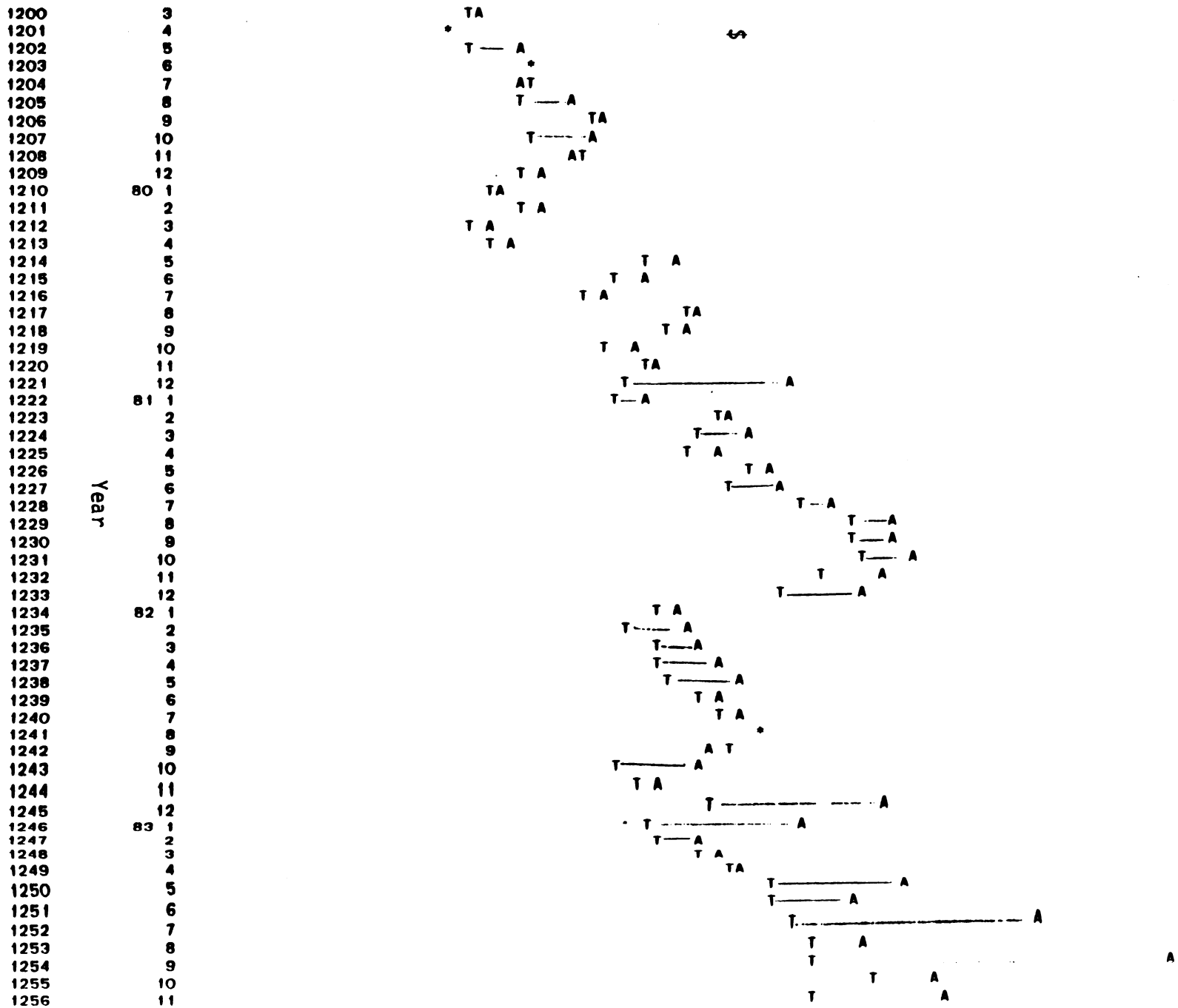


Exhibit 1.6 Dollard Des Ormeau monthly percentage difference between average and trimmed mean.

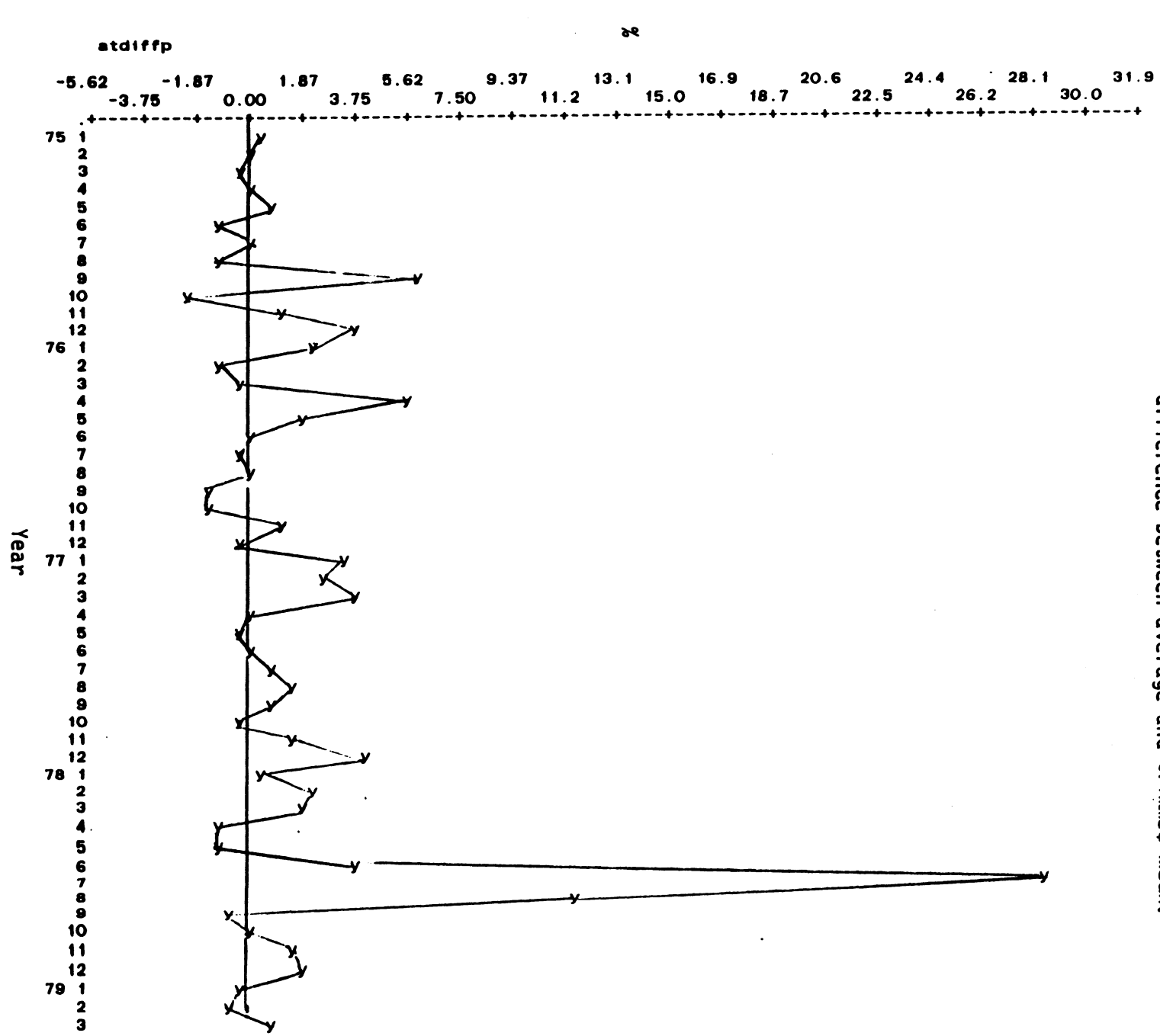
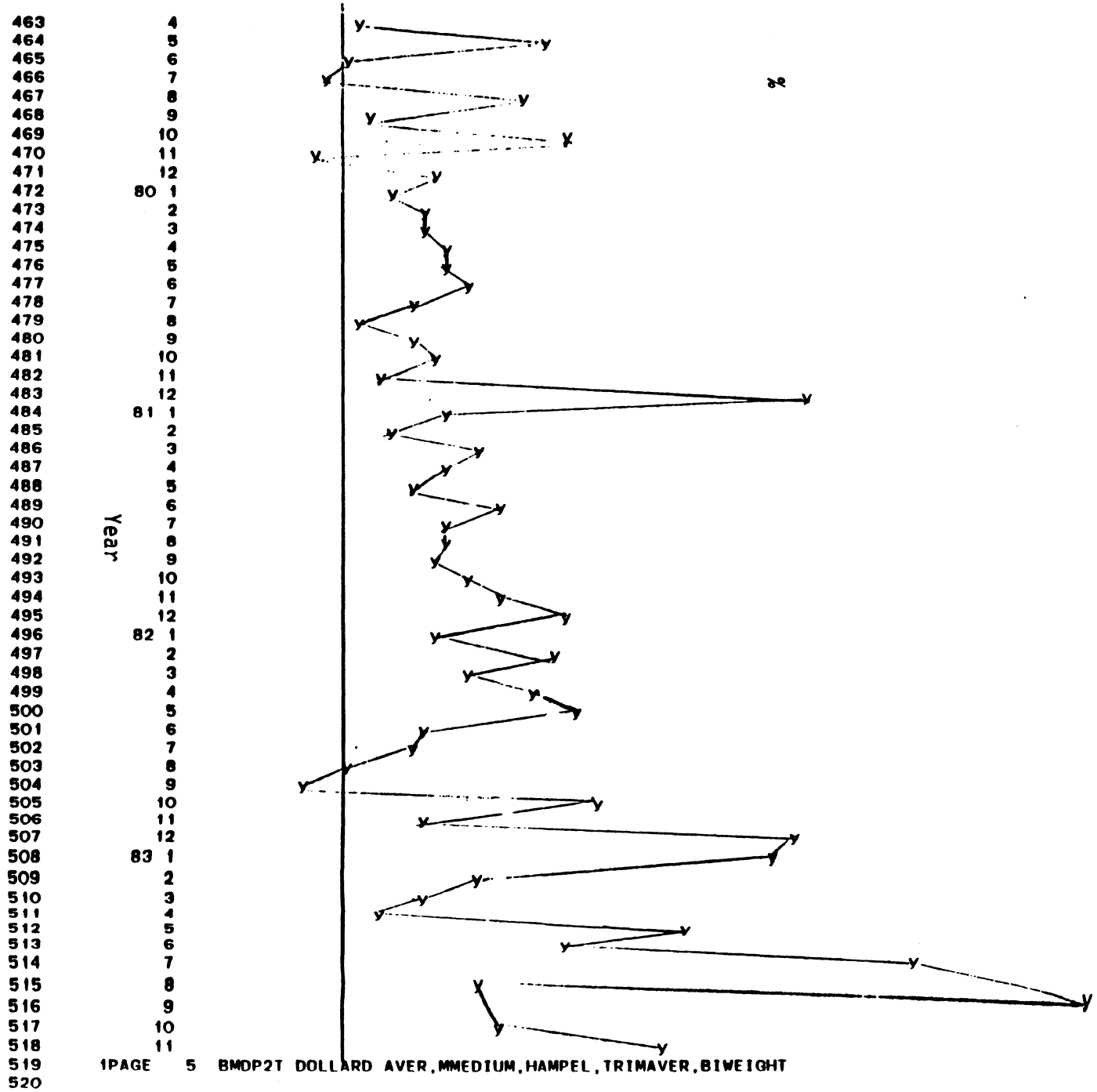


Exhibit 1.6 Dollard Des Ormeau monthly percentage difference between average and trimmed mean.



519 1PAGE 5 BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

520

Exhibit 1.7 Dollard Des Ormeau monthly average and biweight housing price series in $'000's.

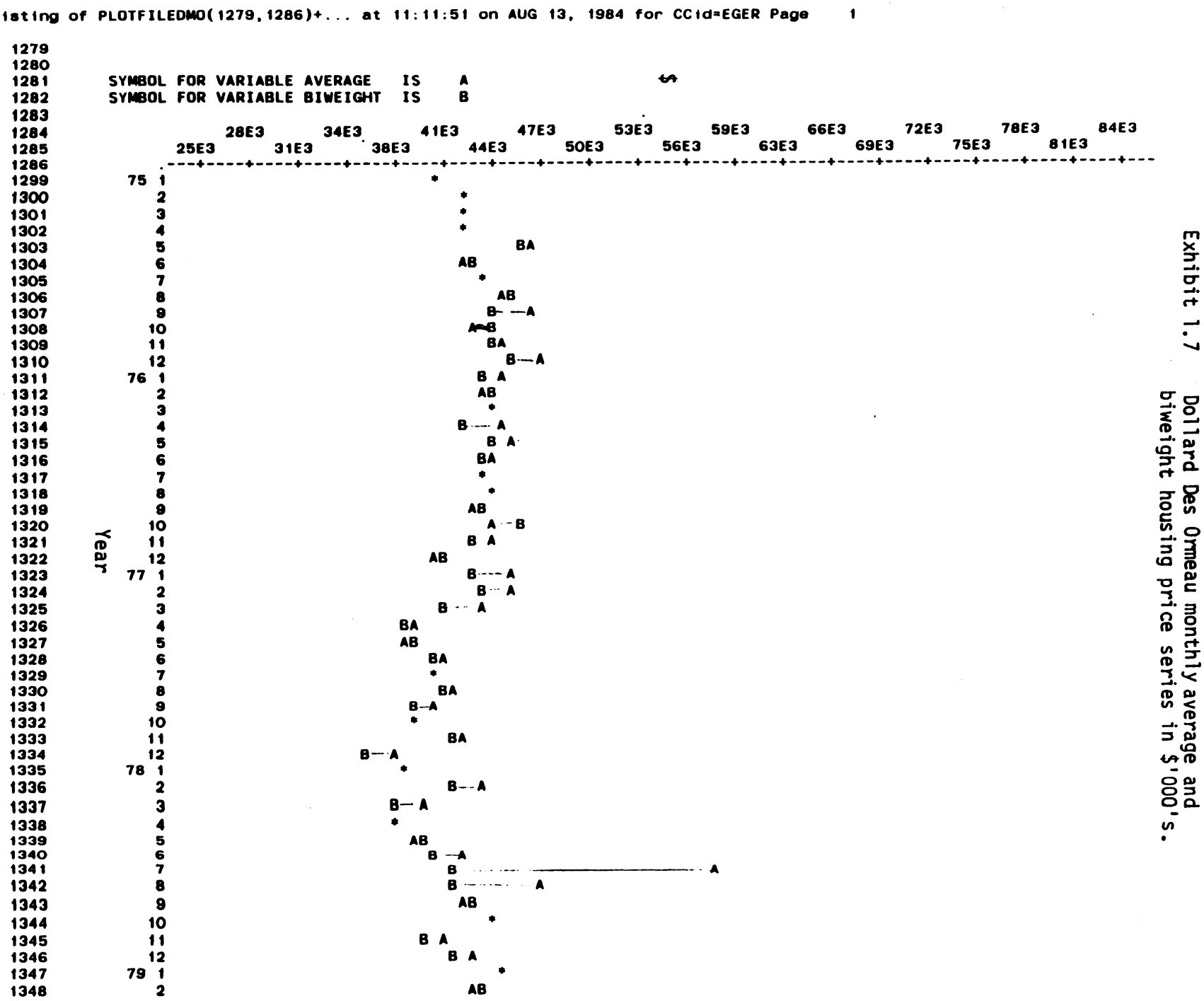
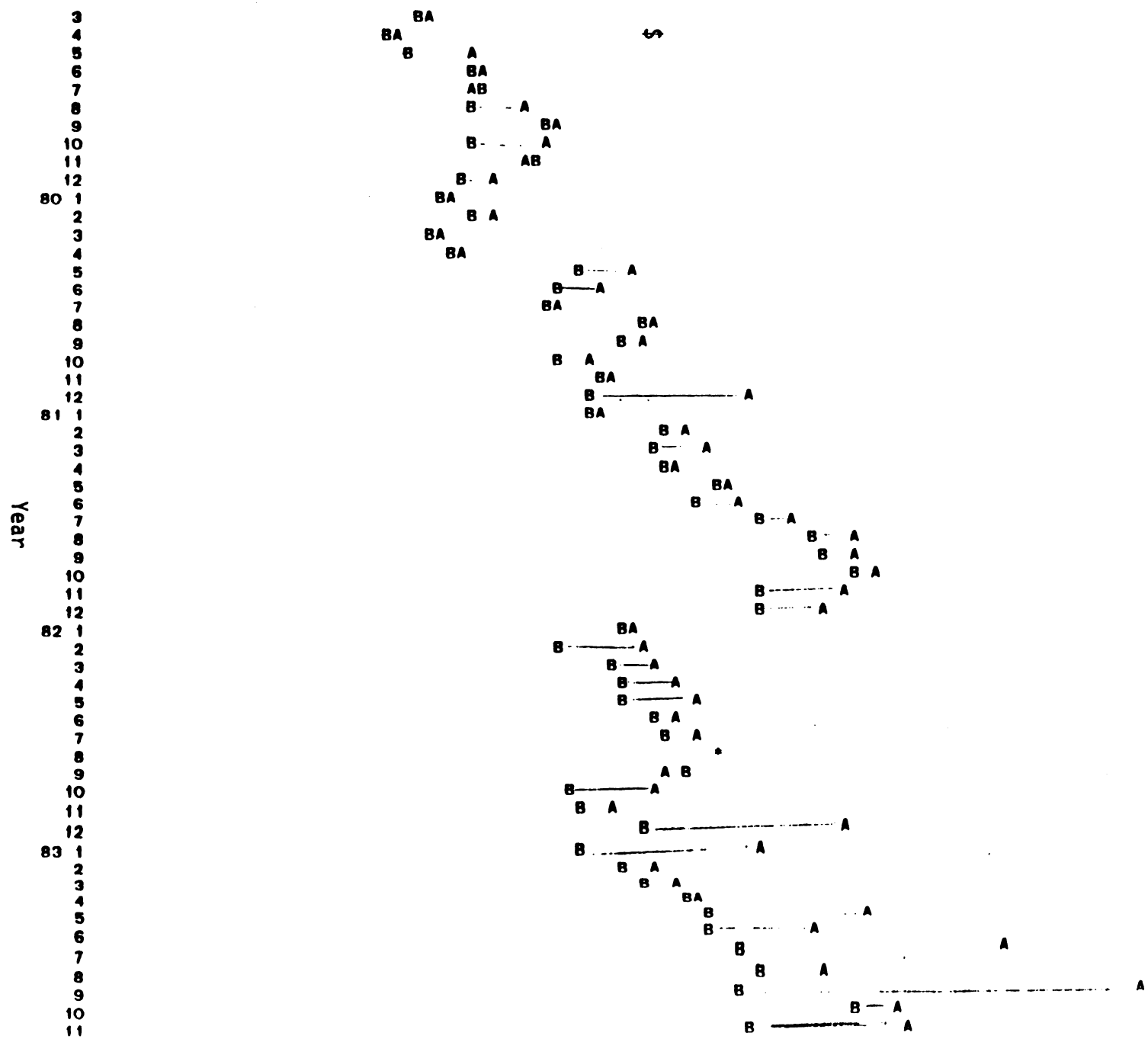


Exhibit 1.7 Dollard Des Ormeau monthly average and biweight housing price series in $'000's.



1406 1PAGE 11 BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Exhibit 1.8 Dollard Des Ormeau monthly percentage difference between average and biweight.

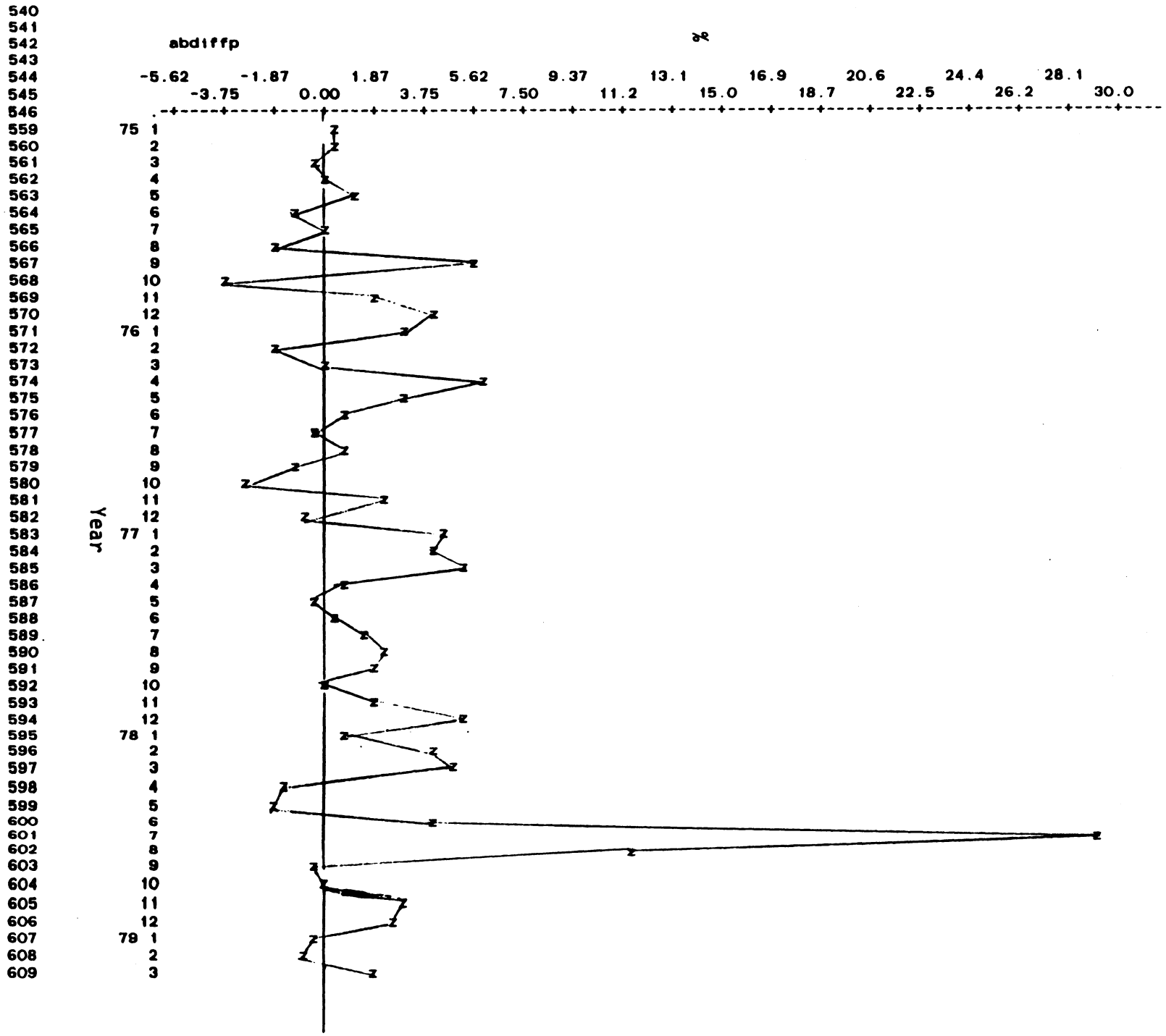
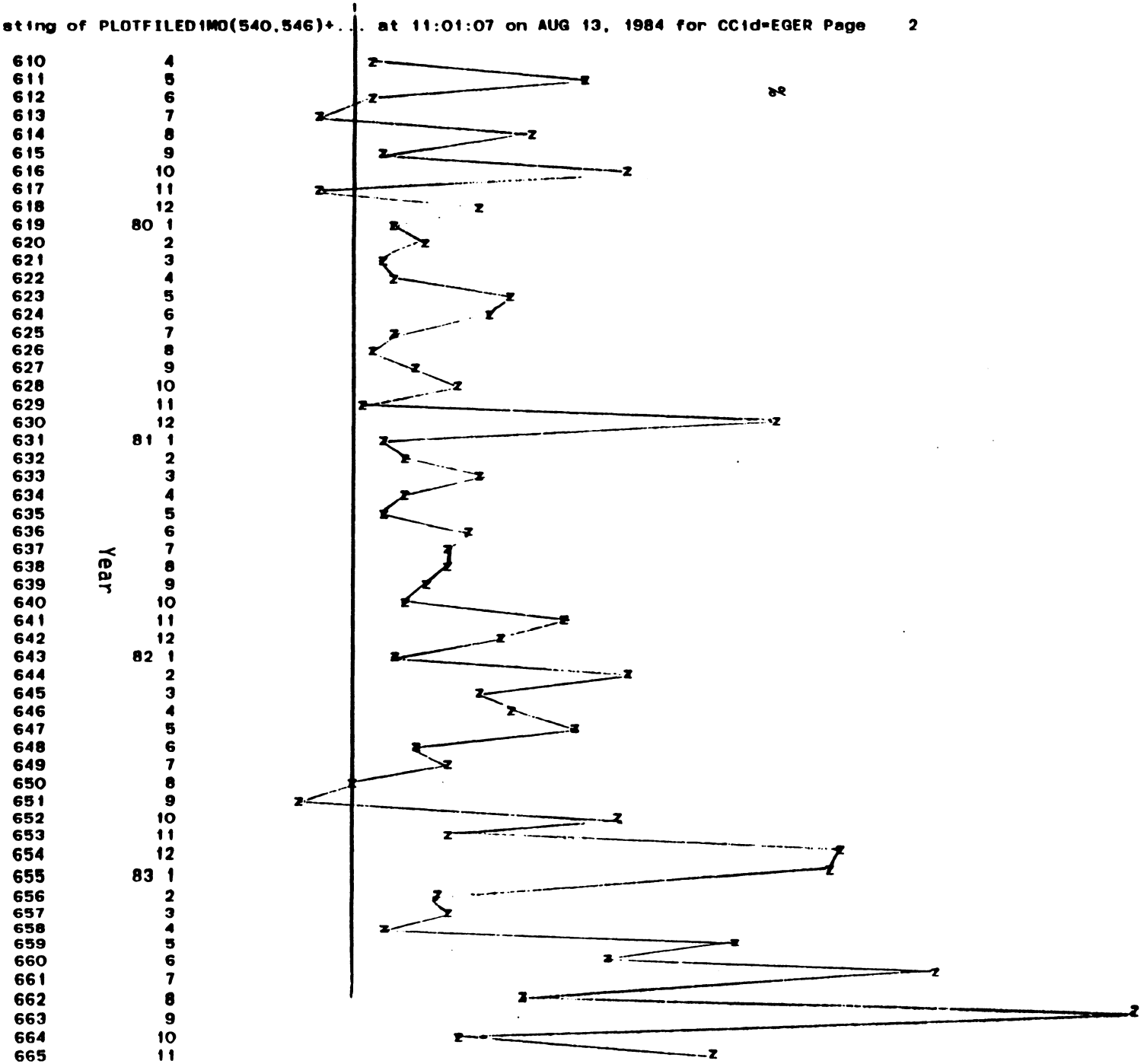


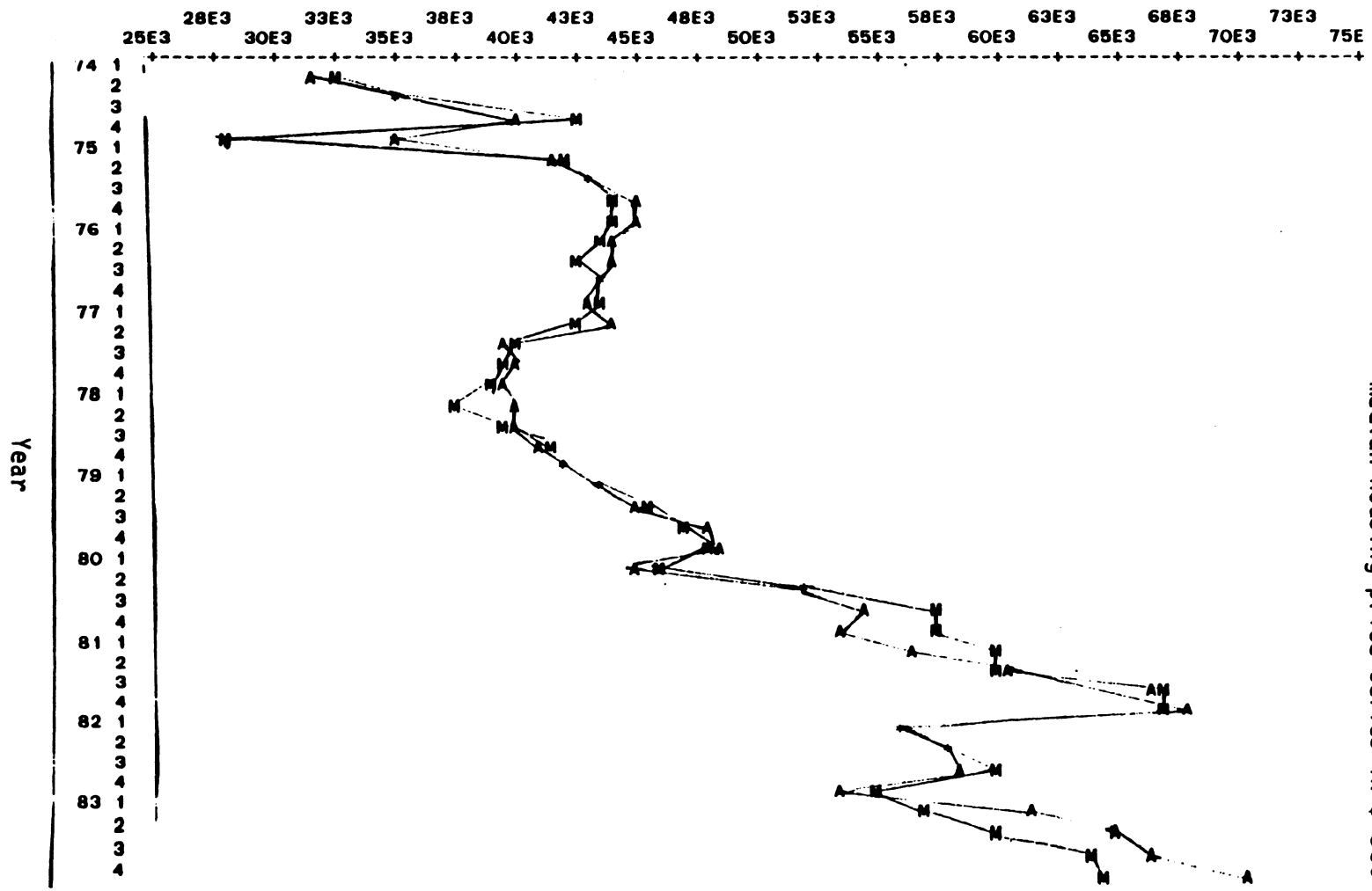
Exhibit 1.8 Dollard Des Ormeau monthly percentage difference between average and biweight.



1PAGE 6 BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Exhibit 2.1 Dollard Des Ormeau quarterly average and median housing price series in $'000's.

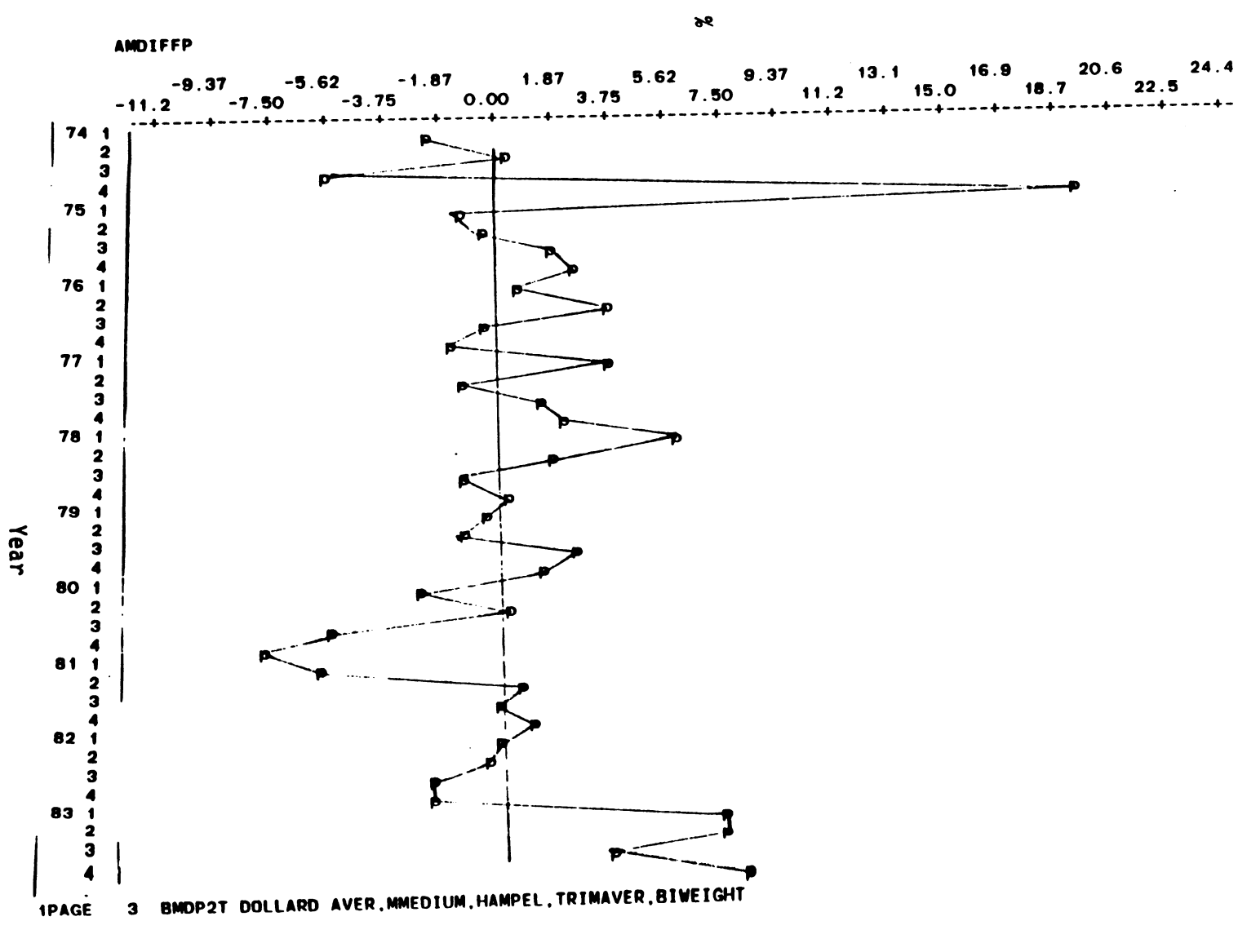
SYMBOL FOR VARIABLE AVERAGE IS A
SYMBOL FOR VARIABLE MEDIAN IS M



1PAGE 8 BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Exhibit 2.2 Dollard Des Ormeau quarterly percentage difference between average and median.

Listing of PLOTFILED1(99,148) at 12:33:01 on JUL 31, 1984 for CC1d=EGER Page 1



$L PLOTFILED1(167,216)

Exhibit 2.3 Dollard Des Ormeau quarterly average and Hampel housing price series in $'000's.

```
Listing of PLOTFILED(507,557) at 12:30:23 on JUL 31, 1984 for CCid=EGER Page    1
507
508
509      SYMBOL FOR VARIABLE AVERAGE   IS    A
510      SYMBOL FOR VARIABLE HAMPEL    IS    H
511
512                 34E3      38E3      42E3      46E3      50E3      54E3      58E3      62E3      66E3      70E3
513          32E3      36E3      40E3      44E3      48E3      52E3      56E3      60E3      64E3      68E3
514      74 1 +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
515         2
516         3
517         4
518      75 1
519         2
520         3
521         4
522      76 1
523         2
524         3
525         4
526      77 1
527         2
528         3
529         4
530      78 1
531         2
532         3
533         4
534      79 1
535         2
536         3
537         4
538      80 1
539         2
540         3
541         4
542      81 1
543         2
544         3
545         4
546      82 1
547         2
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550      83 1
551         2
552         3
553         4
554
555   Year
556
557   1PAGE    9  BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

$L PLOTFILED(581,626)
```

Exhibit 2.4 Dollard Des Ormeau quarterly percentage difference between average and Hampel.

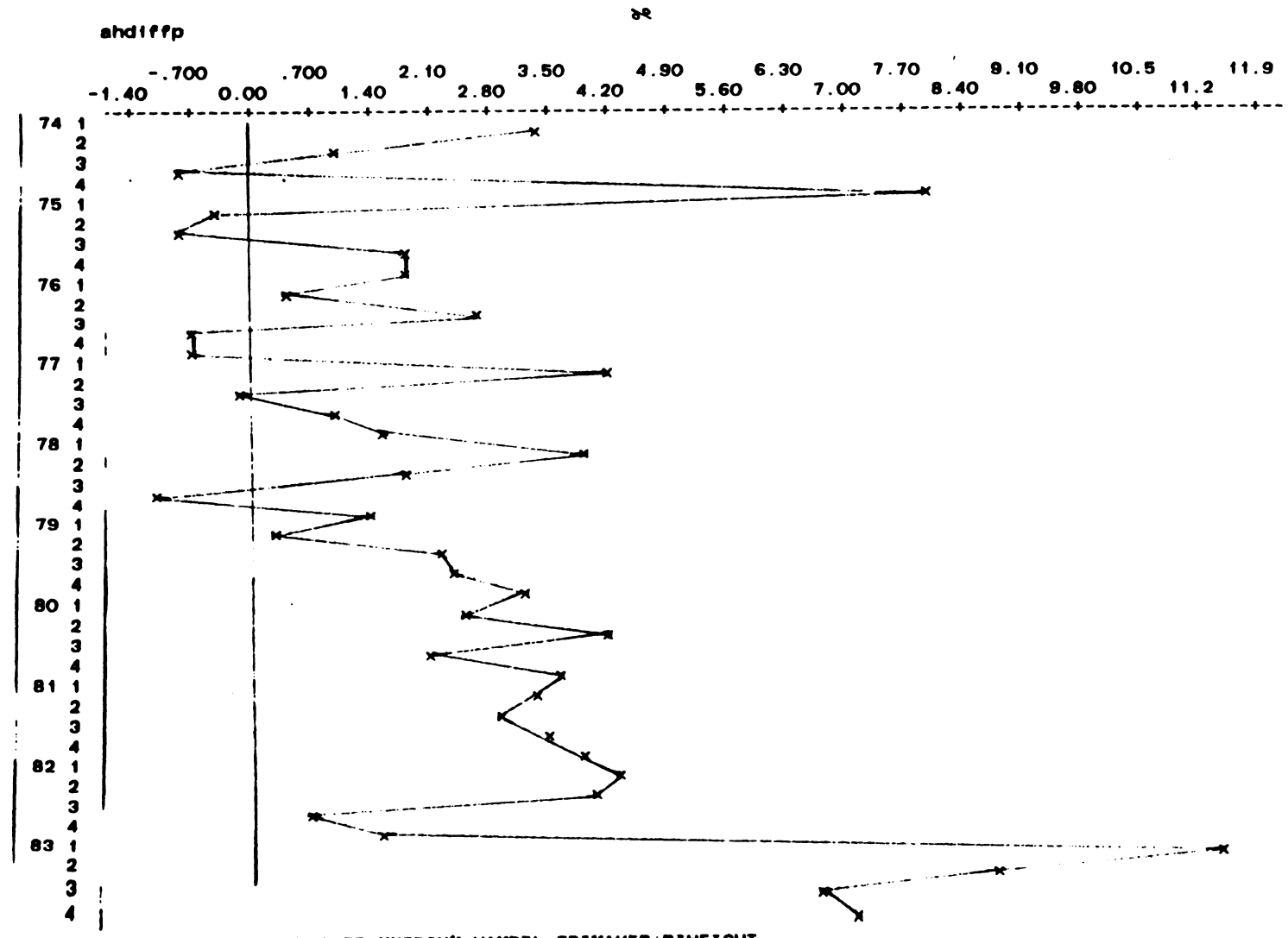
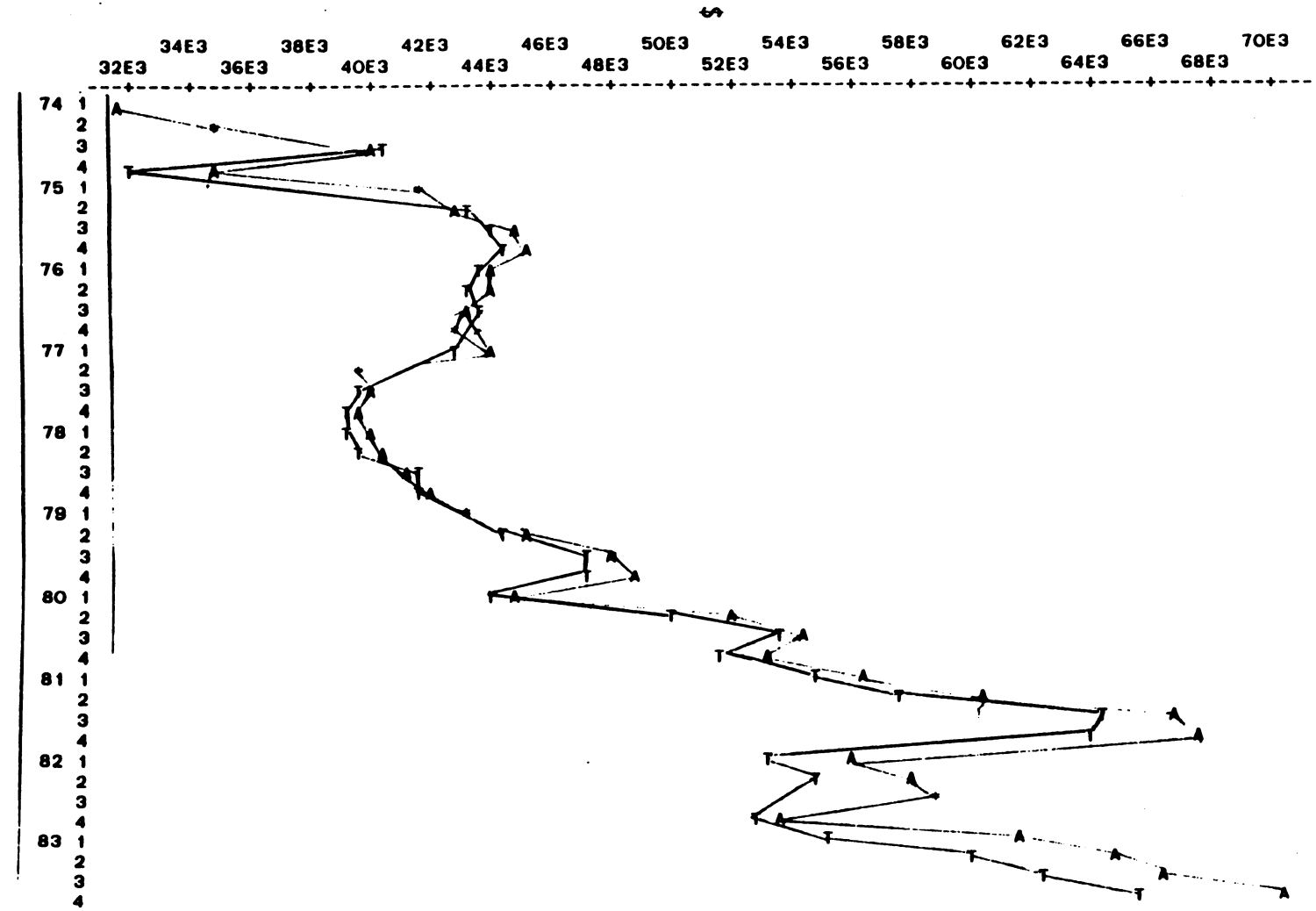


Exhibit 2.5 Dollard Des Ormeau quarterly average and trimmed mean housing price series in $'000's.

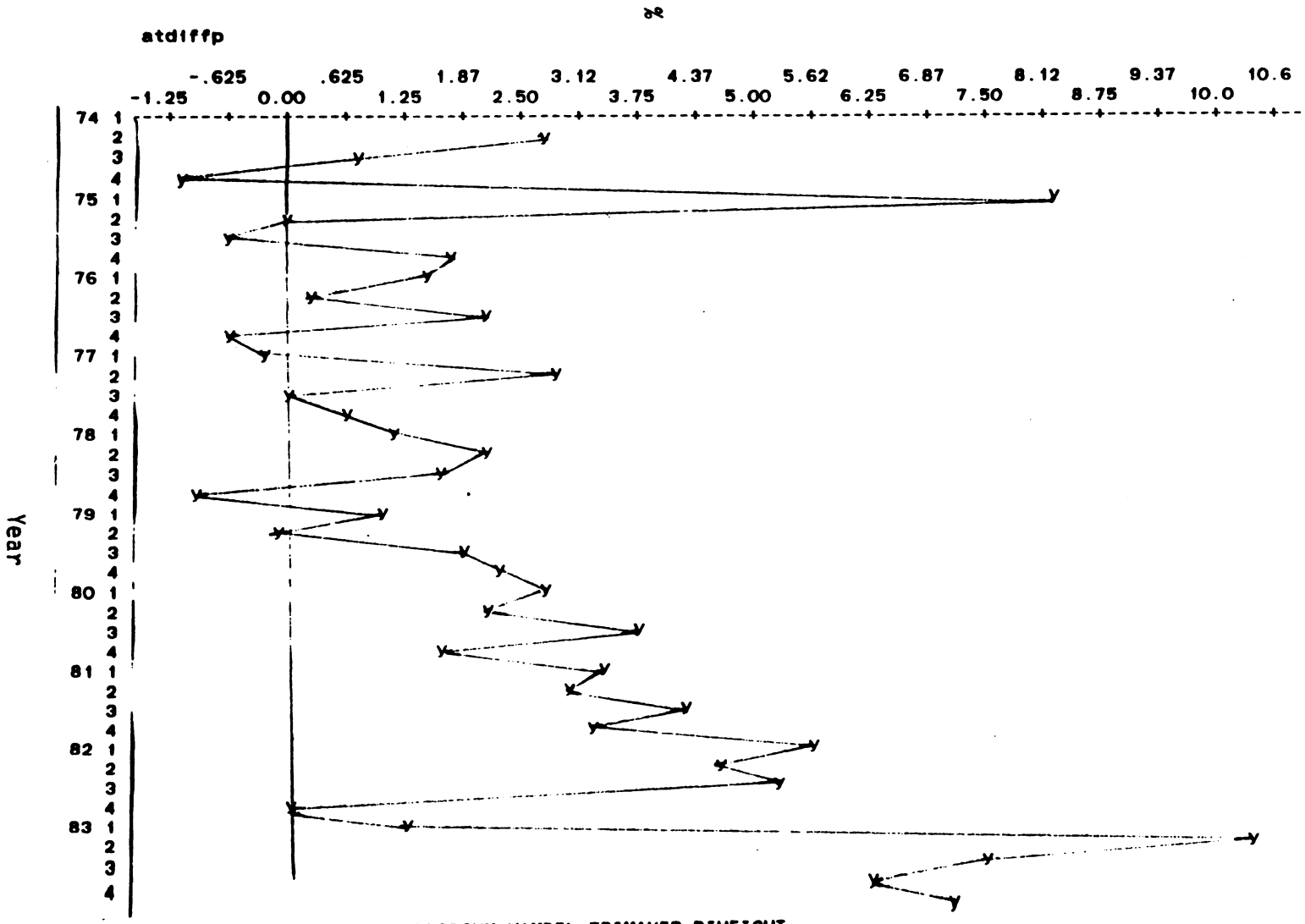
Listing of PLOTFILED(581,626) at 12:30:23 on JUL 31, 1984 for CCid=EGER Page 1



$L PLOTFILED(647,697)

Exhibit 2.6 Dollard Des Ormeau quarterly percentage difference between average and trimmed mean.

Listing of PLOTFILED1(235,284) at 12:33:02 on JUL 31, 1984 for CCid=EGER Page 1

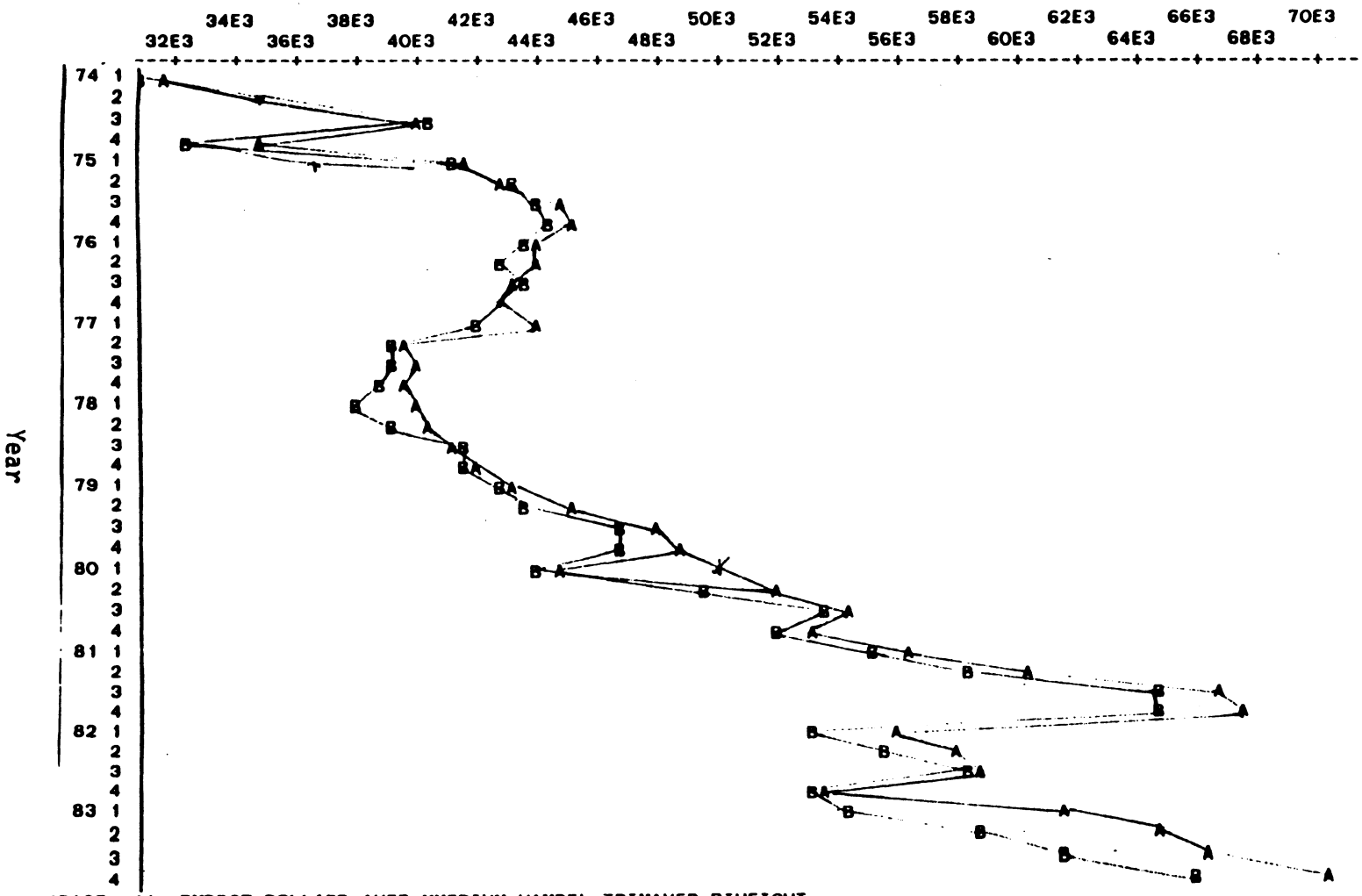


$L PLOTFILED1(304,352)

Exhibit 2.7 Dollard Des Ormeau quarterly average and biweight housing price series in $'000's.

Listing of PLOTFILED(647,697) at 12:30:23 on JUL 31, 1984 for CCid=EGER Page 1

```
SYMBOL FOR VARIABLE AVERAGE   IS    A
SYMBOL FOR VARIABLE BIWEIGHT  IS    B
```

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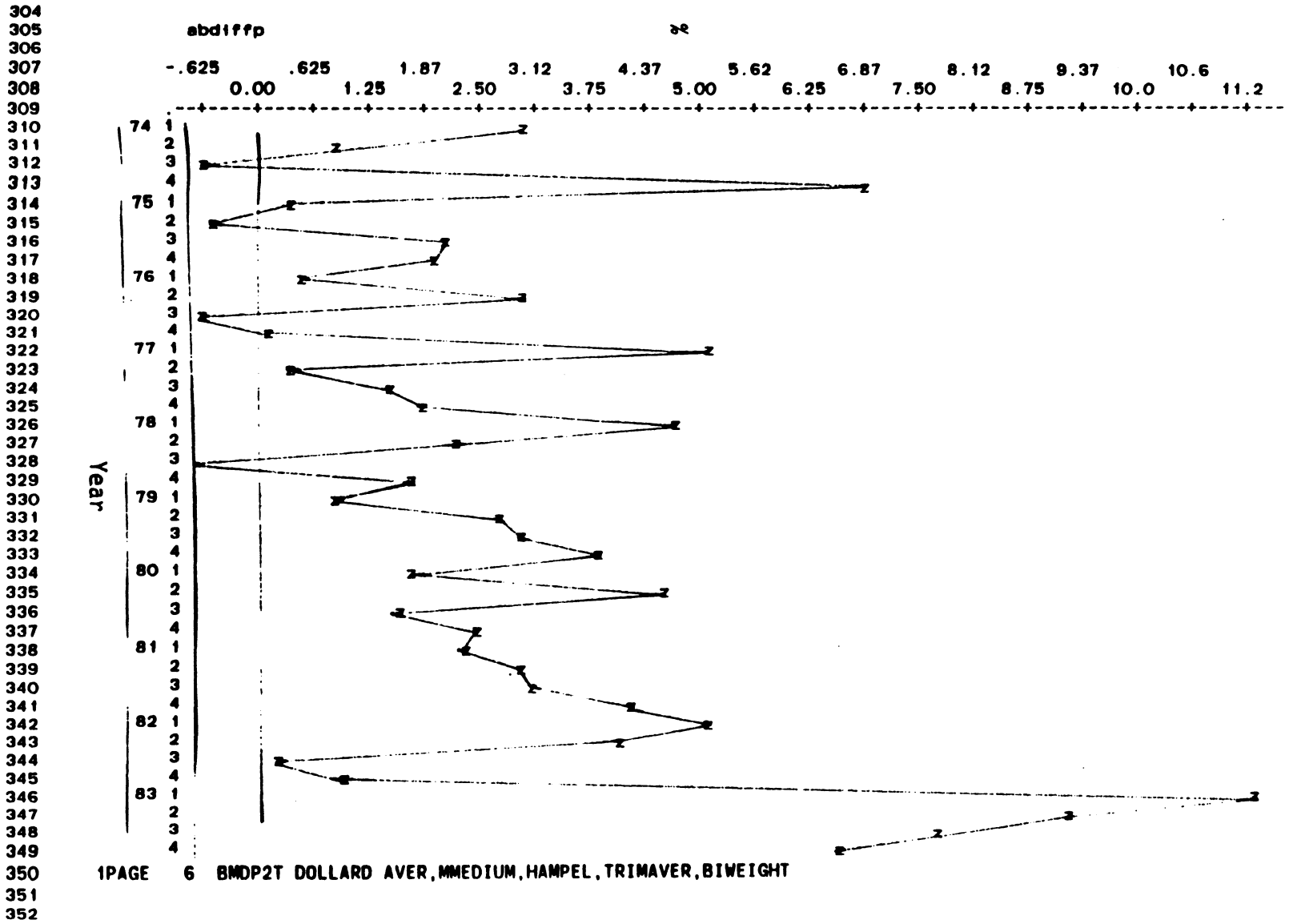
1PAGE   11  BMDP2T DOLLARD AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT
```

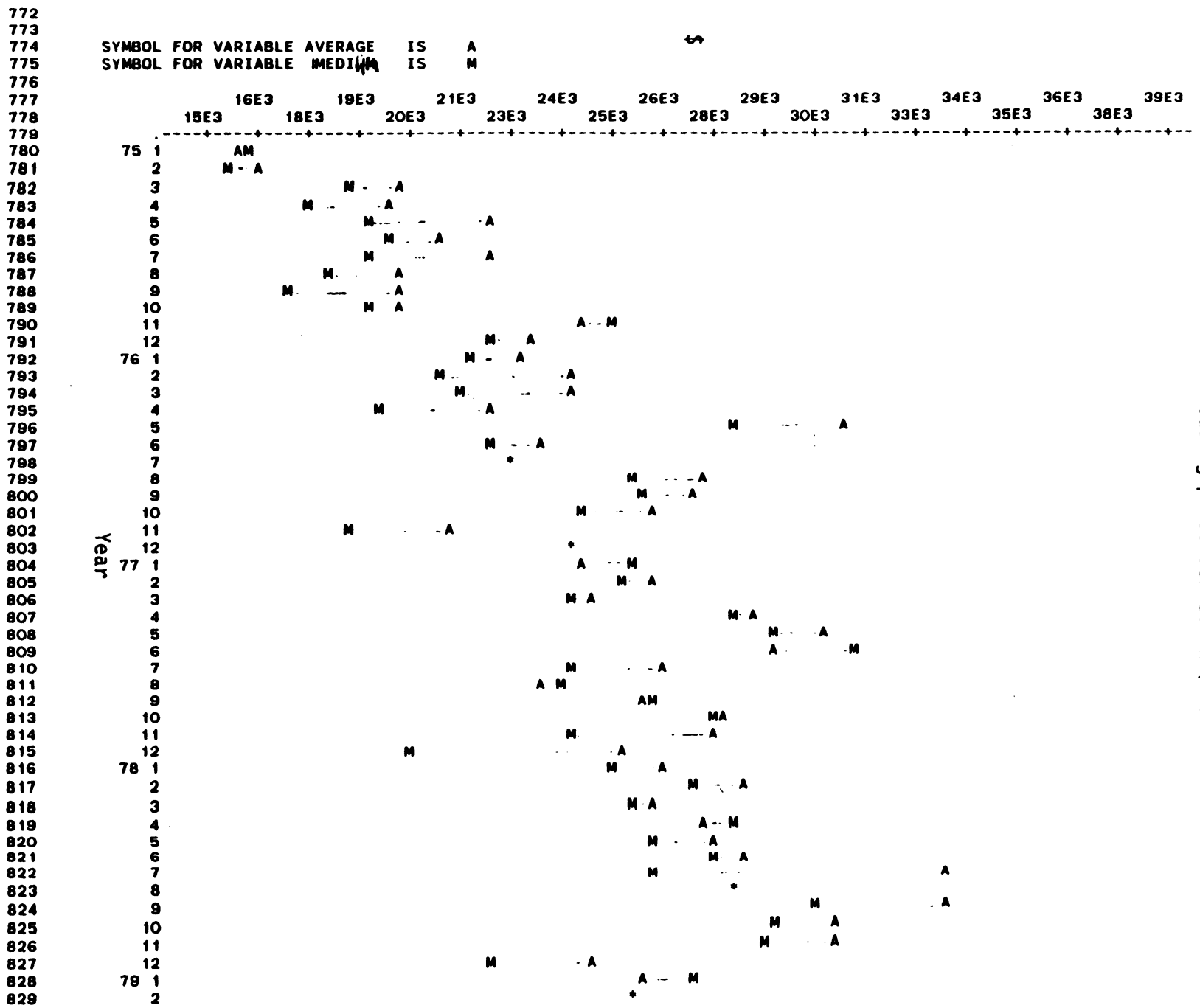
$L PLOTFILED(717,767)

Exhibit 2.8 Dollard Des Ormeau quarterly percentage difference between average and biweight.



$L PLOTFILED1(372,422)

Exhibit 3.1 N. W. Winnipeg monthly average and median housing price series in $'000's.



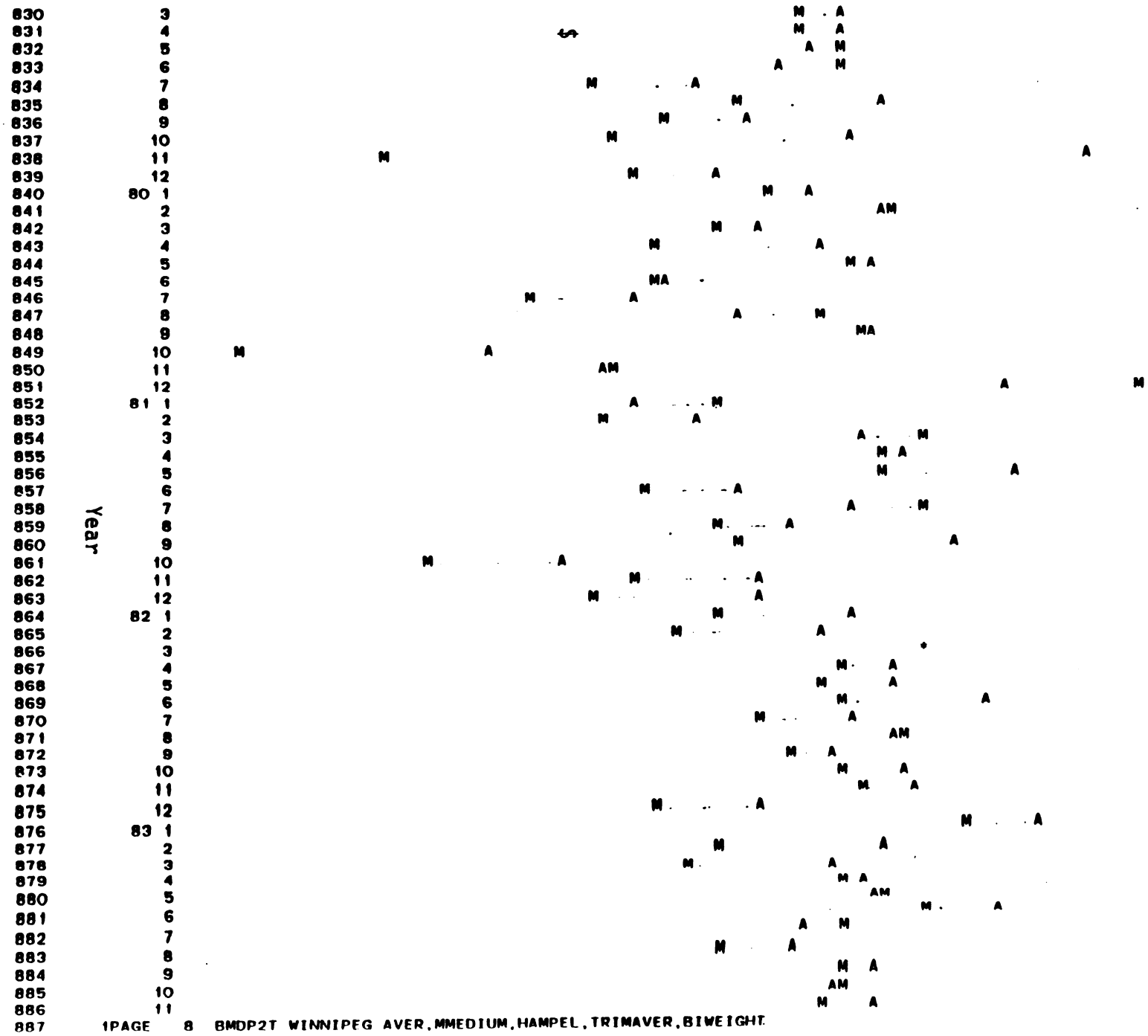


Exhibit 3.1 N.W. Winnipeg monthly average and median housing price series in $'000's.

Exhibit 3.2 N. W. Winnipeg monthly percentage difference between average and median.

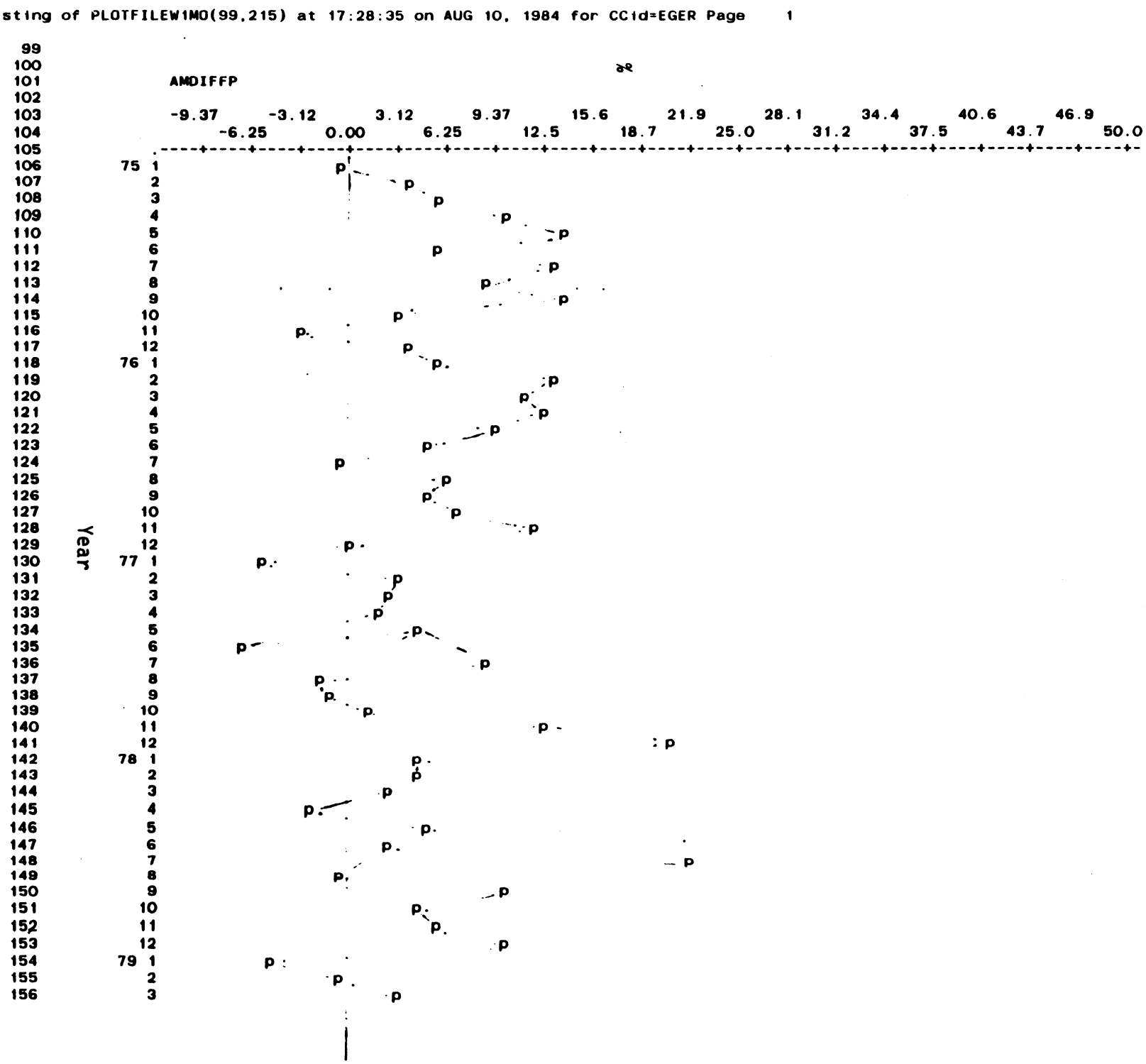
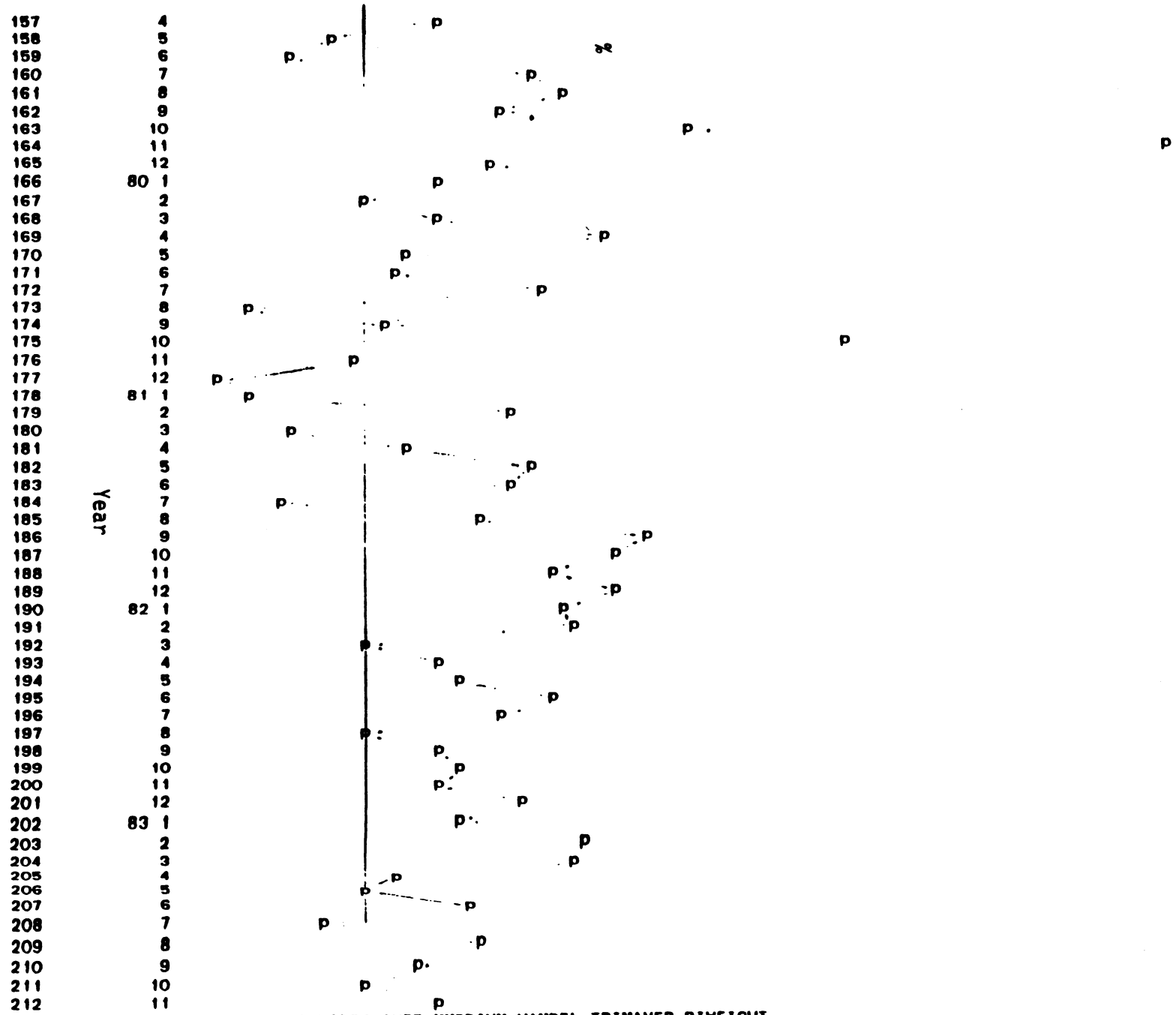
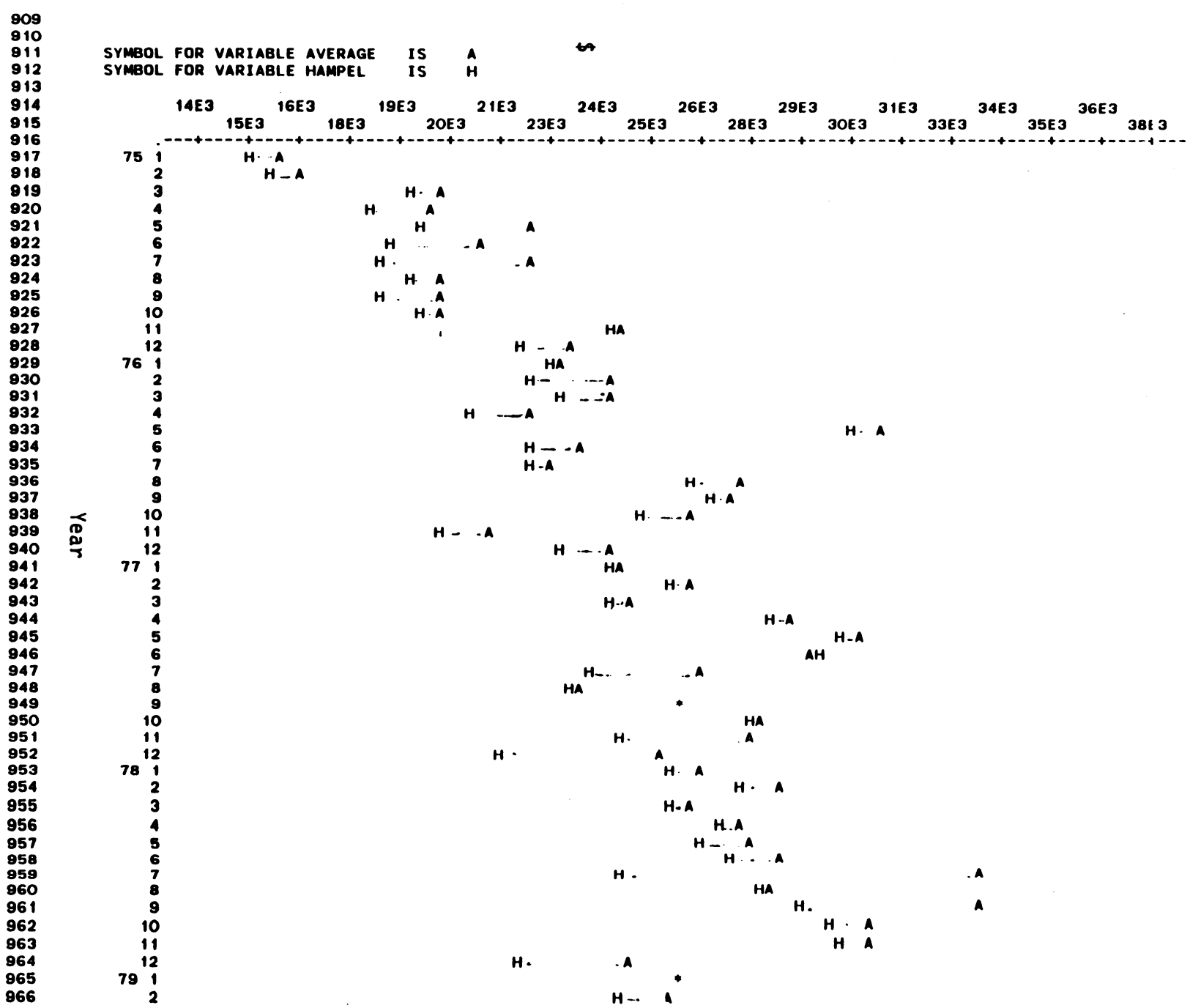


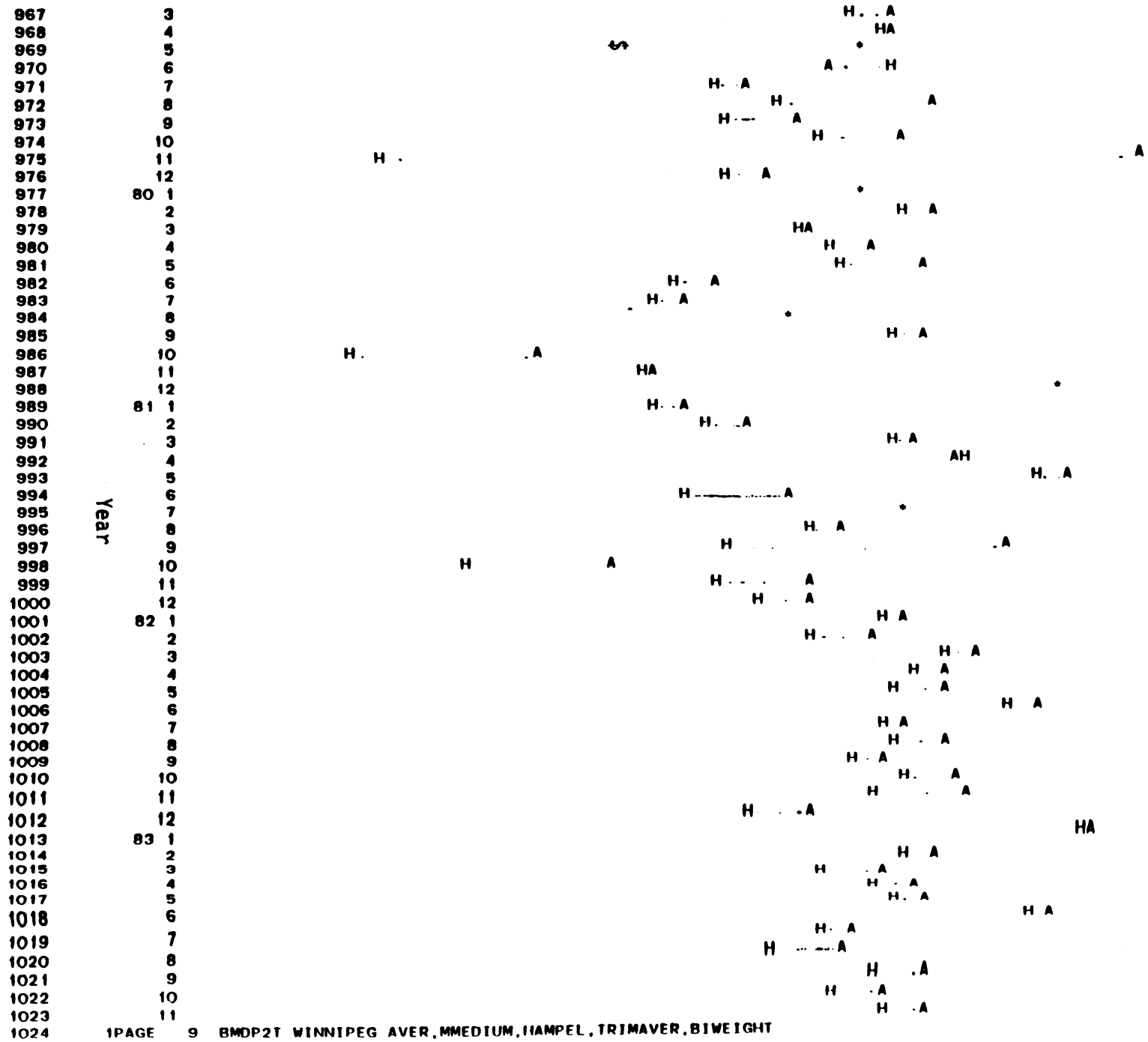
Exhibit 3.2 N. W. Winnipeg monthly percentage difference between average and median.



1PAGE 3 BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

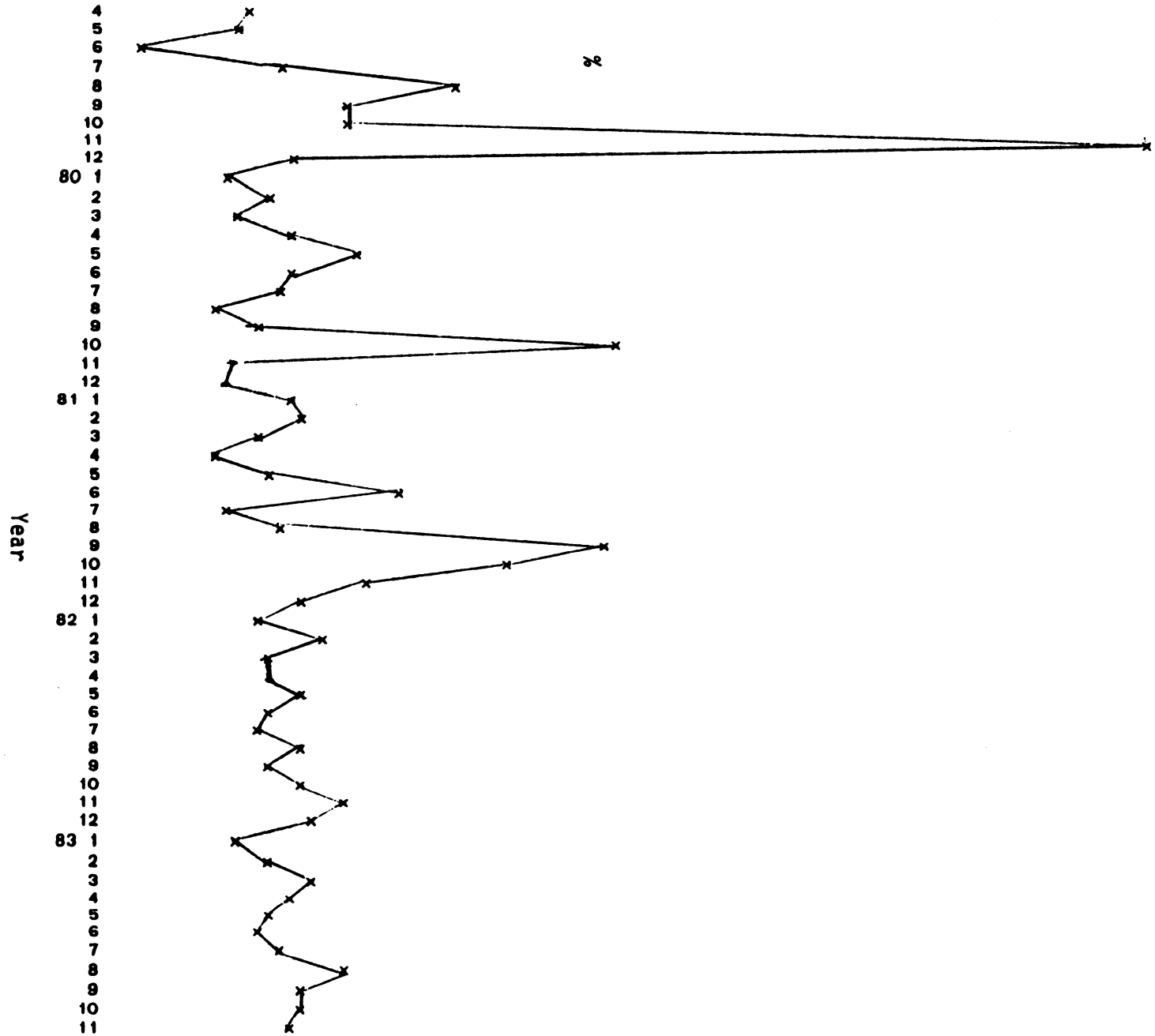
Exhibit 3.3 N. W. Winnipeg monthly average and Hampel housing price series in $'000's.





1PAGE 9 BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

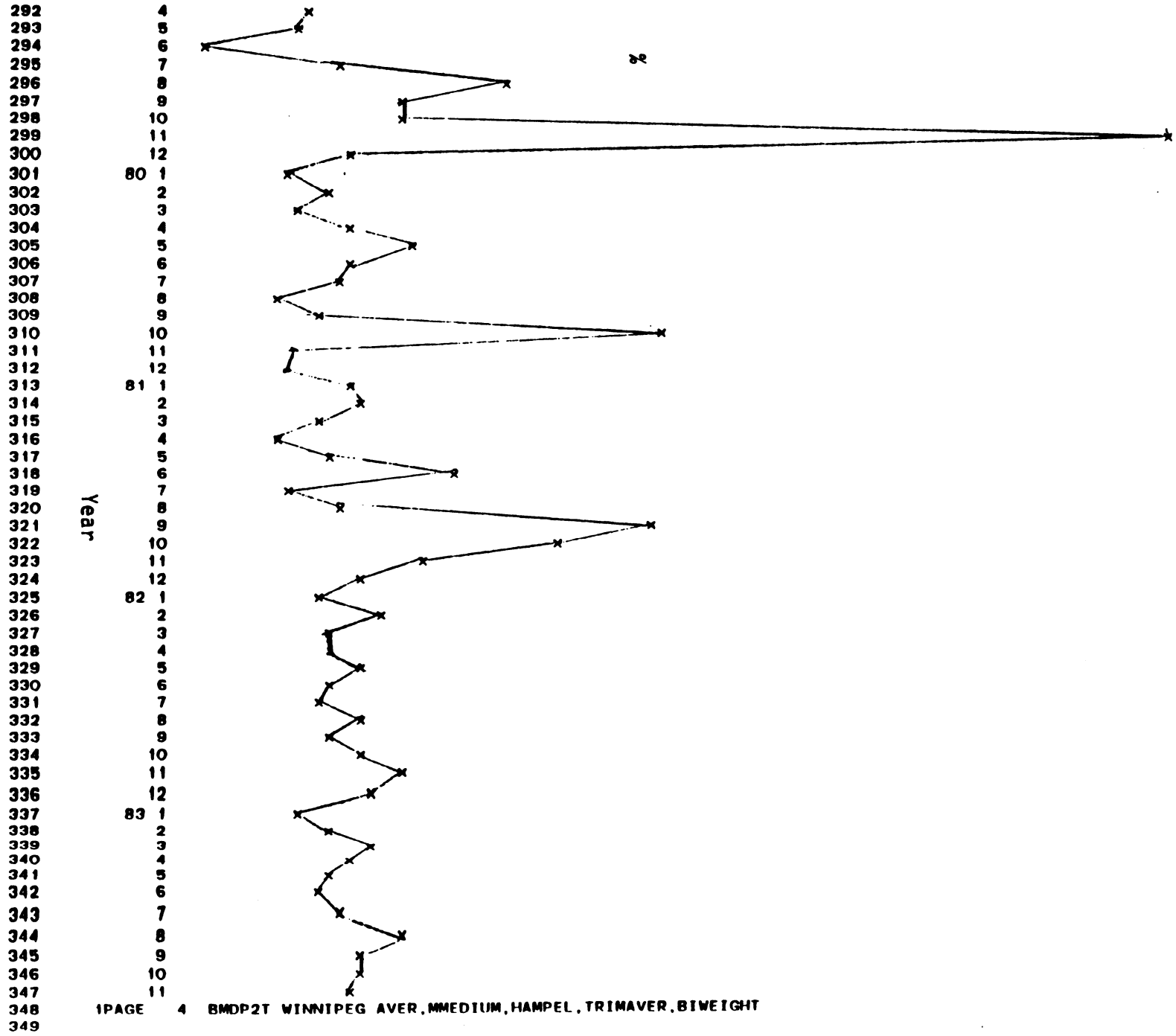
Exhibit 3.3 N. W. Winnipeg monthly average and Hampel housing price series in $'000's.



348 1PAGE 4 BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

349

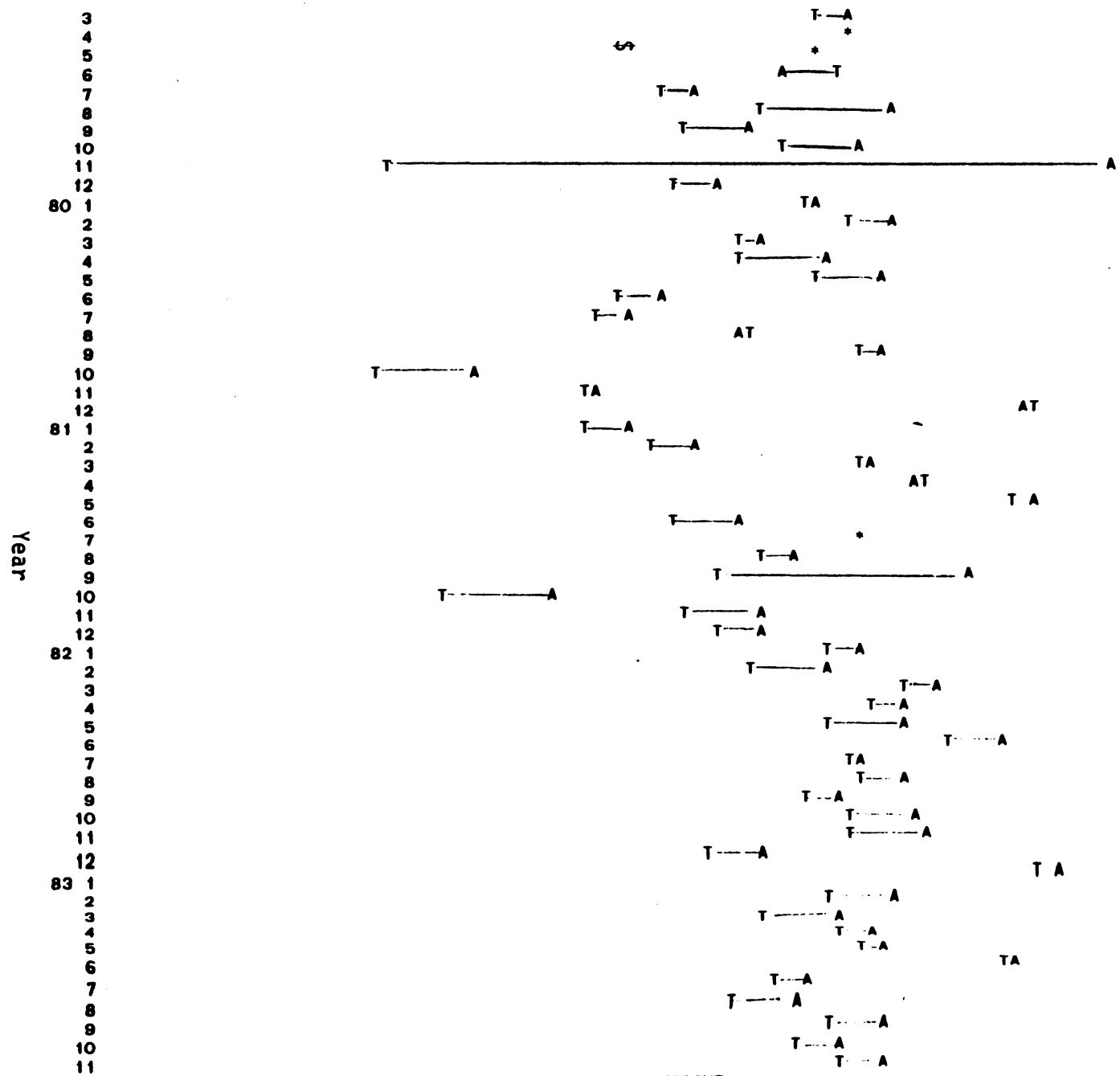
Exhibit 3.4 N. W. Winnipeg monthly percentage difference between average and Hampel



348 1PAGE 4 BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

349

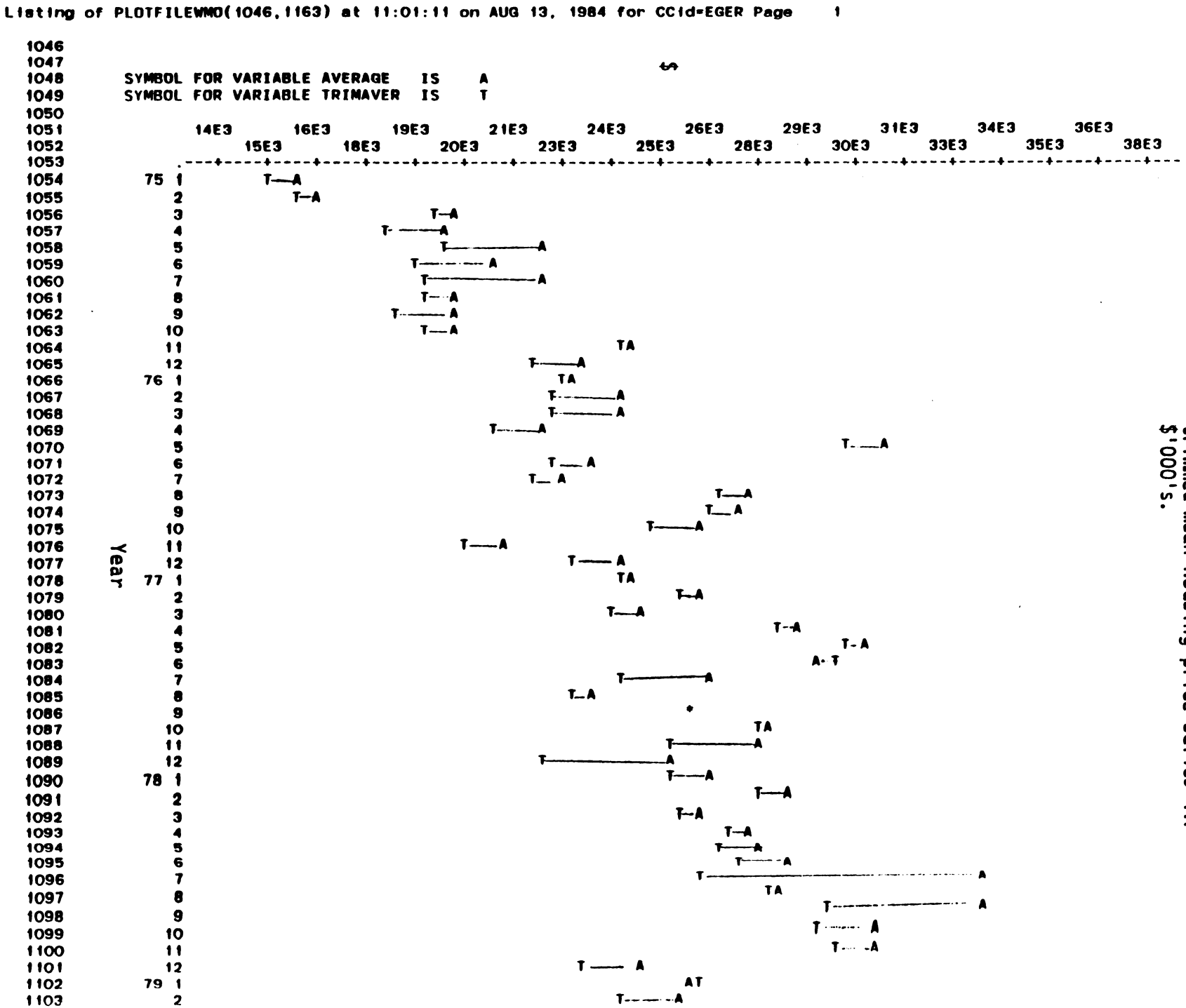
Exhibit 3.4 N. W. Winnipeg monthly percentage difference between average and Hampel



1161 1PAGE 10 BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Exhibit 3.5 N. W. Winnipeg monthly average and trimmed mean housing price series in $'000's.

Exhibit 3.5 N. W. Winnipeg monthly average and trimmed mean housing price series in $'000's.



Listing of PLOTFILEW1MO(369,485) at 17:28:36 on AUG 10, 1984 for CCid=EGER Page 1

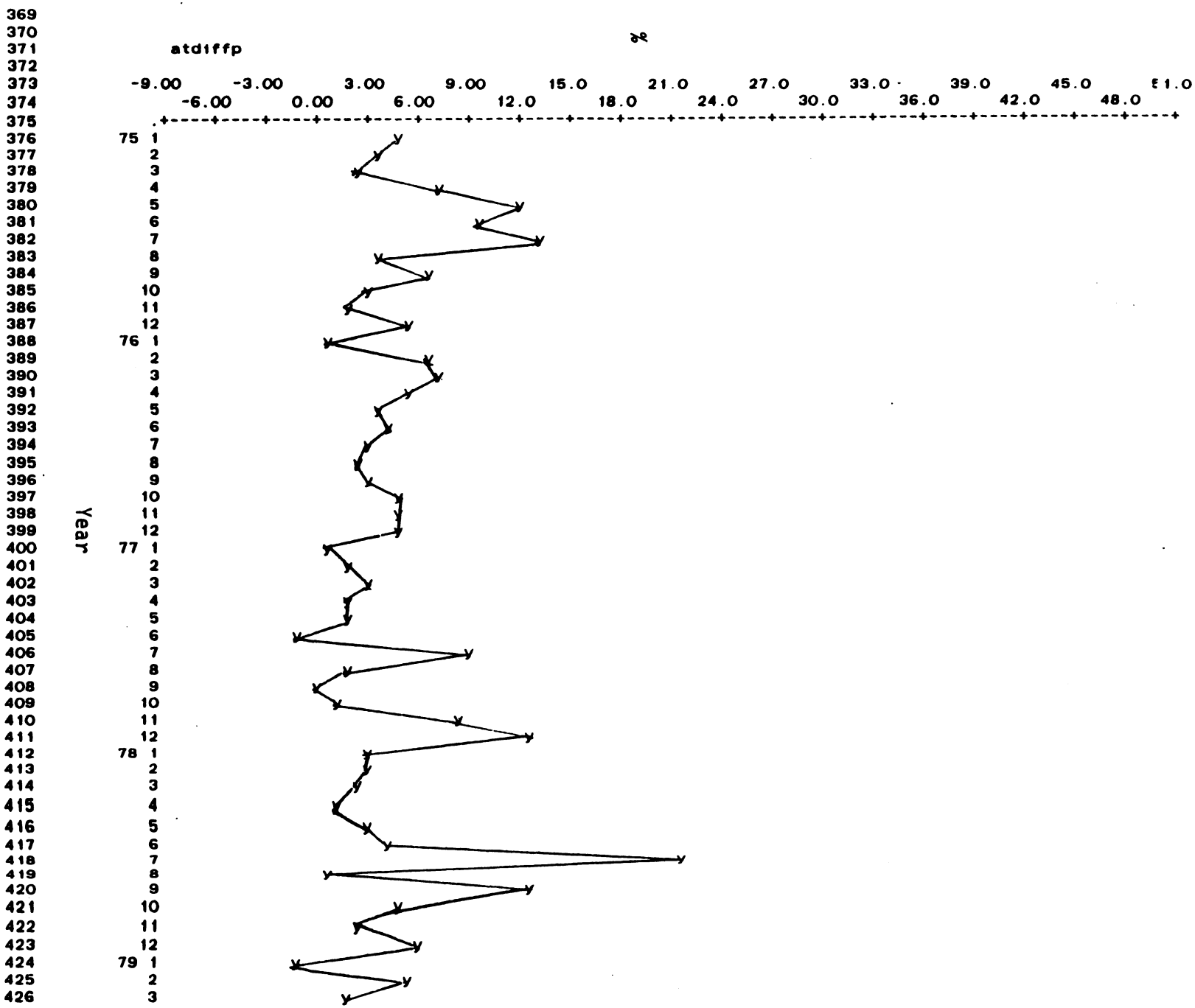
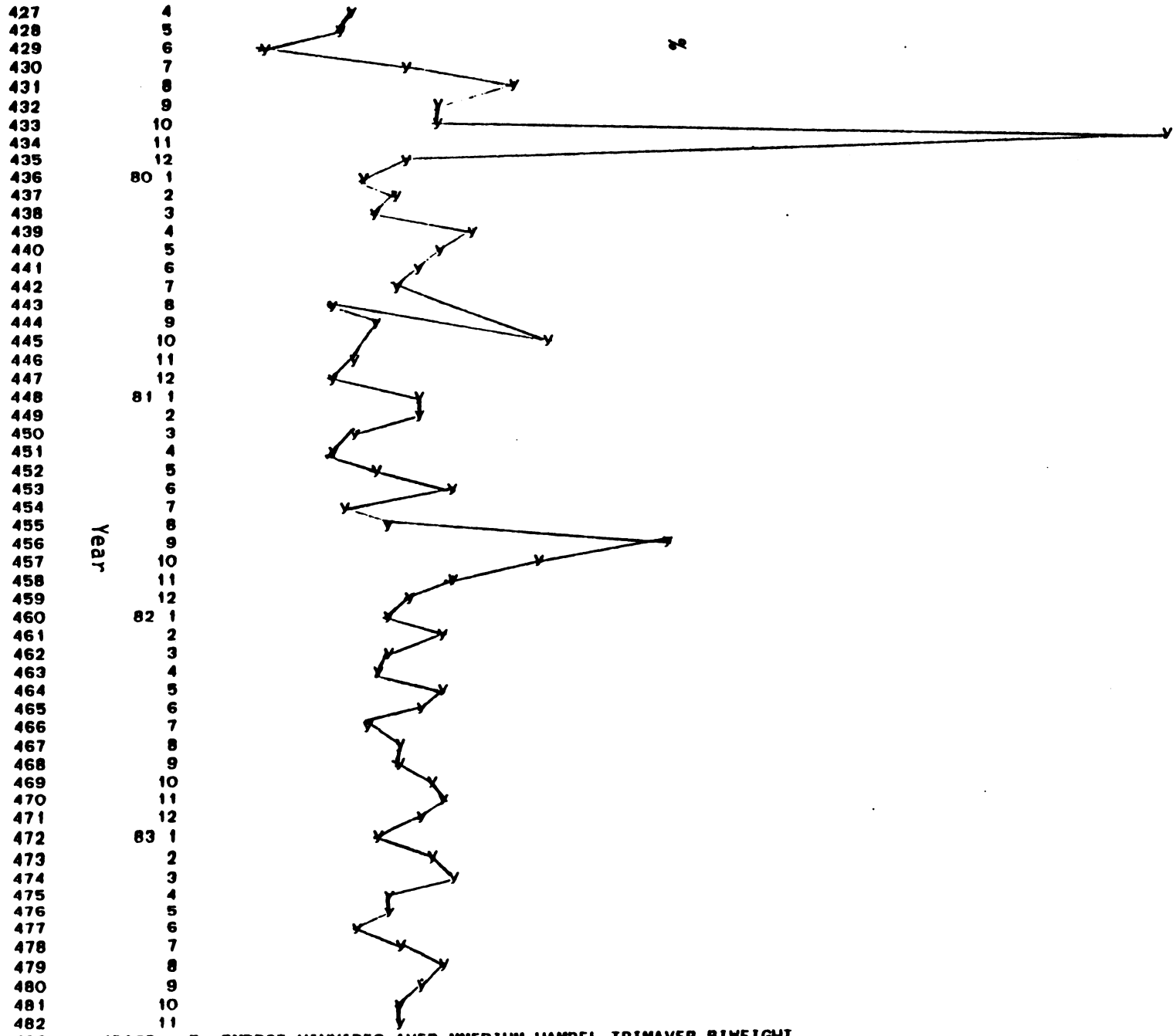


Exhibit 3.6 N. W. Winnipeg monthly percentage difference between average and trimmed mean.



483 1PAGE 5 BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

484

Exhibit 3.6 N. W. Winnipeg monthly percentage difference between average and trimmed mean.

Exhibit 3.7 N. W. Winnipeg monthly average and biweight housing price series in $'000's.

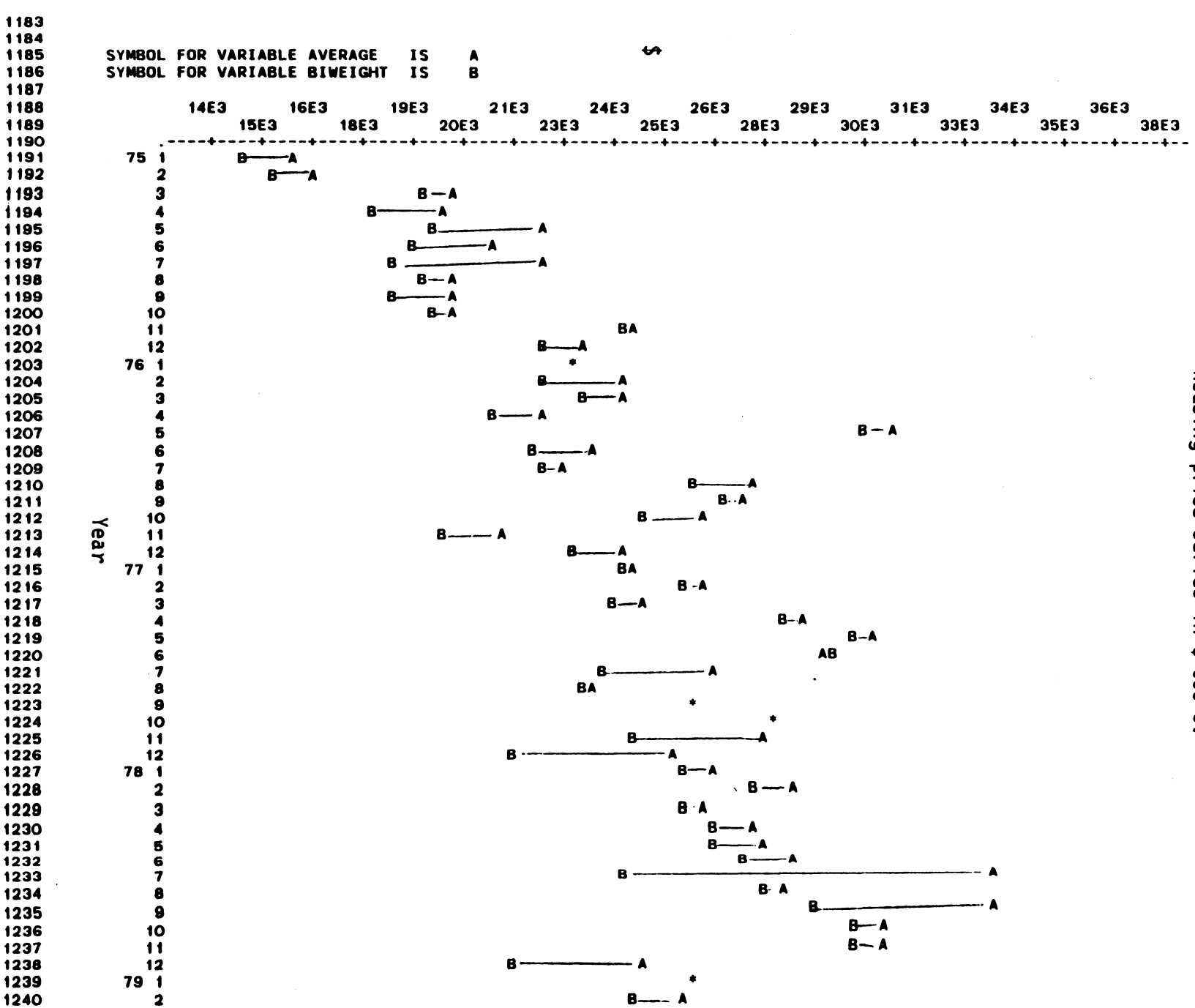
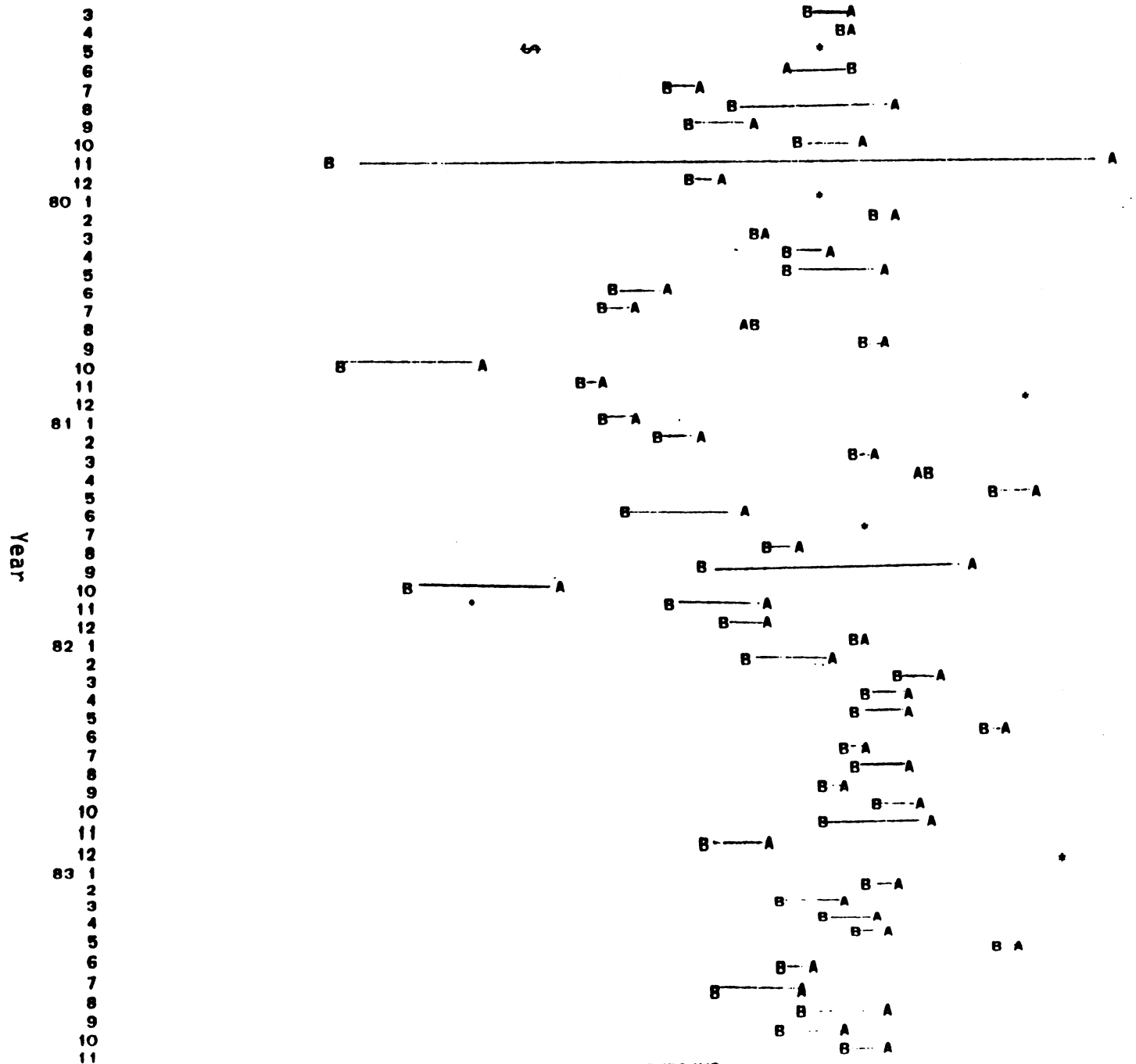


Exhibit 3.7. N. W. Winnipeg monthly average and biweight housing price series in $'000's.



1PAGE 11 BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Listing of PLOTFILEW1MO(505,620) at 17:28:36 on AUG 10, 1984 for CCid=EGER Page 1

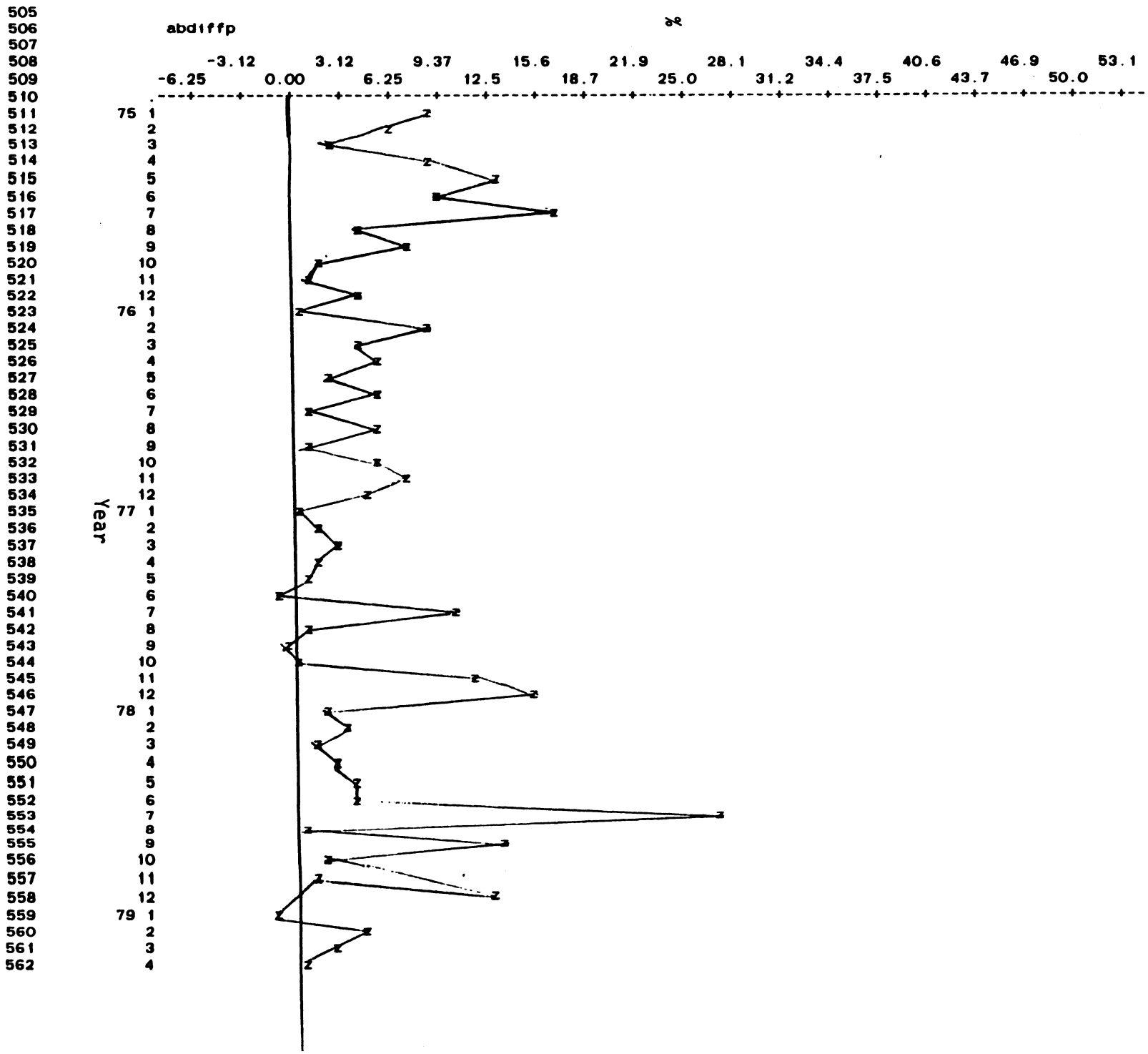


Exhibit 3.8 N. W. Winnipeg monthly percentage difference between average and biweight.

Listing of PLOTFILEW1MO(505,620) at 17:28:36 on AUG 10, 1984 for CCid=EGER Page 1

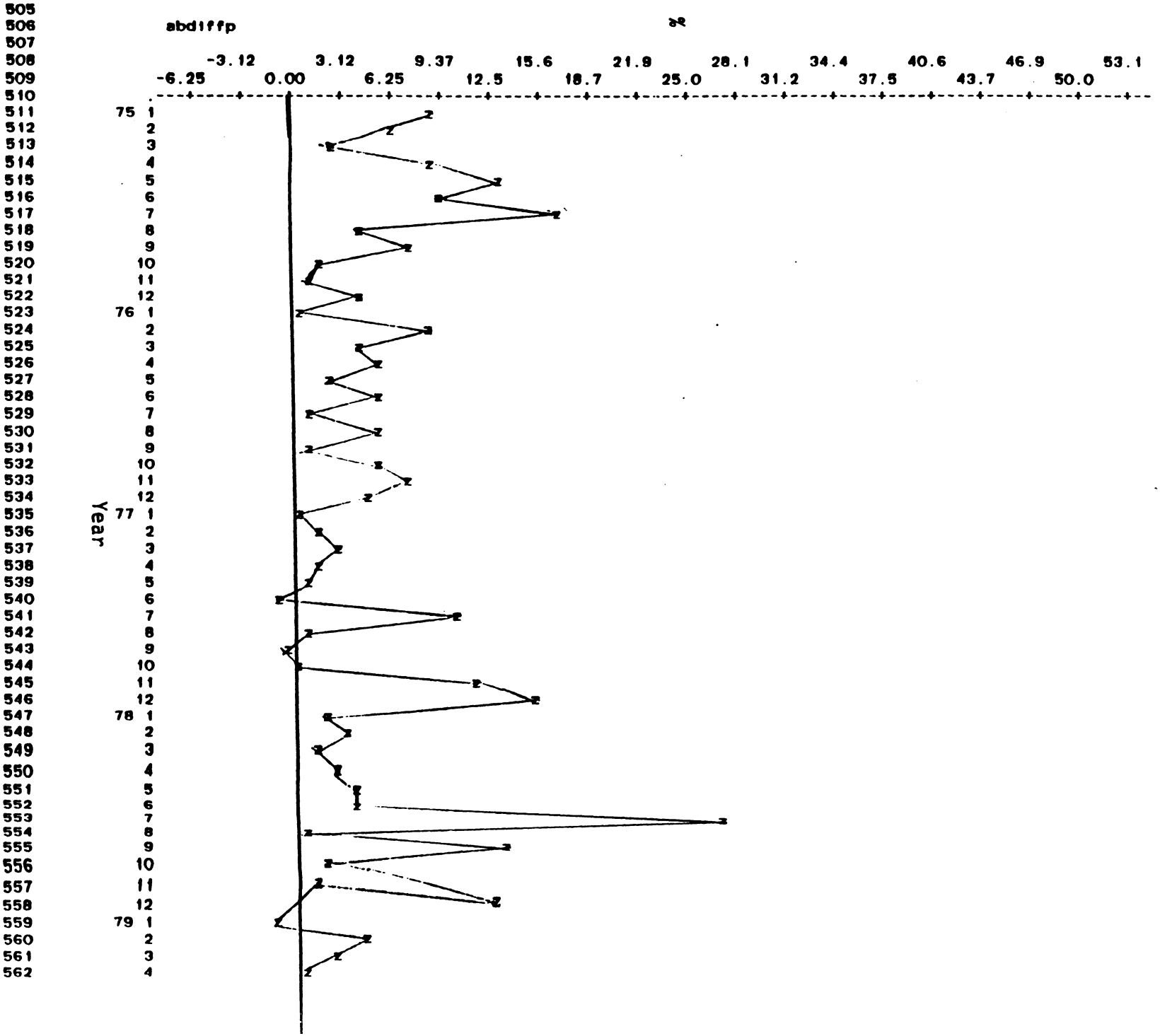


Exhibit 3.8 N. W. Winnipeg monthly percentage difference between average and biweight.

Exhibit 4.1 N. W. Winnipeg quarterly average and median housing price series in $'000's.

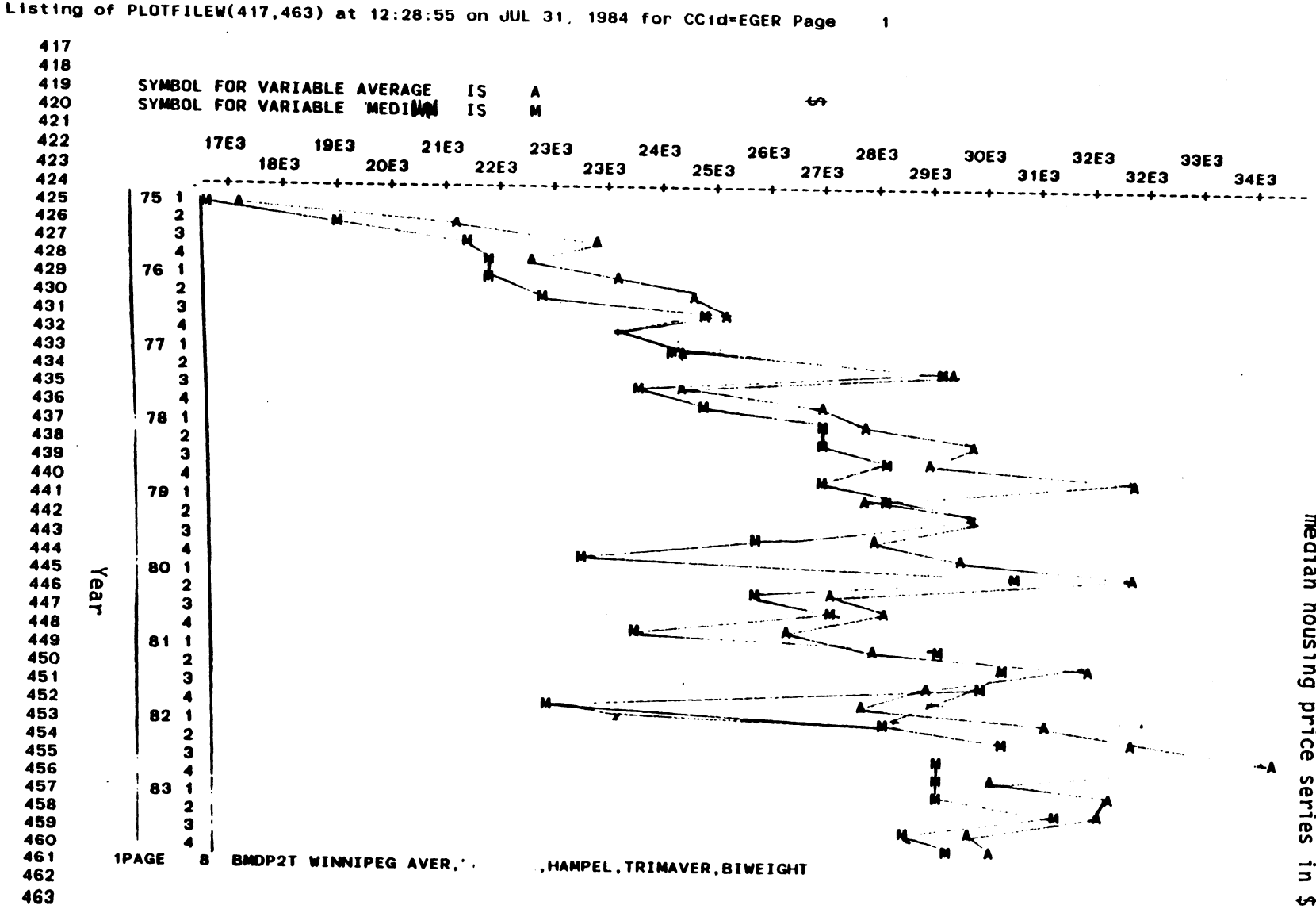
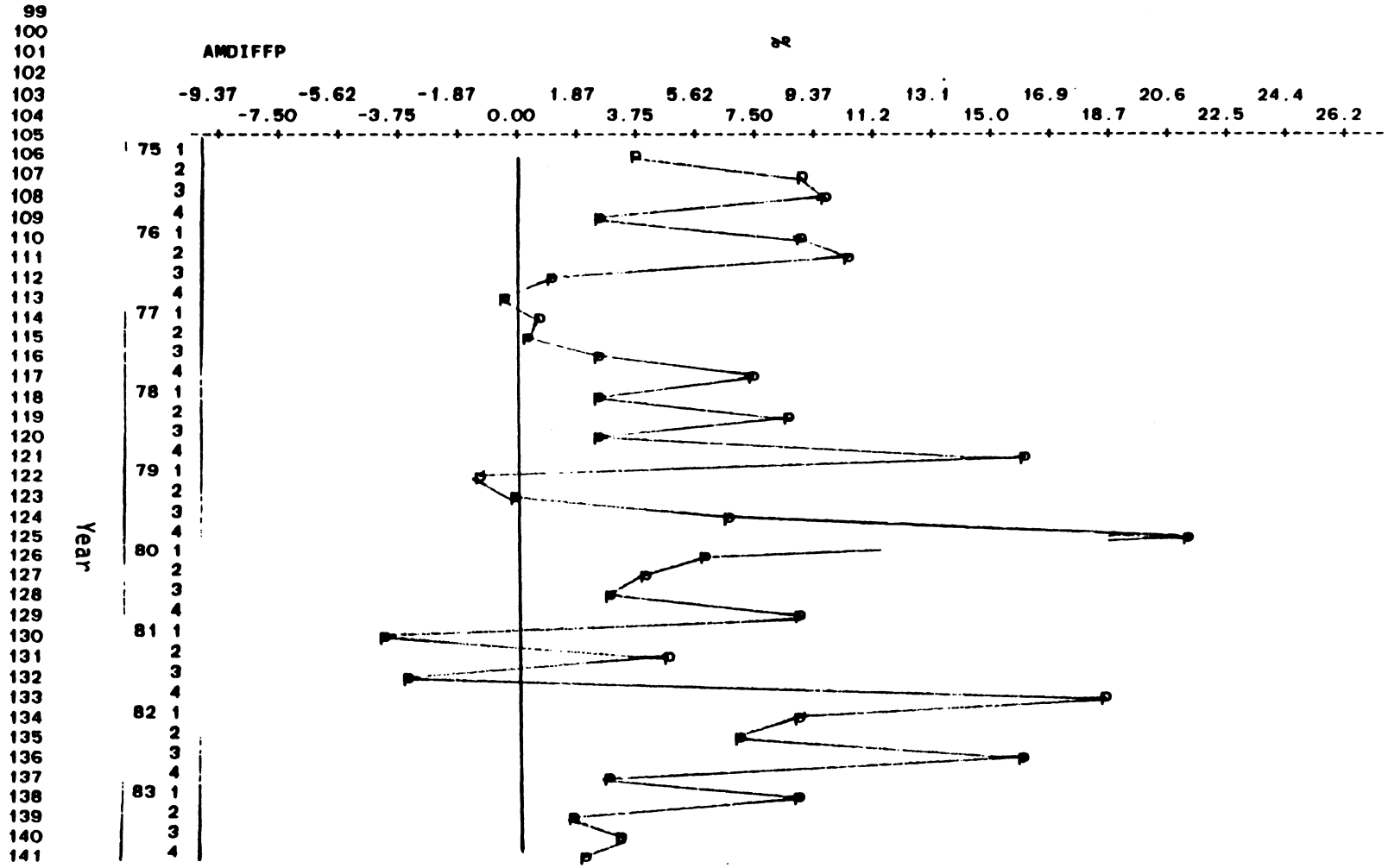


Exhibit 4.2 N. W. Winnipeg quarterly percentage difference between average and median.

Listing of PLOTFILEW1(99,144) at 12:11:16 on JUL 26, 1984 for CCid=EGER Page 1



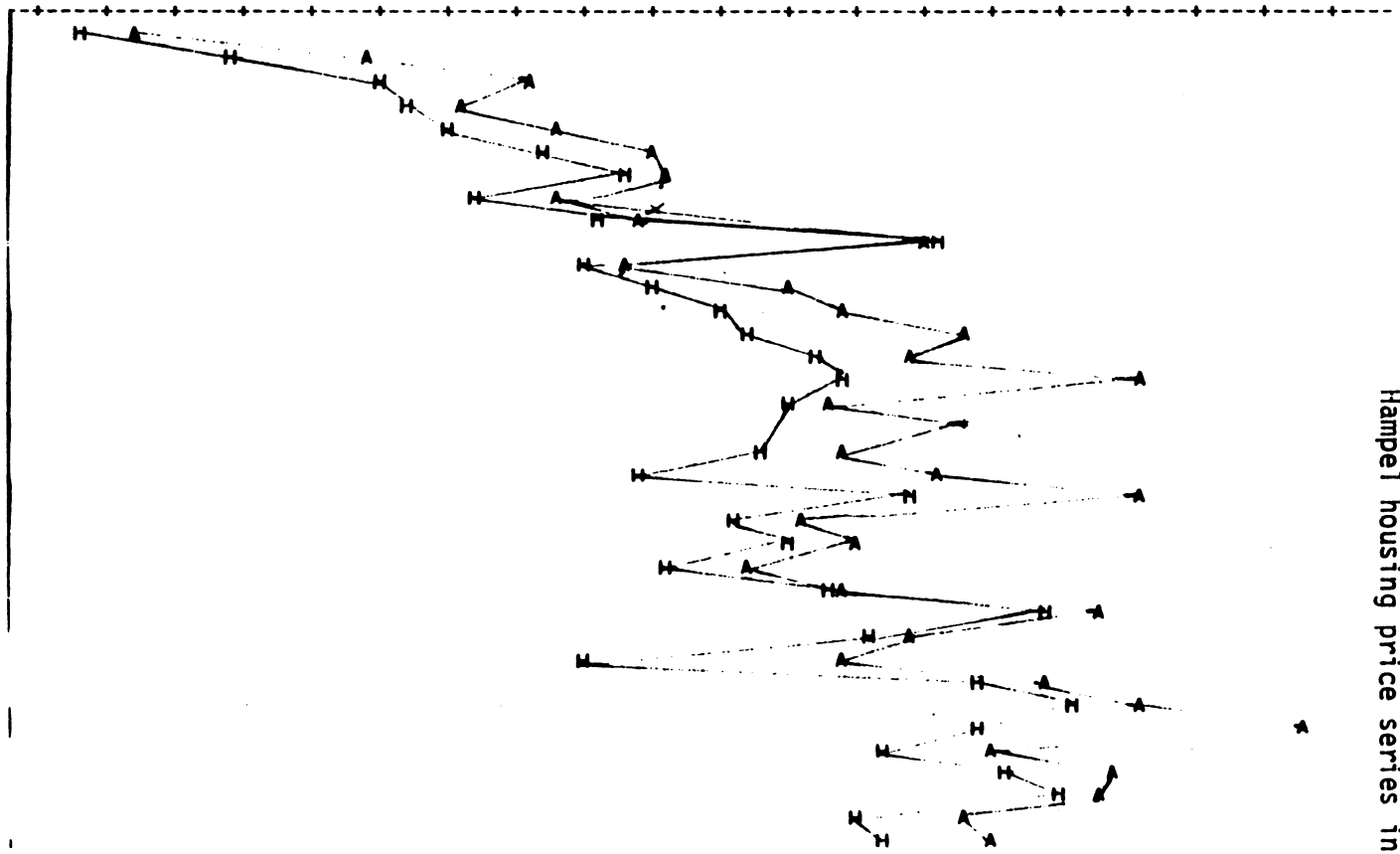
$L PLOTFILEW1(164,208)

Exhibit 4.3 N. W. Winnipeg quarterly average and Hampel housing price series in $'000's.

```
Listing of PLOTFILEW(483,529) at 12:28:55 on JUL 31, 1984 for CCid=EGER Page    1

483
484
485      SYMBOL FOR VARIABLE AVERAGE   IS    A
486      SYMBOL FOR VARIABLE HAMPEL    IS    H
487
488                 17E3      19E3      21E3      23E3      25E3      27E3      29E3      31E3      33E3      35E3
489            16E3      18E3      20E3      22E3      24E3      26E3      28E3      30E3      32E3      34E3
490
491       75 1
492          2
493          3
494          4
495       76 1
496          2
497          3
498          4
499       77 1
500          2
501          3
502          4
503       78 1
504          2
505          3
506          4
507       79 1
508          2
509          3
510          4
511       80 1
512          2
513          3
514          4
515       81 1
516          2
517          3
518          4
519       82 1
520          2
521          3
522          4
523       83 1
524          2
525          3
526          4
527     1PAGE    9  BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT
528
529
```

Year



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$L PLOTFILEW(549,595)
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Exhibit 4.4 N. W. Winnipeg quarterly percentage difference between average and Hampel.

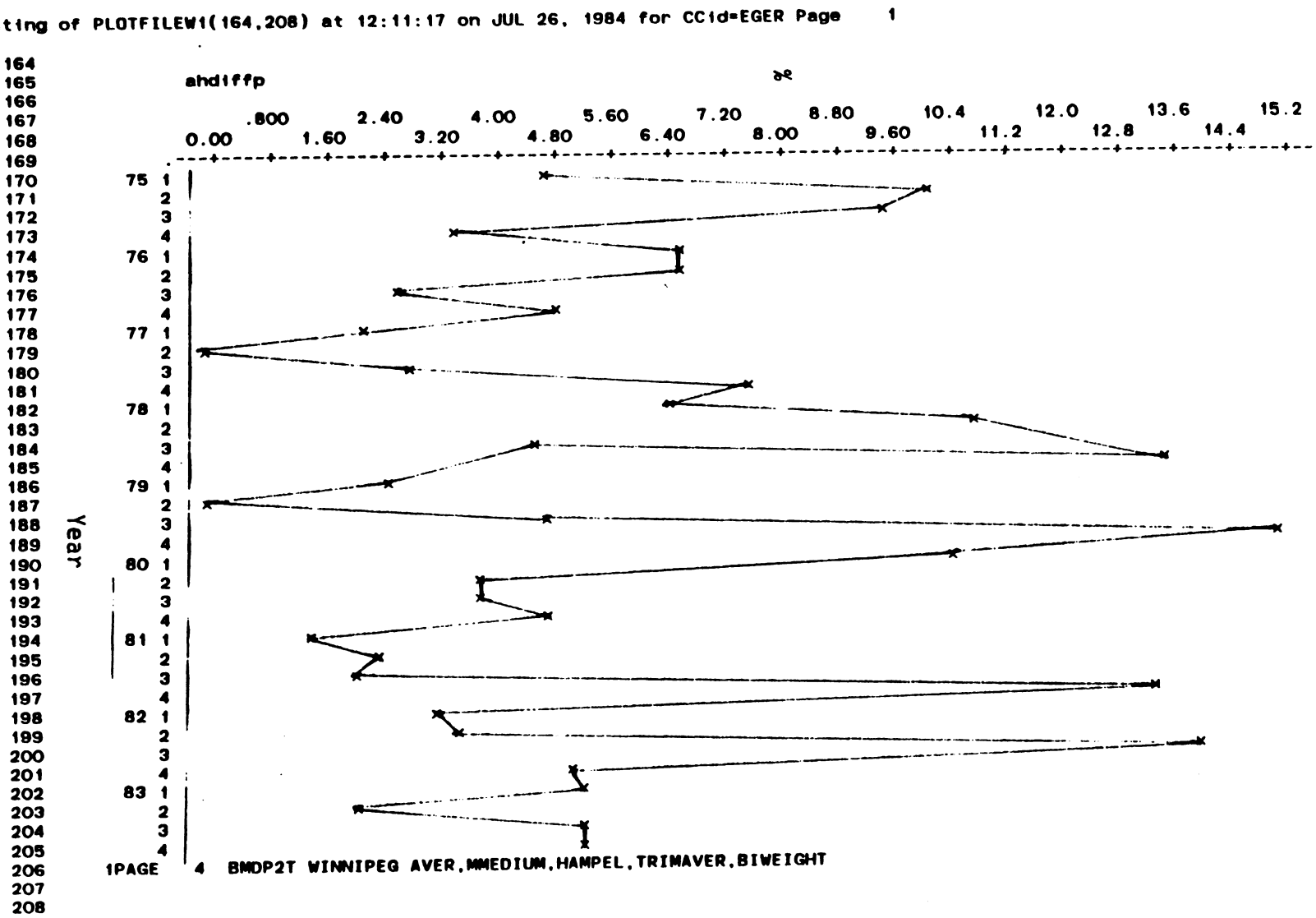


Exhibit 4.5 N. W. Winnipeg quarterly average and trimmed mean housing price series in $'000's.

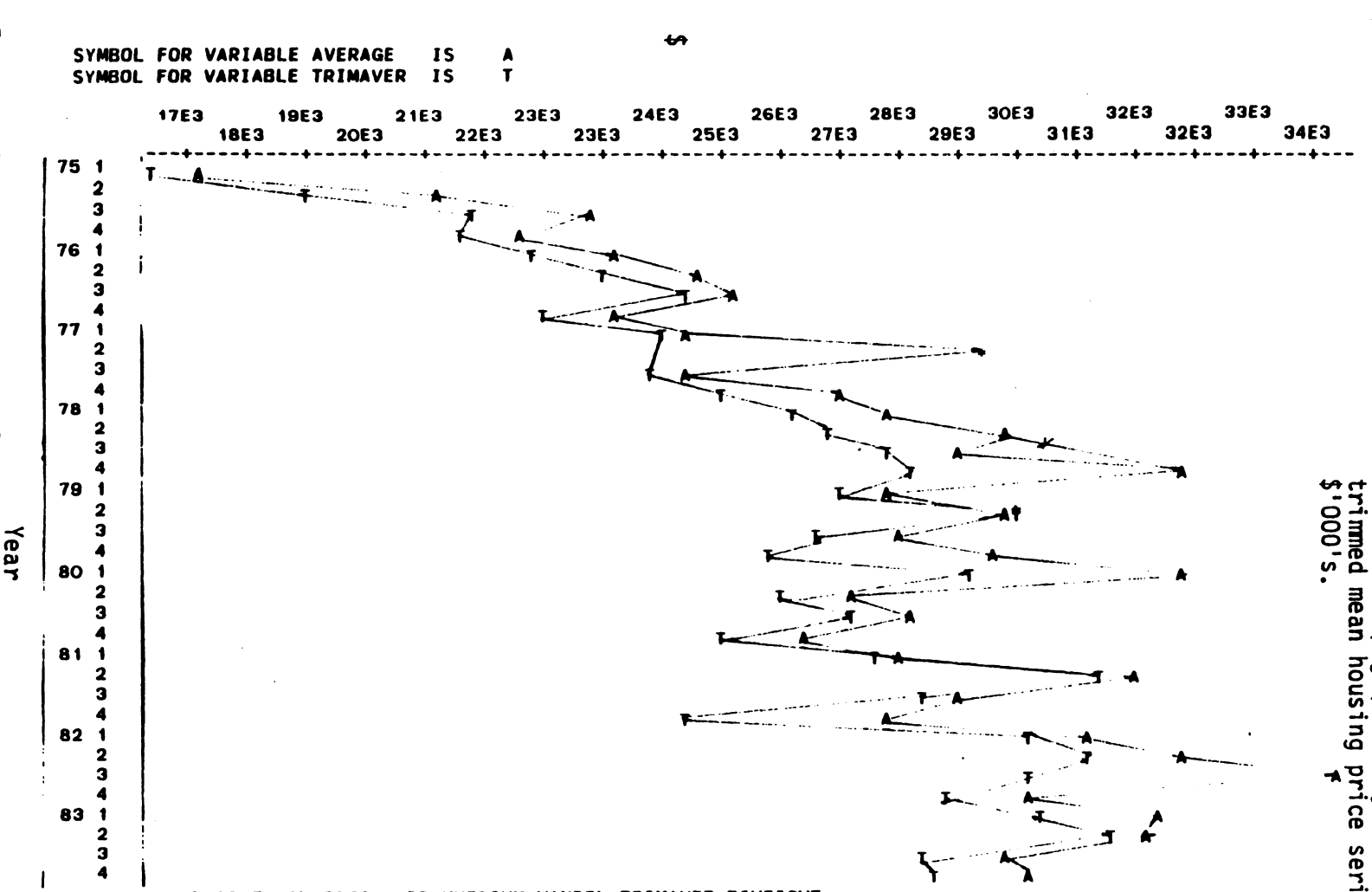
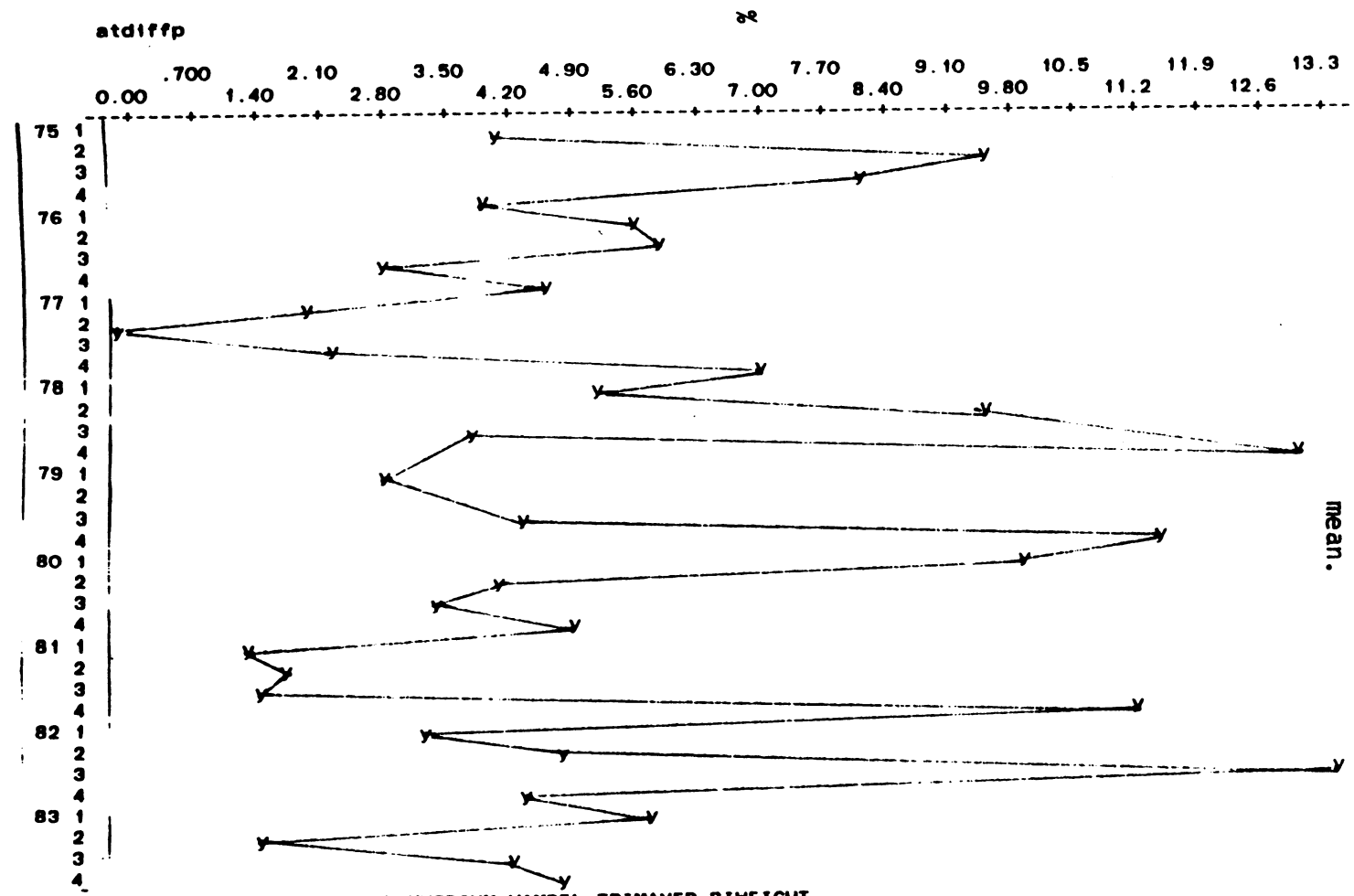


Exhibit 4.6 N. W. Winnipeg quarterly percentage difference between average and trimmed mean.



Listing of PLOTFILEW1(227,272) at 12:11:19 on JUL 26, 1984 for CCid=EGER Page 1

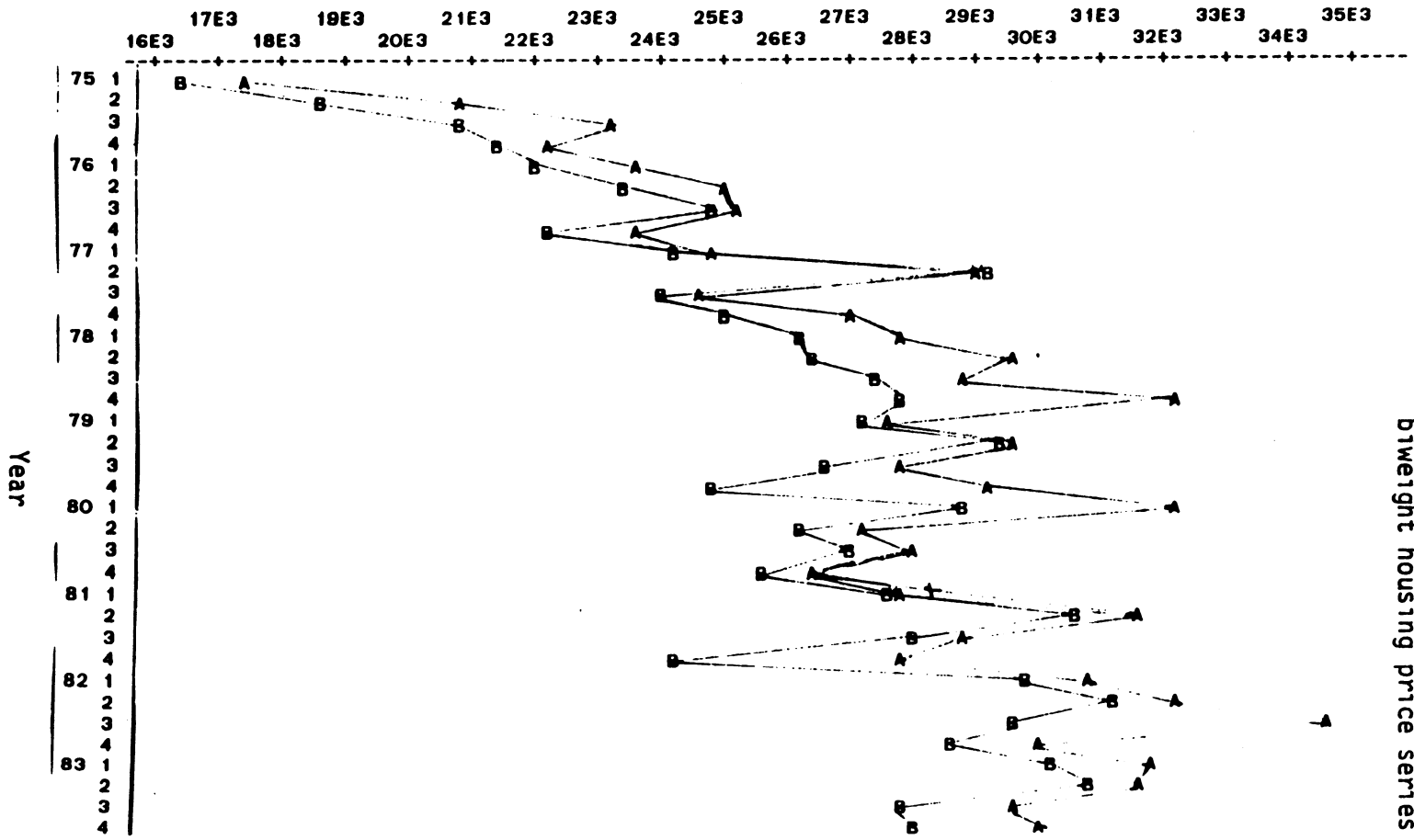
```
227
228
229          atdiffp                                                    %
230
231                .700      2.10      3.50      4.90      6.30      7.70      9.10      10.5      11.9      13.3
232          0.00      1.40      2.80      4.20      5.60      7.00      8.40      9.80      11.2      12.6
233
234      75  1
235          2
236          3
237          4
238      76  1
239          2
240          3
241          4
242      77  1
243          2
244          3
245          4
246.     78  1
247          2
248          3
249          4
250      79  1
251          2
252          3
253          4
254      80  1
255          2
256          3
257          4
258      81  1
259          2
260          3
261          4
262      82  1
263          2
264          3
265          4
266      83  1
267          2
268          3
269          4
270  1PAGE   5  BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT
271
272
```

$L PLOTFILEW1(291,336)

Exhibit 4.7 N. W. Winnipeg quarterly average and biweight housing price series in $'000's.

```
Listing of PLOTFILEW(615,661) at 12:28:56 on JUL 31, 1984 for CCid=EGER Page    1

      SYMBOL FOR VARIABLE AVERAGE   IS    A
      SYMBOL FOR VARIABLE BIWEIGHT  IS    B
```




```
1PAGE   11  BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

$L PLOTFILEW(681,727)
```

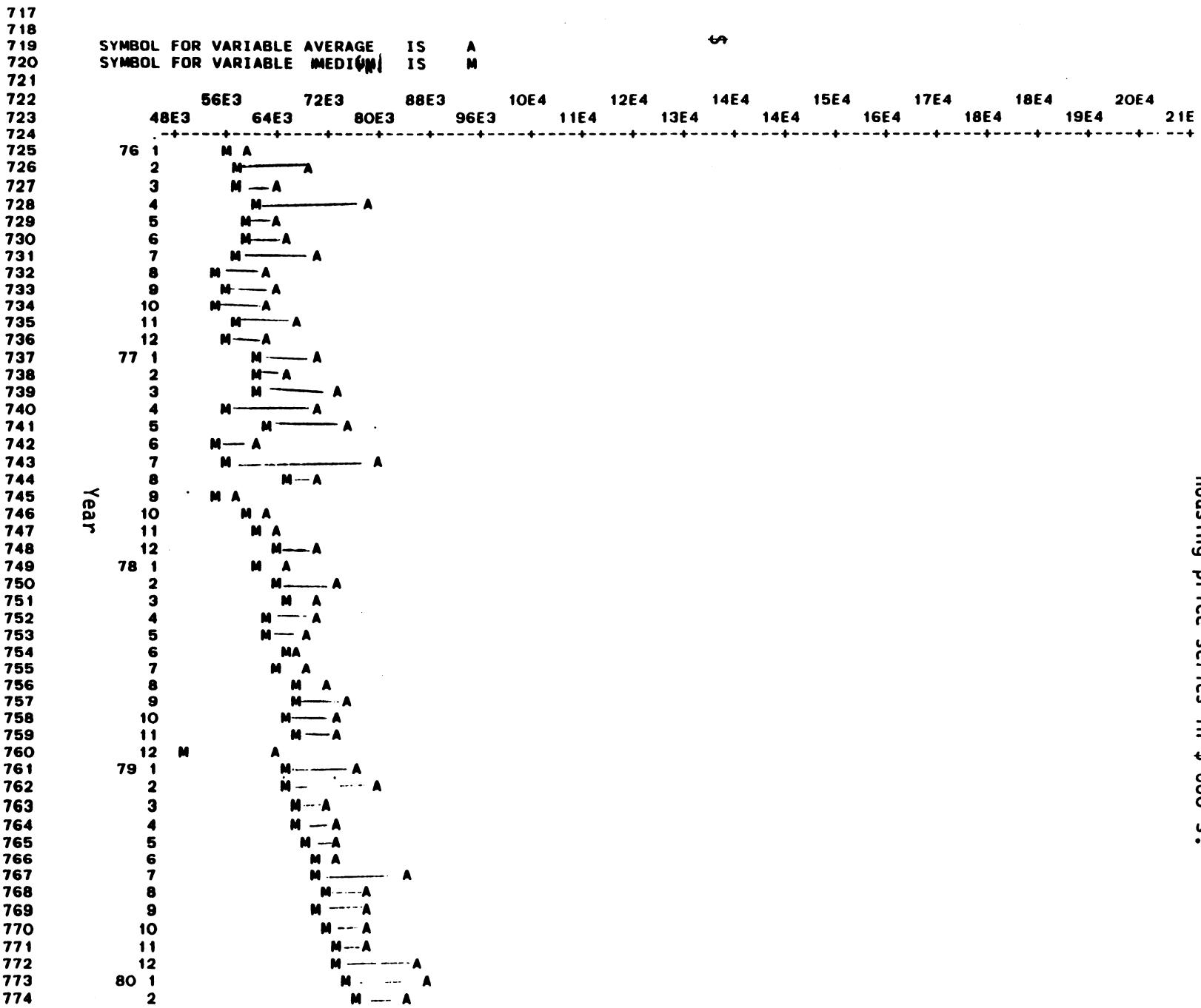
Exhibit 4.8 N. W. Winnipeg quarterly percentage difference between average and biweight.

```
Listing of PLOTFILEW1(291,336) at 12:11:19 on JUL 26, 1984 for CCid=EGER Page    1
291
292
293          abdiffp                                  %
294
295                .800     2.40     4.00     5.60     7.20     8.80     10.4     12.0     13.6     15.2
296          0.00     1.60     3.20     4.80     6.40     8.00     9.60     11.2     12.8     14.4
297                +---------+---------+---------+---------+---------+---------+---------+---------+---------+
298        75 1
299           2
300           3
301           4
302        76 1
303           2
304           3
305           4
306        77 1
307           2
308           3
309           4
310        78 1
311           2
312           3
313           4
314        79 1
315           2
316           3
317           4
318        80 1
319           2
320           3
321           4
322        81 1
323           2
324           3
325           4
326        82 1
327           2
328           3
329           4
330        83 1
331           2
332           3
333           4
334      1PAGE    6  BMDP2T WINNIPEG AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT
335
336
```

Year

$L PLOTFILEW1(356,402)

Exhibit 5.1 Richmond monthly average land and median housing price series in $'000's.



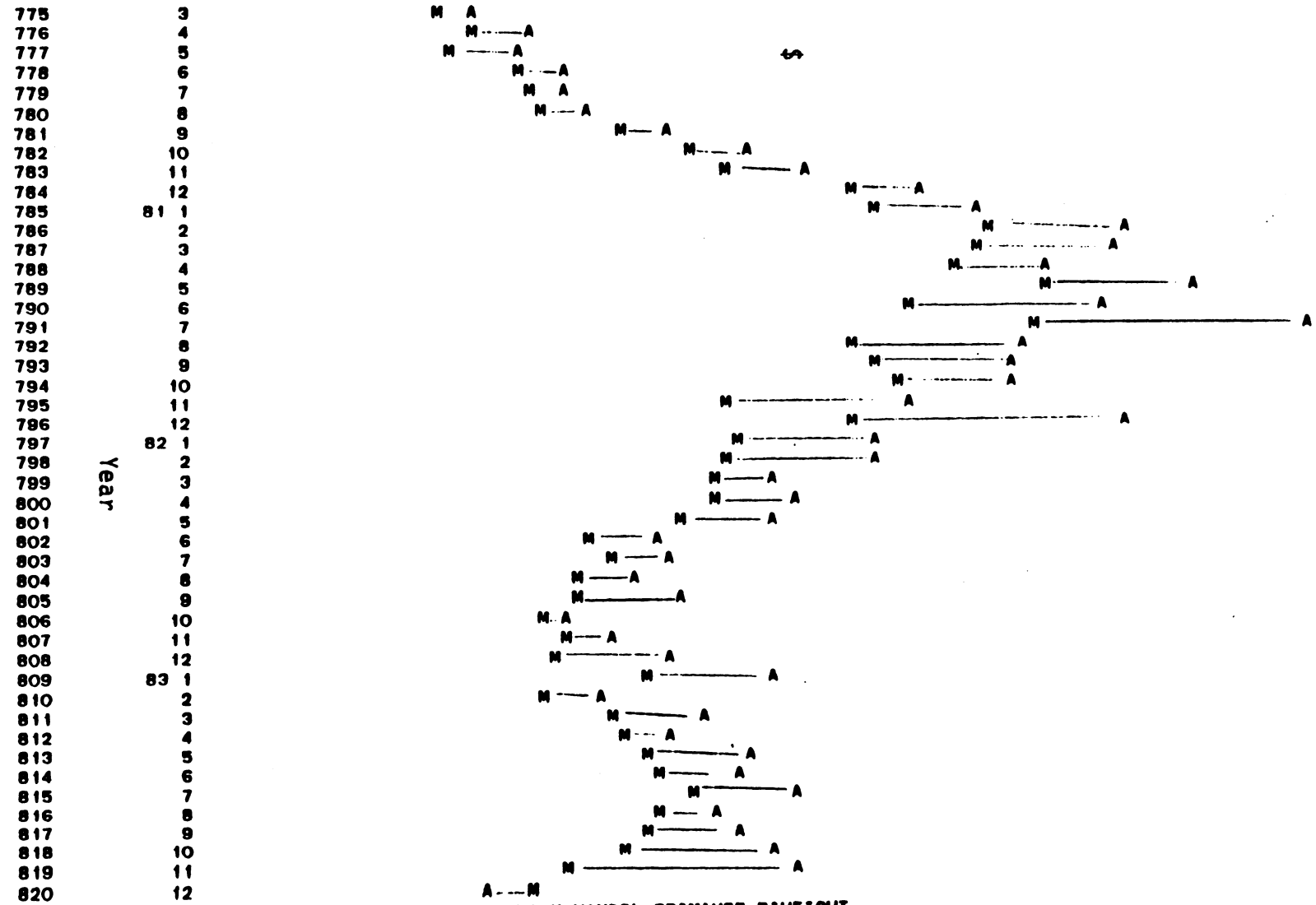
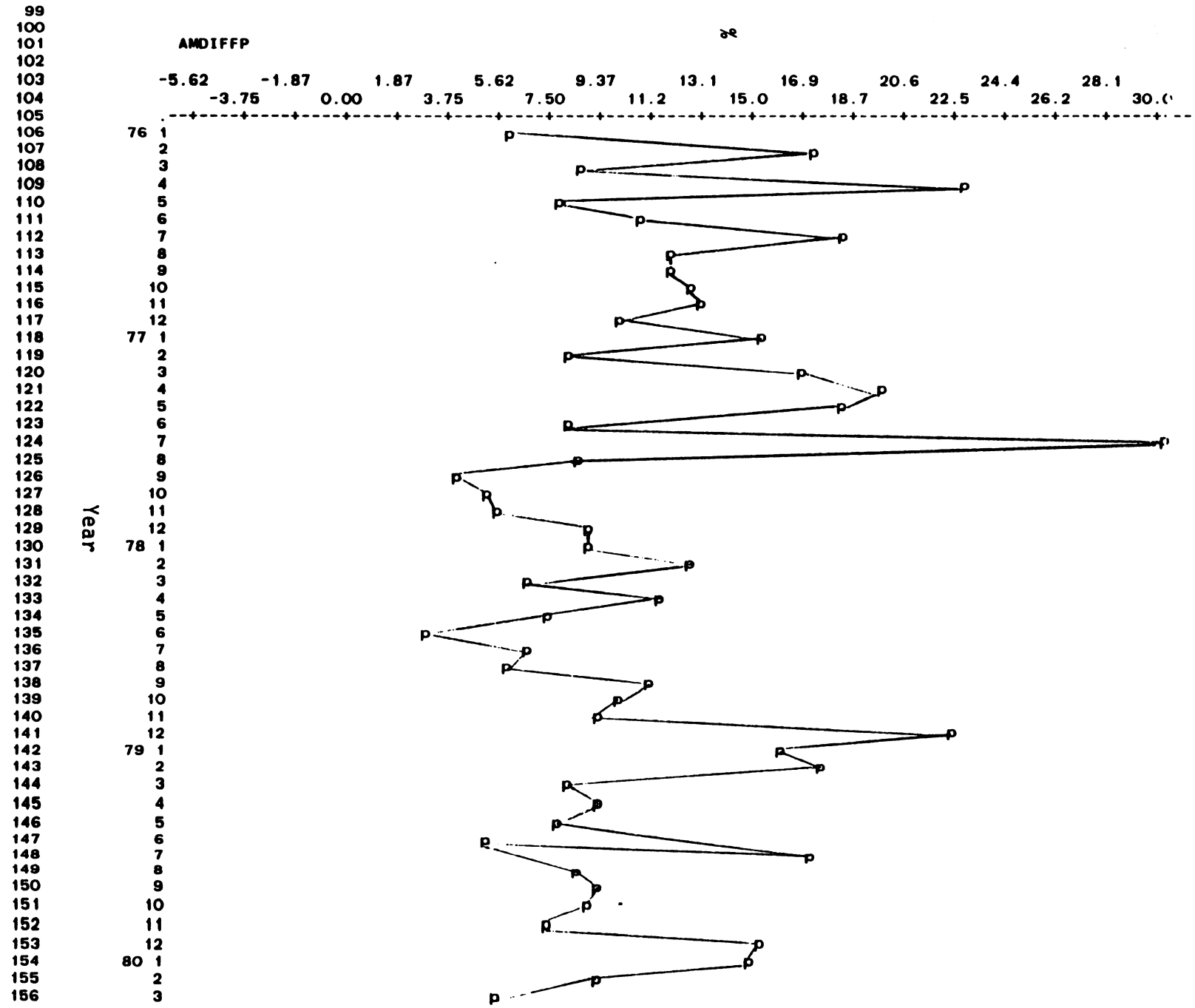


Exhibit 5.1 Richmond monthly

Exhibit 5.2 Richmond monthly percentage difference between average and median.



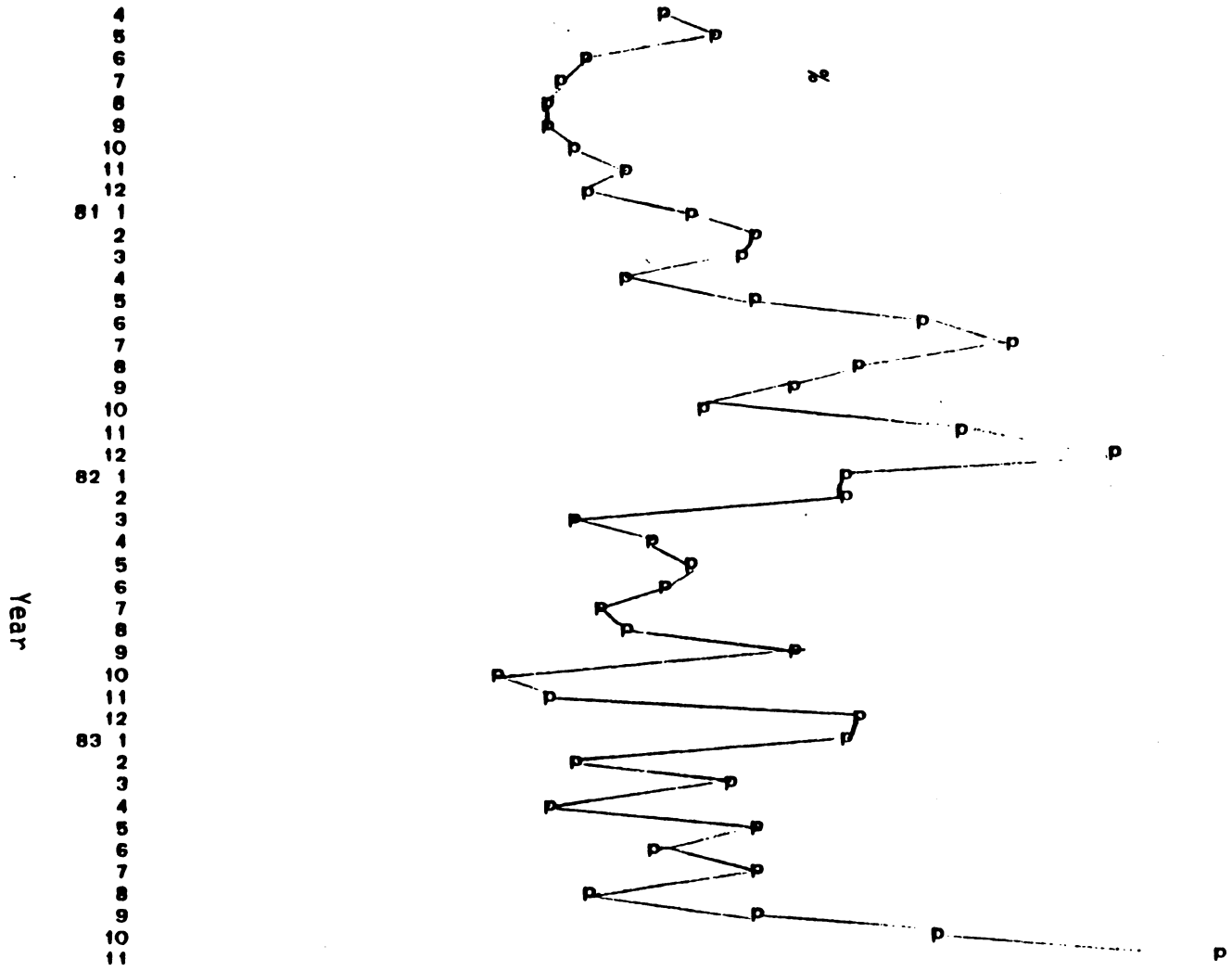
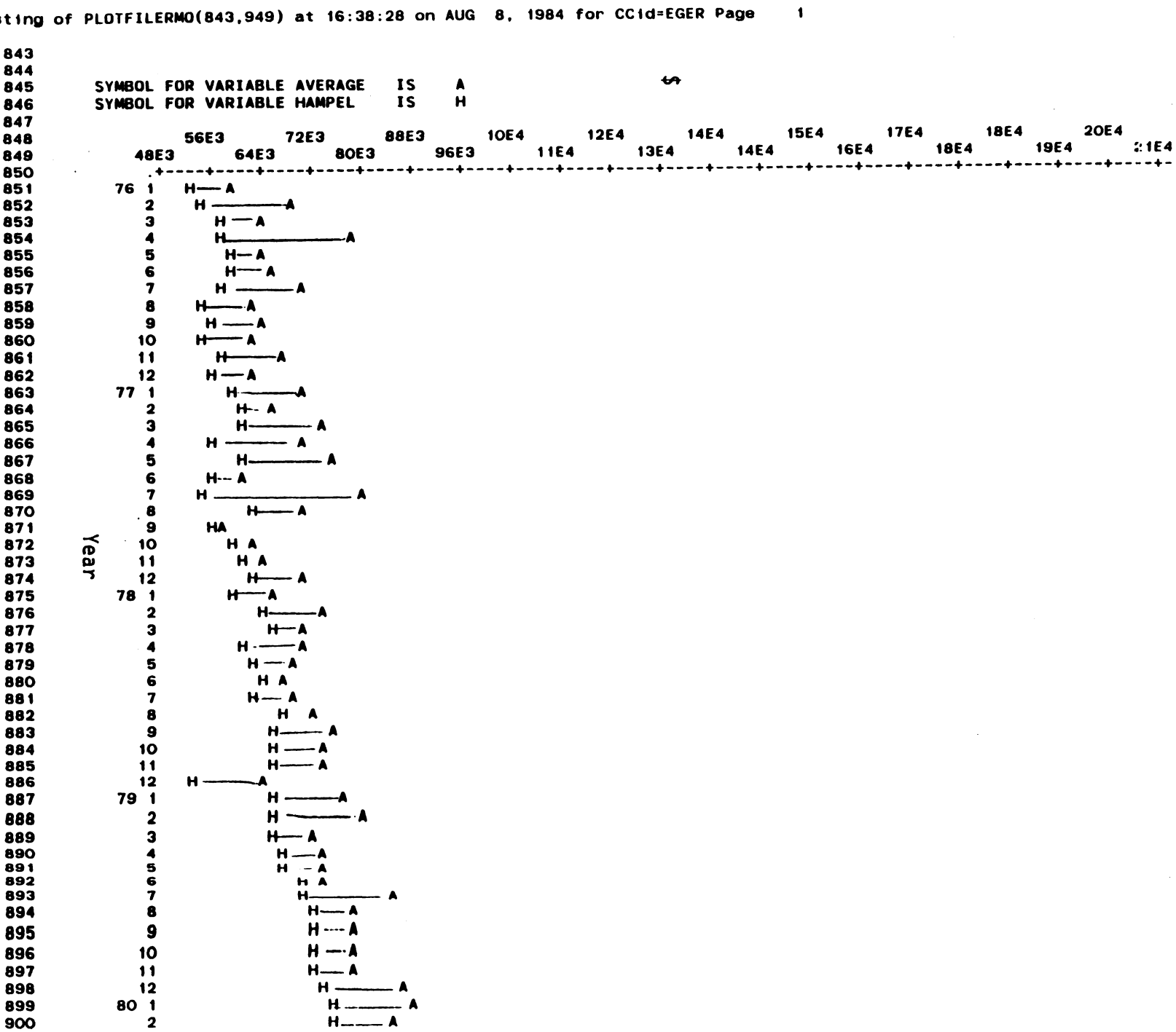


Exhibit 5.2 Richmond monthly

$L PLOTFILER1MO(223,451)

Exhibit 5.3 Richmond monthly average and Hampel housing price series in $'000's.



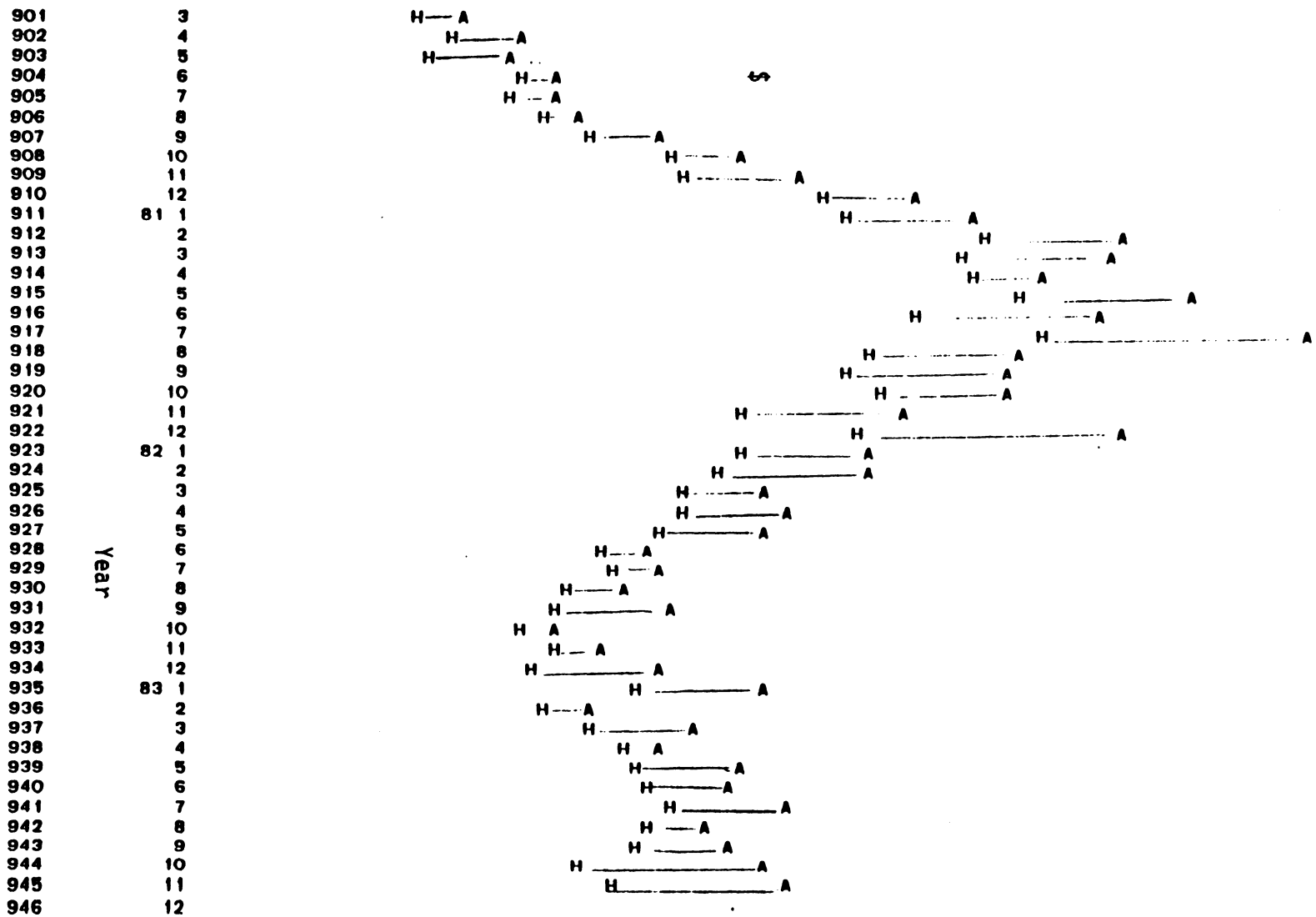
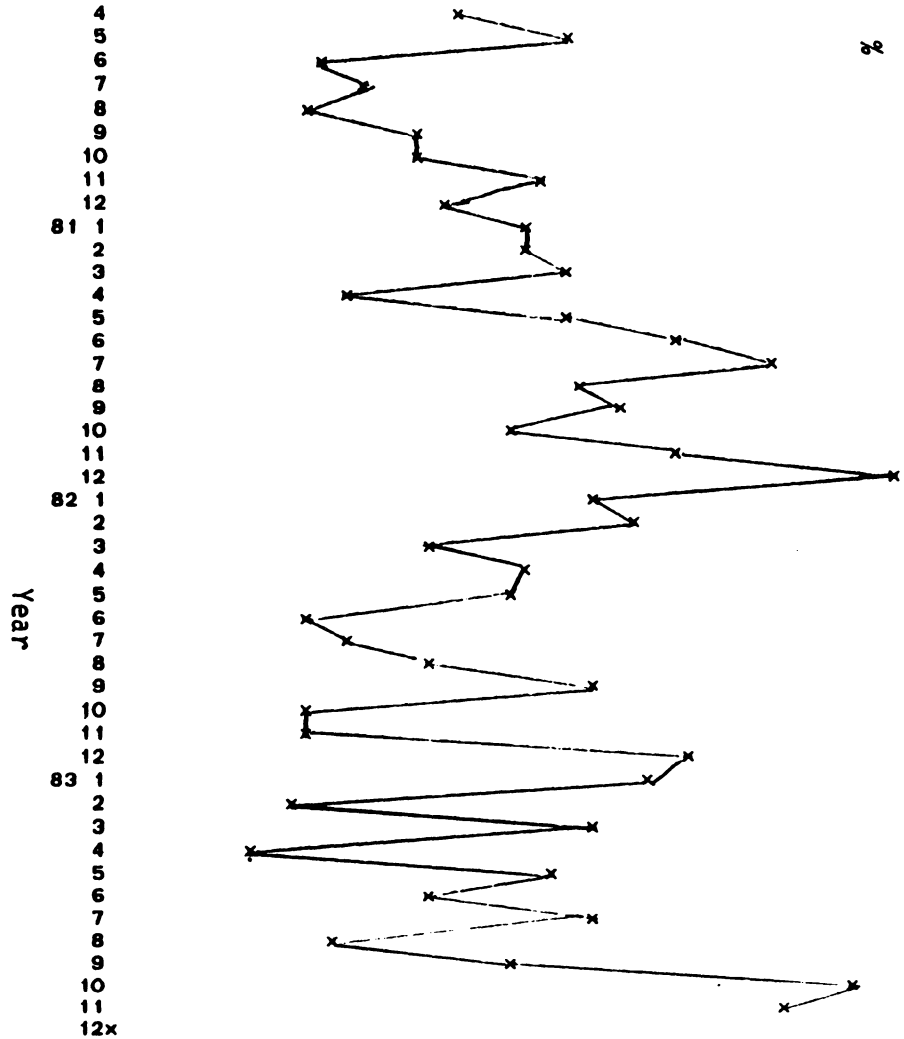


Exhibit 5.3 Richmond monthly

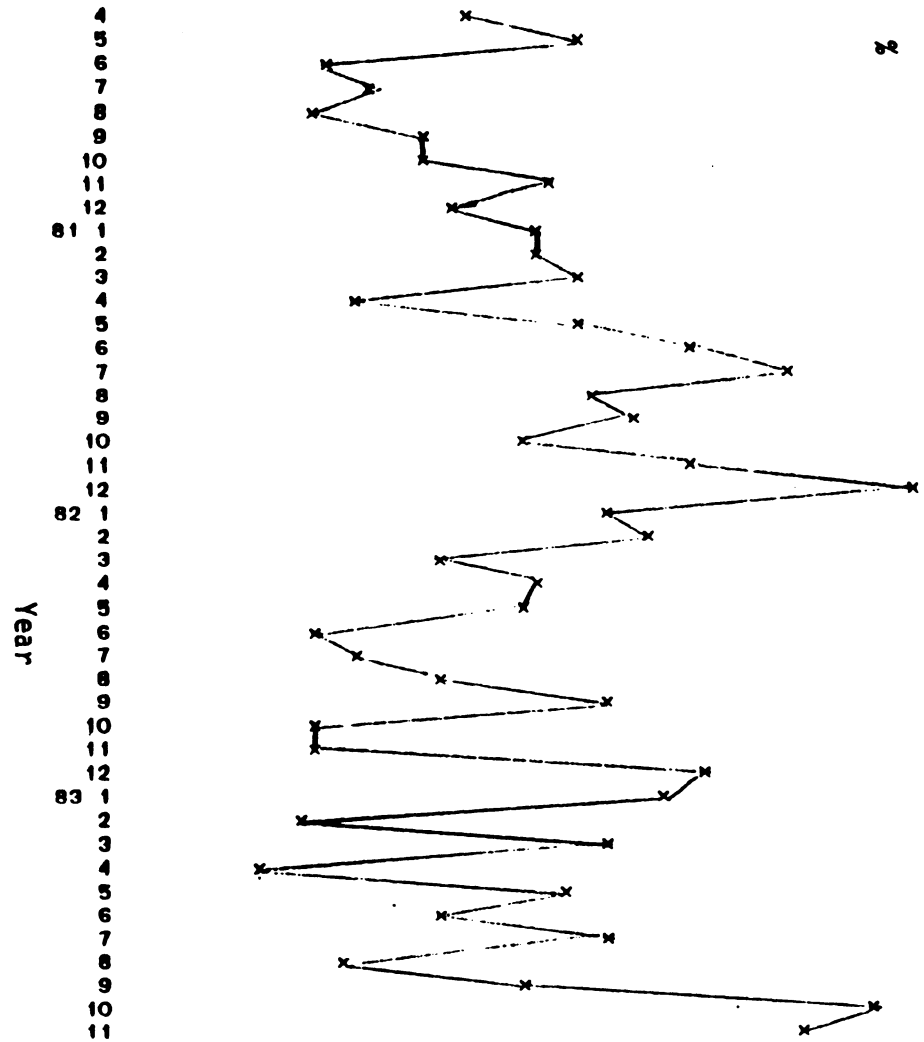
Exhibit 5.4 Richmond monthly




```
1PAGE   4  BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT


      TPLOT   VARIABLE IS AtDIFFP.
              SIZE IS 100.
              TIME = 75.25,83,.25.
              SYMBOLS ARE y./


 * * * WARNING * * * IN PARAGRAPH TPLOT    THE FOLLOWING TEXT IS IGNORED:
 TIME = 75.25,83,.25.
 * * * NOTE THAT THE FOLLOWING STATEMENTS WERE NOT FOUND:
 CASE     COMM     MARK     MINI     MAXI     DEBU
```




```
1PAGE   4  BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT


     TPLOT   VARIABLE IS AtDIFFP.
             SIZE IS 100.
             TIME = 75.25,83,.25.
             SYMBOLS ARE y./

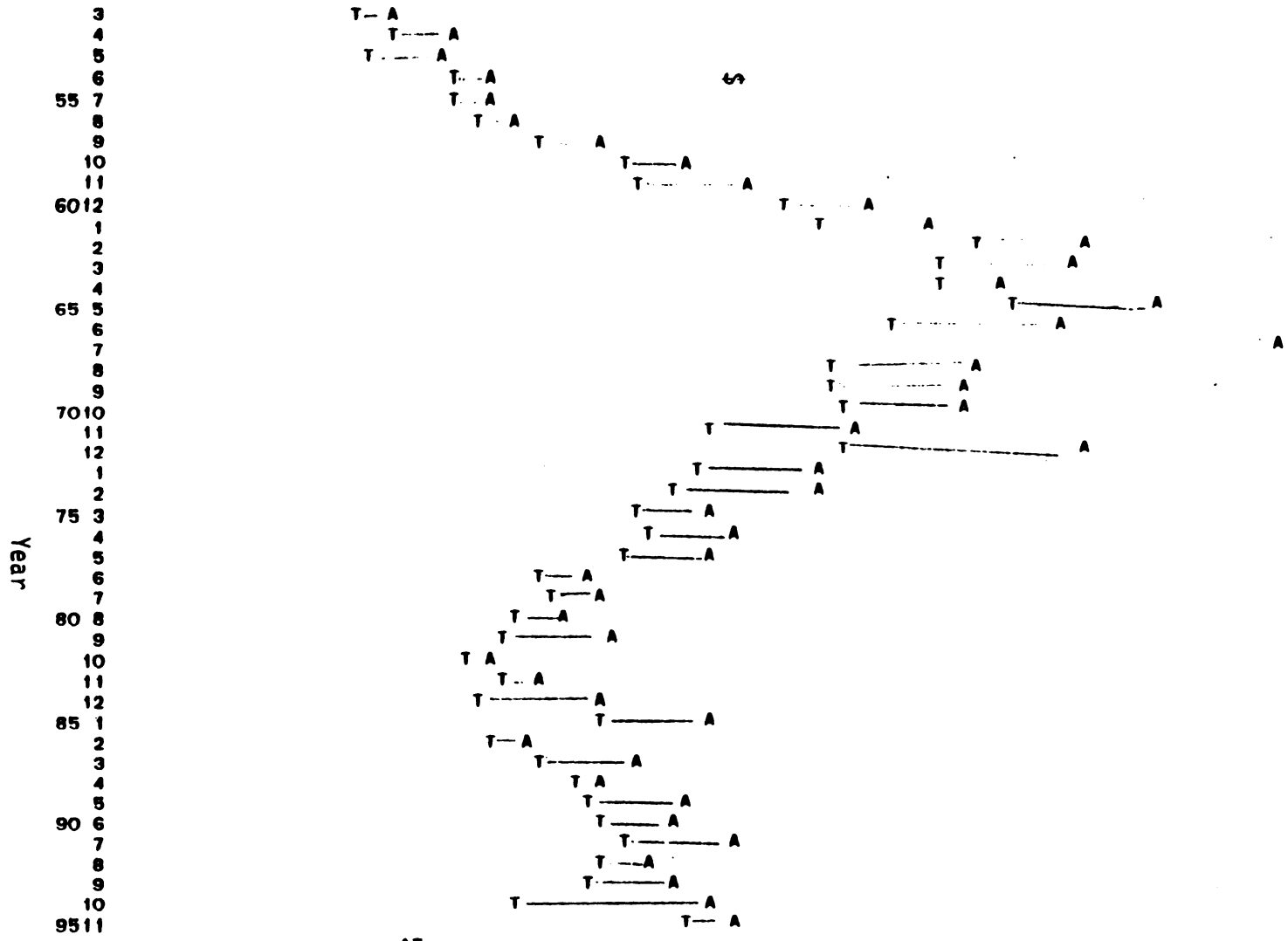

 * * * WARNING * * * IN PARAGRAPH TPLOT    THE FOLLOWING TEXT IS IGNORED:
 TIME = 75.25,83,.25.
 * * * NOTE THAT THE FOLLOWING STATEMENTS WERE NOT FOUND:
 CASE     COMM     MARK     MINI     MAXI     DEBU
```

Exhibit 5.4 Richmond monthly

Exhibit 5.5 Richmond monthly average and trimmed mean housing price series in $'000's.


```
969
970
971      SYMBOL FOR VARIABLE AVERAGE   IS    A
972      SYMBOL FOR VARIABLE TRIMAVER  IS    T
973
974                 56E3      72E3      88E3      10E4      12E4      14E4      15E4      17E4      18E4      20E4
975          48E3      64E3      80E3      96E3      11E4      13E4      14E4      16E4      18E4      19E4      21E4
976          .+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+-
977           1    T-A
978           2     T_______A
979           3      T-- A
980           4       T_________ A
981         5 5        T A
982           6       T--A
983           7       T-- --A
984           8     T--A
985           9      T--A
986        1010    T---A
987          11       T---A
988          12      T-A
989           1        T----A
990           2        T-- A
991        15 3         T-----A
992           4      T-------A
993           5        T------ --A
994           6     T-- A
995           7     T-------------A
996        20 8          T-- A
997           9     TA
998          10       T A
999          11        T A
1000         12         T ---A
1001       25 1        T-- A
1002          2          T ----A
1003          3           T-A
1004          4         T---A
1005          5          T-A
1006       30 6           TA
1007          7          T-A
1008          8            T--A
1009          9            T----A
1010         10            T---A
1011       3511           T---A
1012         12    T-----A
1013          1            T-------A
1014          2             T -------A
1015          3             T- A
1016       40 4             T-- A
1017          5              T  A
1018          6               T A
1019          7                T------ A
1020          8                 T- A
1021       45 9                T--A
1022         10                T--A
1023         11                T --A
1024         12                  T ----A
1025          1                   T -----A
1026       50 2                  T ----A
```

Year



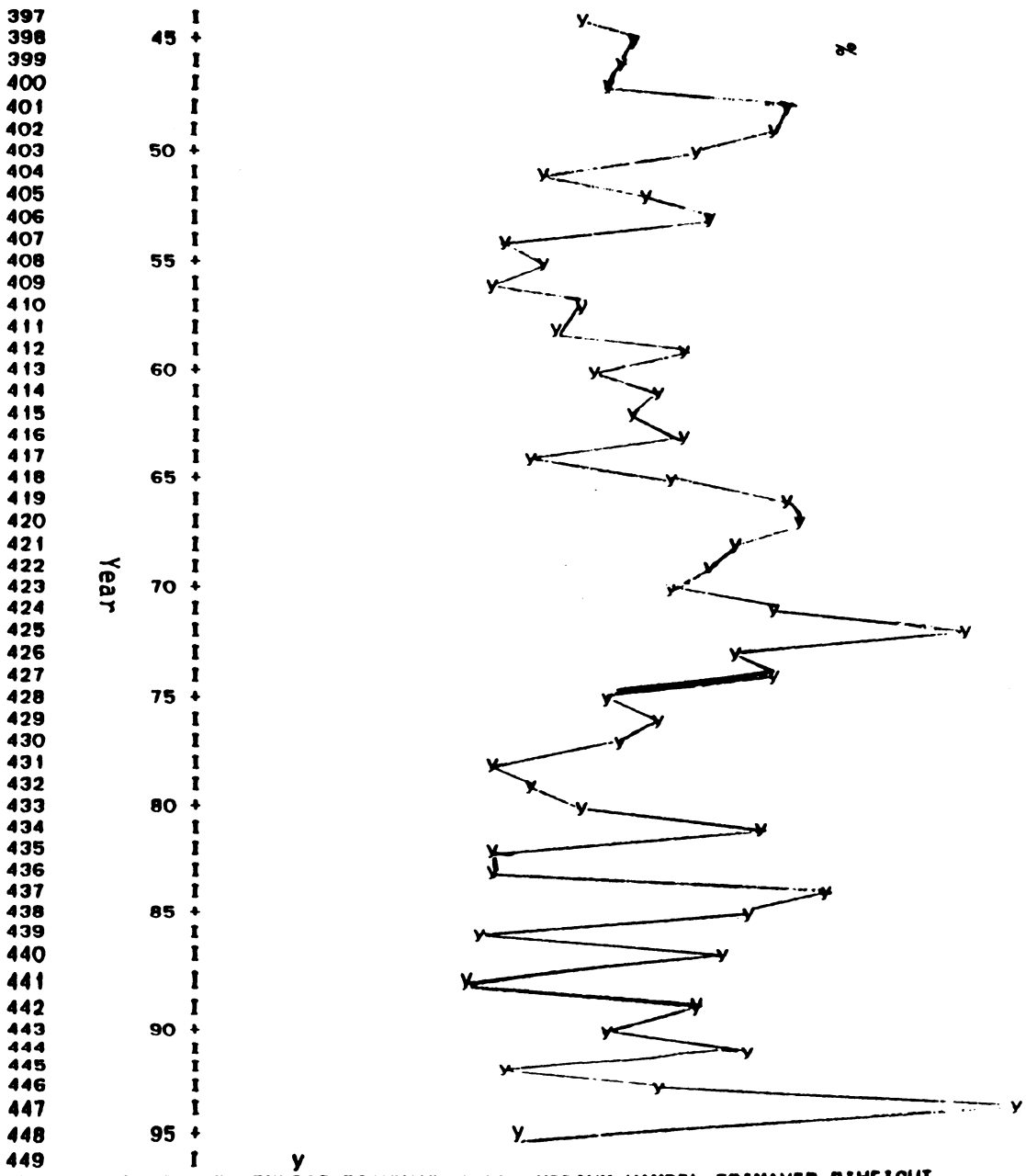
1PAGE 10 BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Exhibit 5.5 Richmond monthly

Exhibit 5.6 Richmond monthly percentage difference difference between average and trimmed mean.


```
339
340      THE MOST COMMON EXPLANATIONS FOR EXTRANEOUS CONTROL LANGUAGE ARE:
341      - MISSPELLED PARAGRAPH OR SENTENCE NAME
342      - SENTENCE IN THE WRONG PARAGRAPH
343      - SENTENCE OR PARAGRAPH REPEATED UNEXPECTEDLY
344      - OPTION NOT DEFINED IN THIS PROGRAM
345      - MUTUALLY EXCLUSIVE OPTIONS SELECTED
346
347
348
349          atdiffp
350
351              -1.87     1.87     5.62     9.37     13.1     16.9     20.6     24.4     28.1     31.9
352        -3.75     0.00     3.75     7.50     11.2     15.0     18.7     22.5     26.2     30.0     33.7
353          .+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
354          I
355          I
356          I
357          I
358        5 +
359          I
360          I
361          I
362          I
363       10 +
364          I
365          I
366          I
367          I
368       15 +
369          I
370          I
371          I
372          I
373       20 +
374          I
375          I
376          I
377          I
378       25 +
379          I
380          I
381          I
382          I
383       30 +
384          I
385          I
386          I
387          I
388       35 +
389          I
390          I
391          I
392          I
393       40 +
394          I
395          I
396          I
```

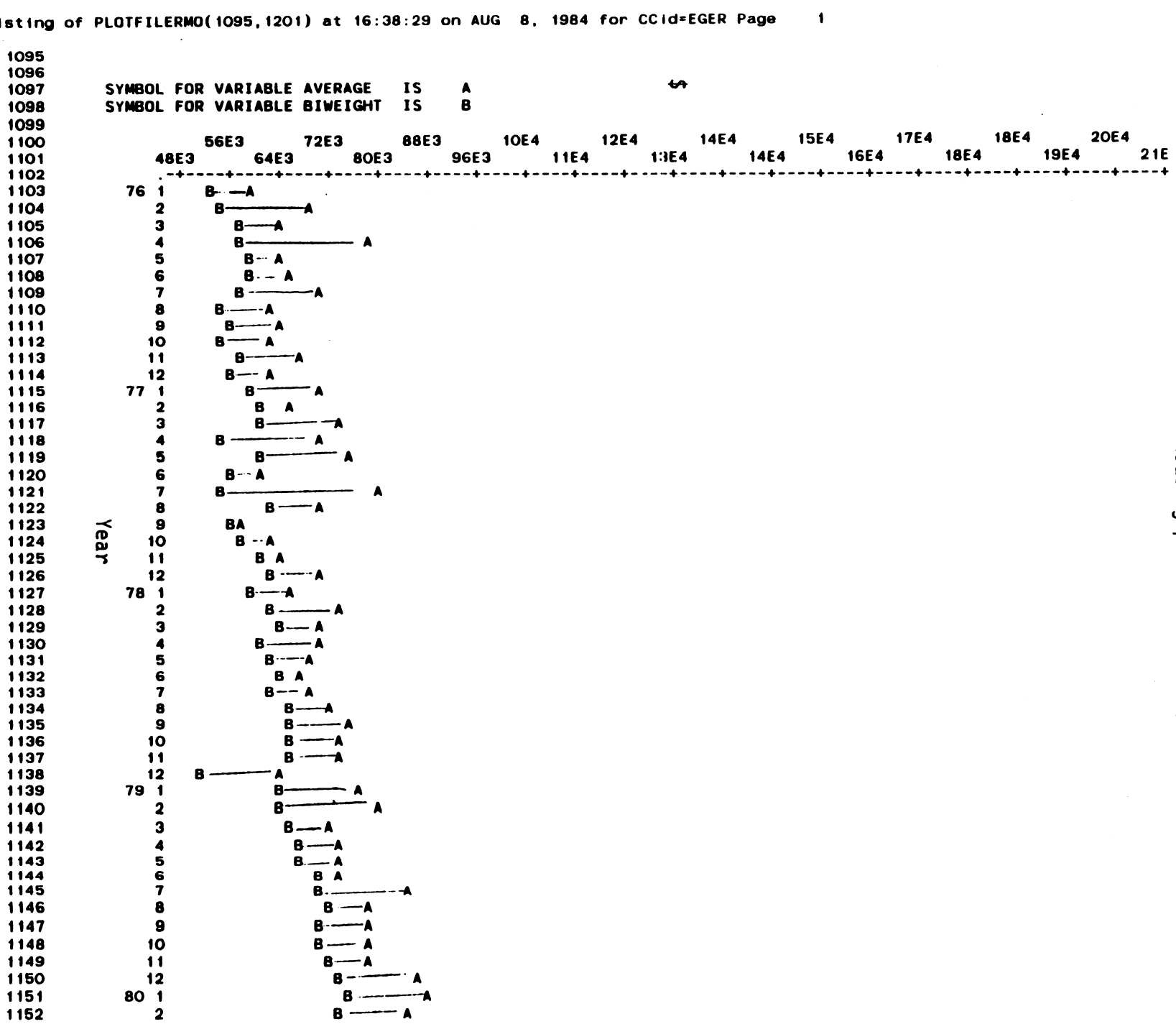
Year



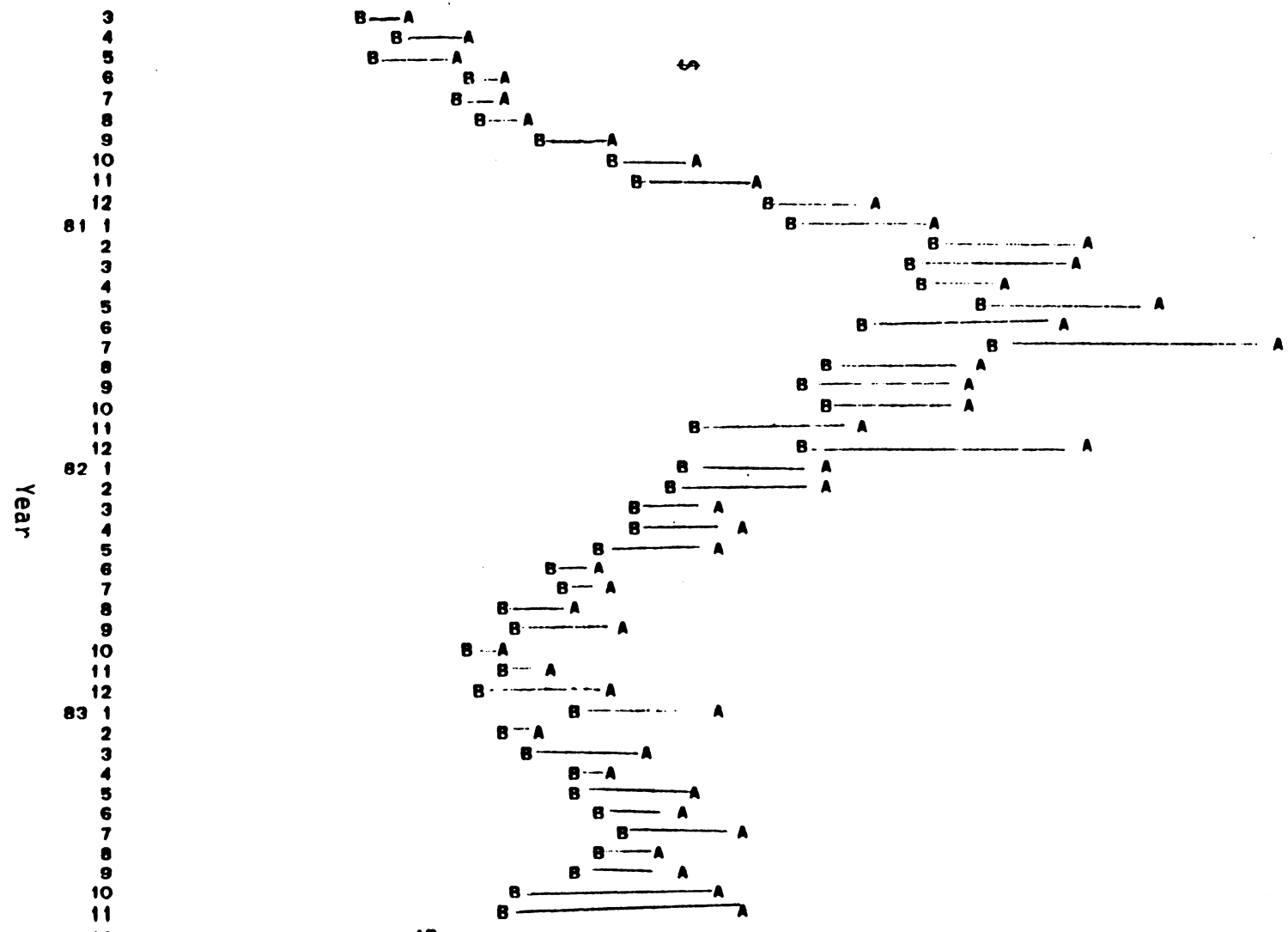
1PAGE 5 BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

Exhibit 5.6 Richmond monthly

Exhibit 5.7 Richmond monthly average and biweight housing price series in $'000's.



Listing of PLOTFILERMO(1095,1201) at 16:38:29 on AUG 8, 1984 for CCId=EGER Page 2



$SIG

Exhibit 5.7 Richmond monthly

Exhibit 5.8 Richmond monthly percentage difference between average and biweight.

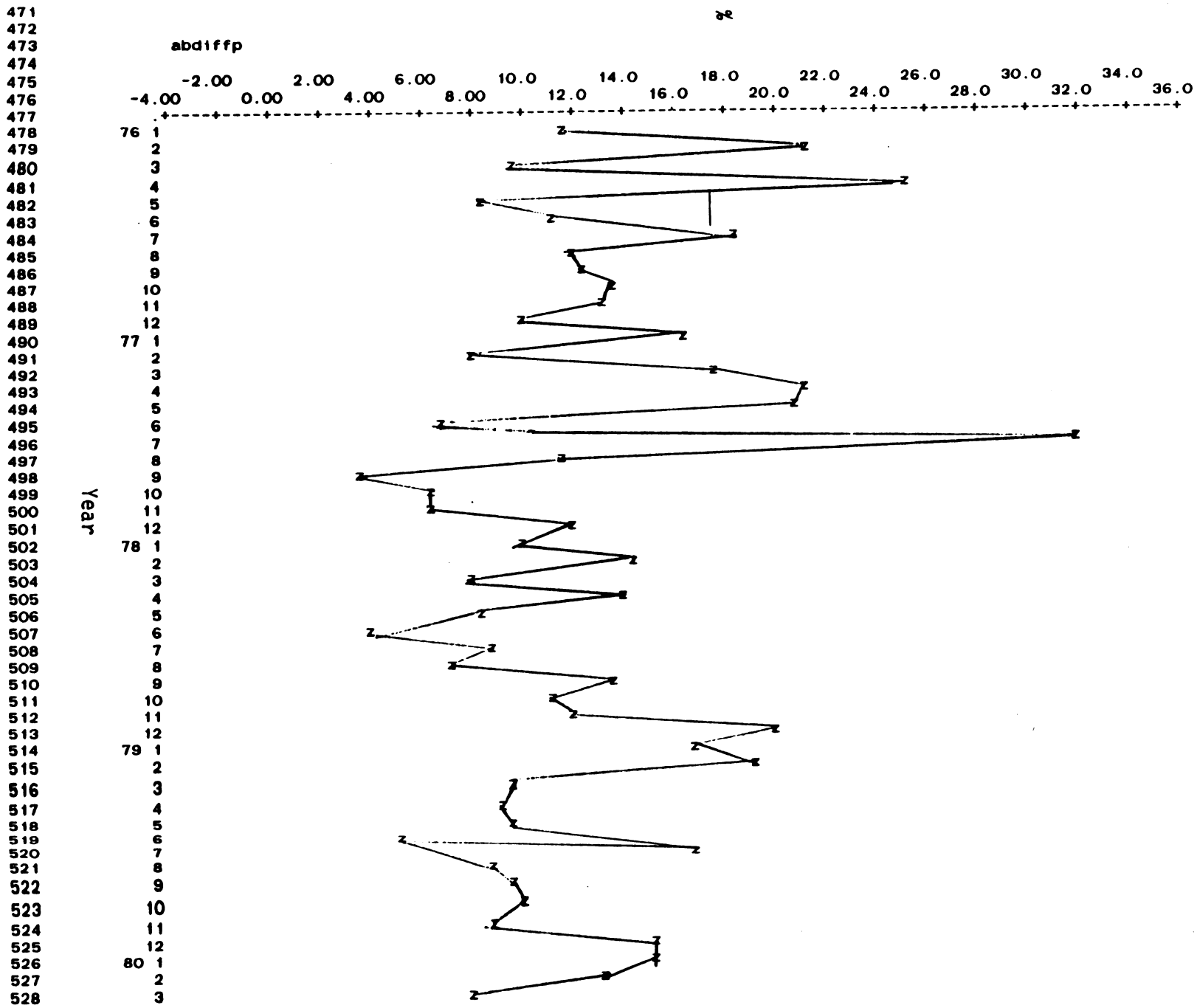
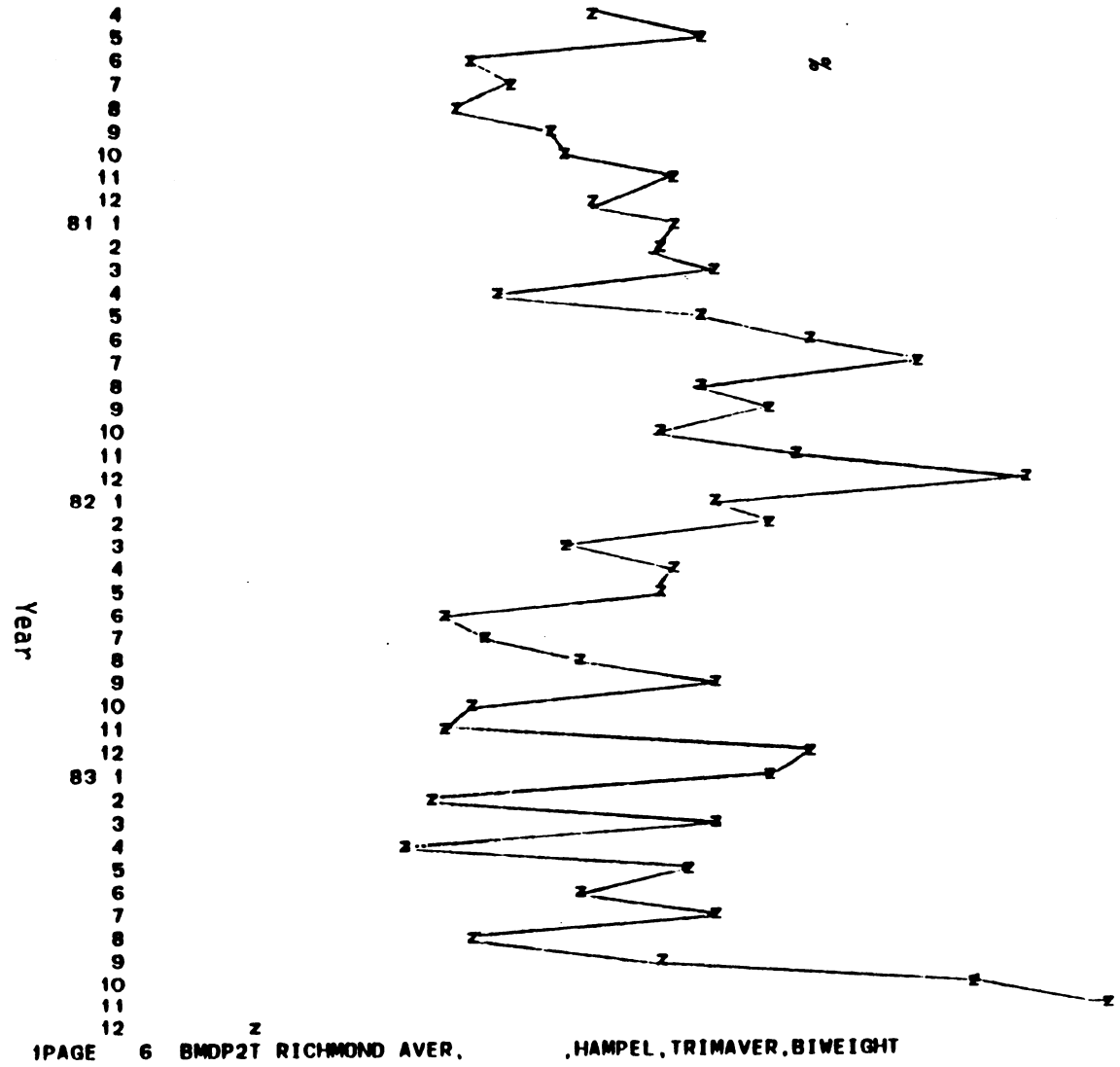


Exhibit 5.8 Richmond monthly

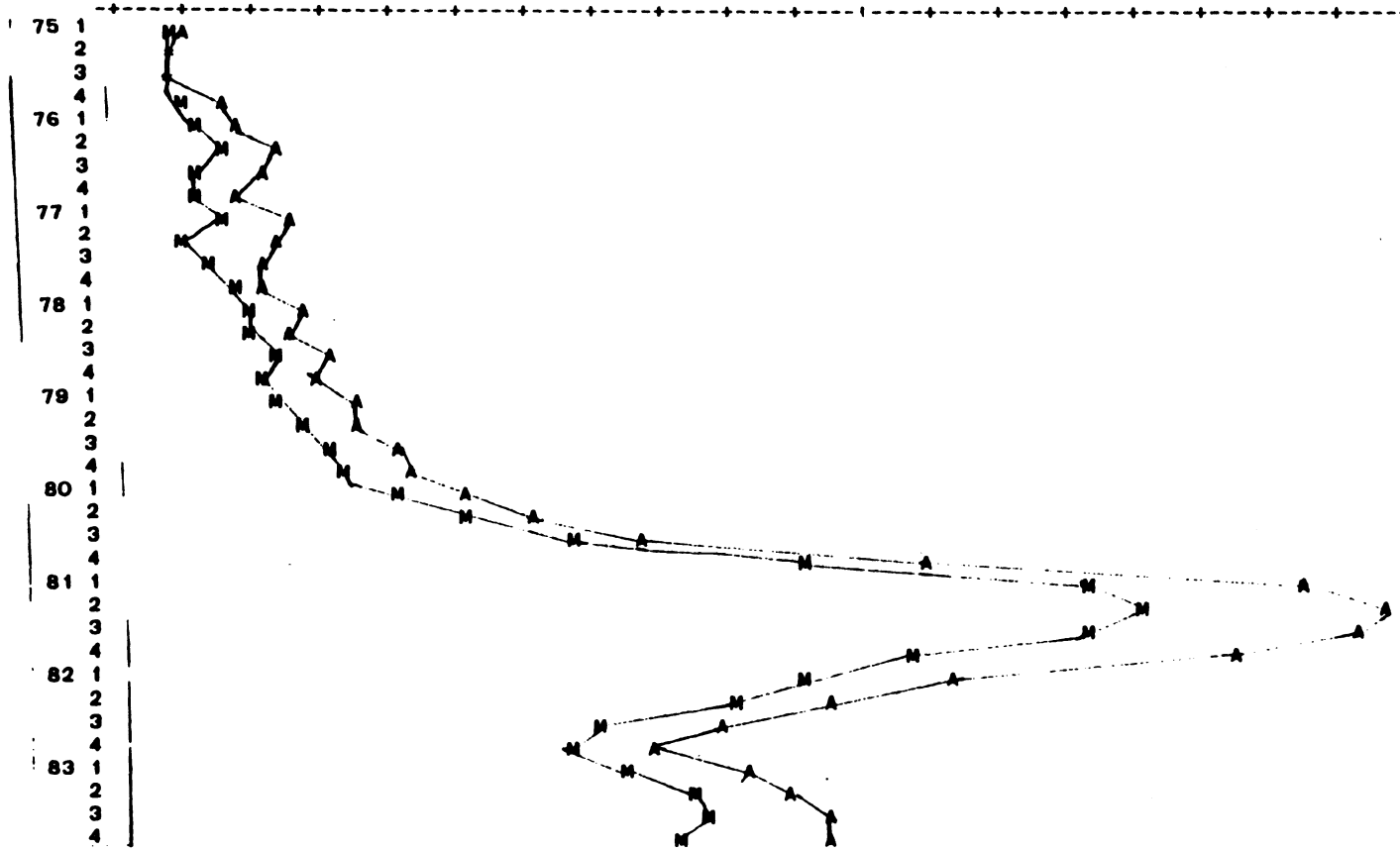


$SIG

Exhibit 6.1 Richmond quarterly average and median housing price series in $'000's.


```
417
418
419      SYMBOL FOR VARIABLE AVERAGE   IS    A
420      SYMBOL FOR VARIABLE MEDIAN    IS    M
421
422          49E3      63E3      77E3      91E3      11E4      12E4      13E4      15E4      16E4      18E4      19E
423             56E3      70E3      84E3      98E3      11E4      13E4      14E4      15E4      17E4      18E4
424          -+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
425     75 1
426        2
427        3
428        4
429     76 1
430        2
431        3
432        4
433     77 1
434        2
435        3
436        4
437     78 1
438        2
439        3
440        4
441     79 1
442        2
443        3
444        4
445     80 1
446        2
447        3
448        4
449     81 1
450        2
451        3
452        4
453     82 1
454        2
455        3
456        4
457     83 1
458        2
459        3
460        4
461  1PAGE   8  BMDP2T RICHMOND AVER,        ,HAMPEL,TRIMAVER,B:WEIGHT
462
463
```

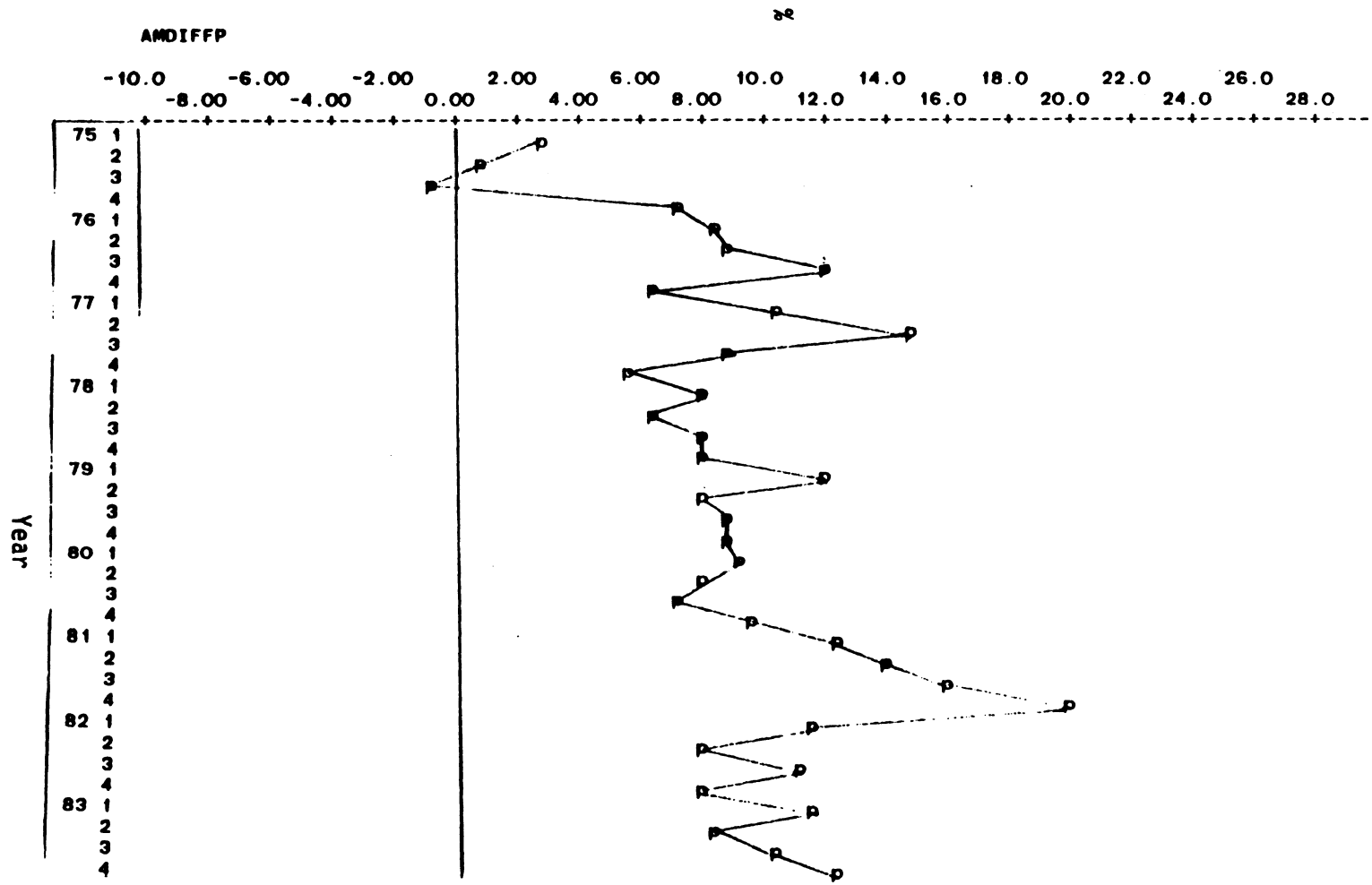
Year



$L PLOTFILER(483,529)

Exhibit 6.2 Richmond quarterly percentage difference between average and median.

```
Listing of PLOTFILER1(99,144) at 12:12:17 on JUL 26, 1984 for CCid=EGER Page    1
```



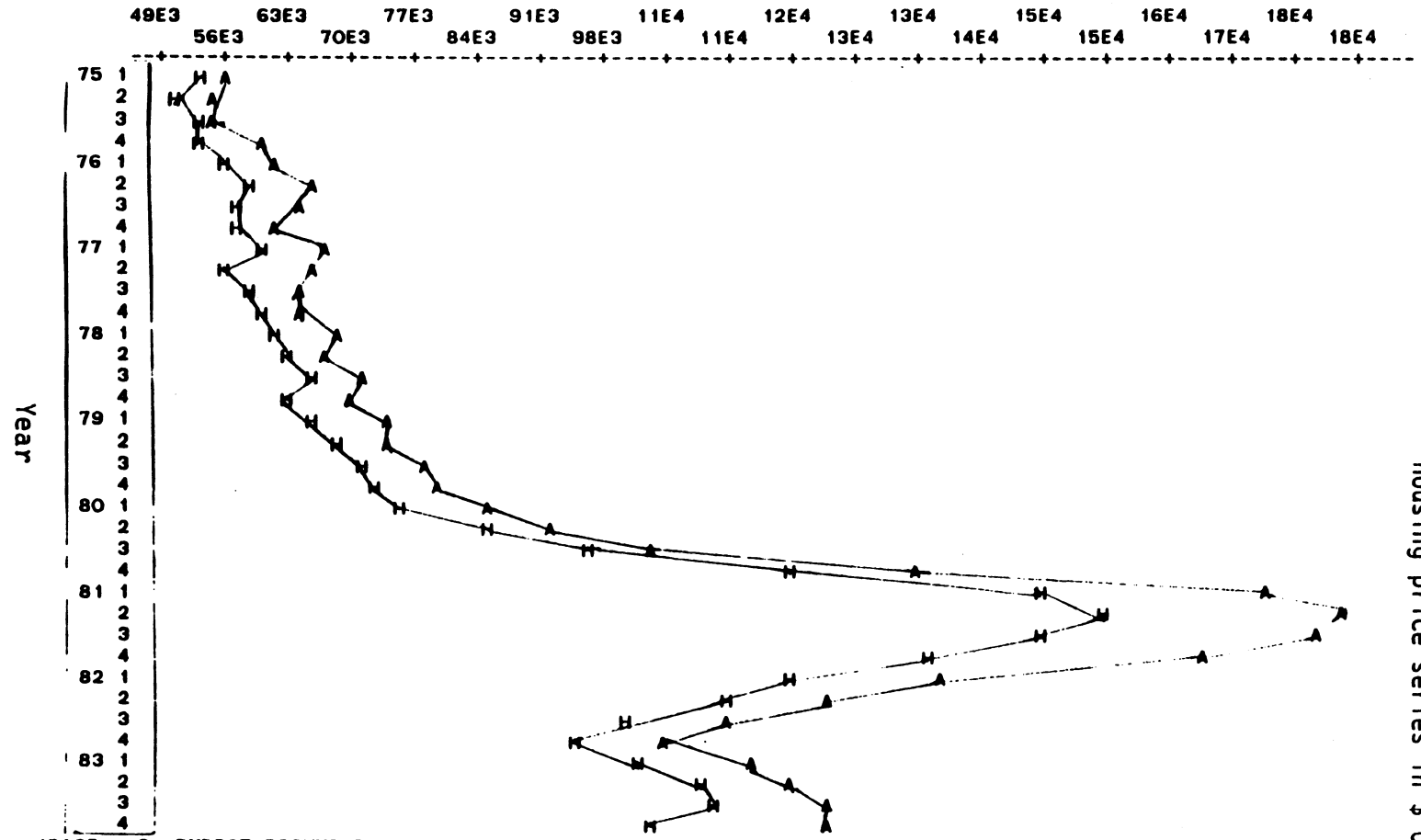

```
1PAGE    3  BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

$L PLOTFILER1(163,208)
```

Exhibit 6.3 Richmond quarterly average and Hampel housing price series in $'000's.

```
Listing of PLOTFILER(483,529) at 12:26:02 on JUL 31, 1984 for CCid=EGER Page    1

SYMBOL FOR VARIABLE AVERAGE   IS    A
SYMBOL FOR VARIABLE HAMPEL    IS    H
```




```
1PAGE    9  BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

$L PLOTFILER(549,595)
```

Exhibit 6.4 Richmond quarterly percentage difference between average and Hampel.

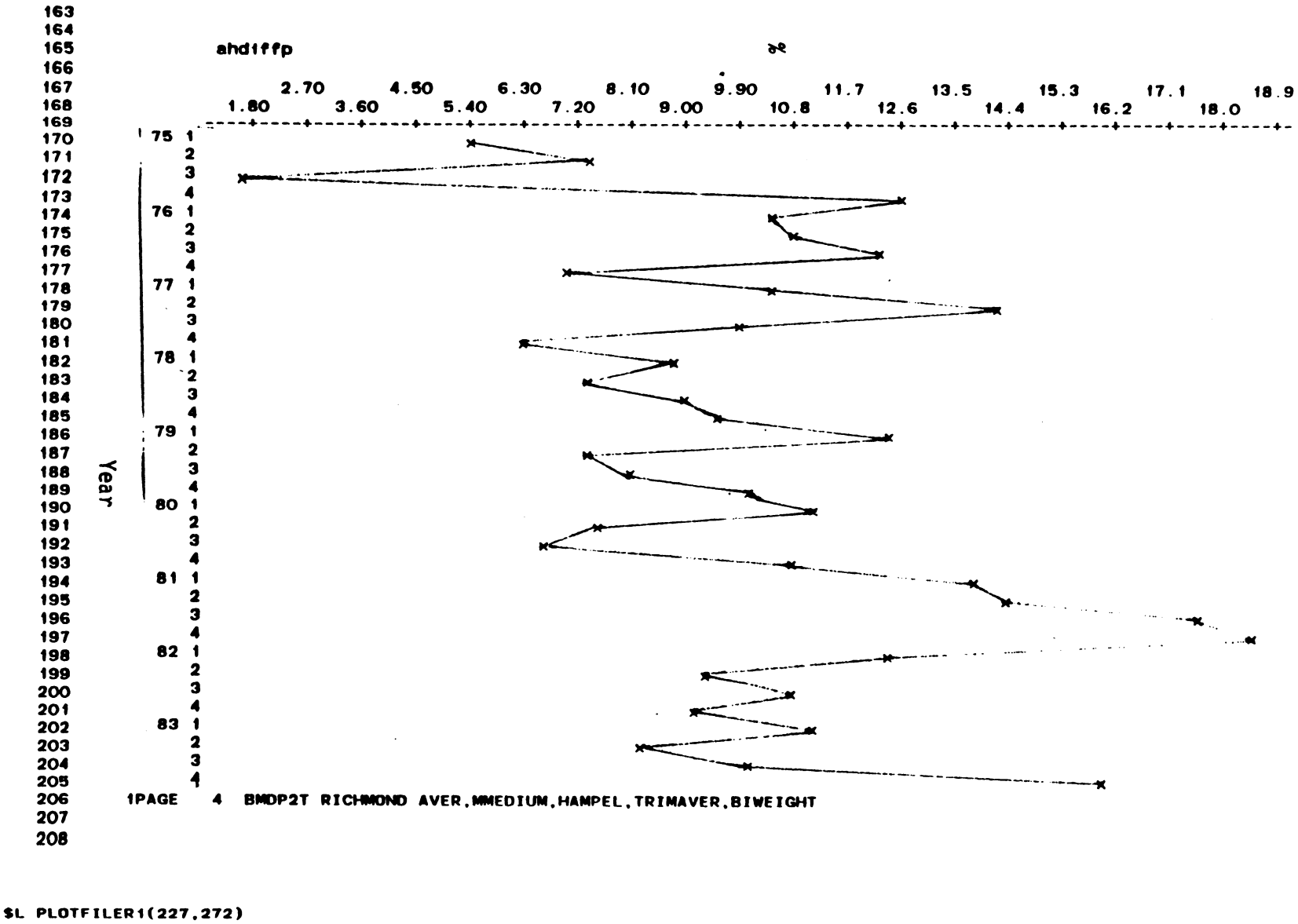


Exhibit 6.5 Richmond quarterly average and trimmed mean housing price series in $'000's.

Listing of PLOTFILER(549,595) at 12:26:02 on JUL 31, 1984 for CCid=EGER Page 1

```
549
550
551     SYMBOL FOR VARIABLE AVERAGE   IS    A
552     SYMBOL FOR VARIABLE TRIMAVER  IS    T
553
554          49E3      63E3      77E3      91E3      11E4      12E4      13E4      15E4      16E4      18E4
555              56E3      70E3      84E3      98E3      11E4      13E4      14E4      15E4      17E4      18E4
556
557     75 1
558        2
559        3
560        4
561     76 1
562        2
563        3
564        4
565     77 1
566        2
567        3
568        4
569     78 1
570        2
571        3
572        4
573     79 1
574        2
575        3
576        4
577     80 1
578        2
579        3
580        4
581     81 1
582        2
583        3
584        4
585     82 1
586        2
587        3
588        4
589     83 1
590        2
591        3
592        4
593 1PAGE  10  BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT
594
595
```

Year

$L PLOTFILER(615,661)

Exhibit 6.6 Richmond quarterly percentage difference between average and trimmed mean.

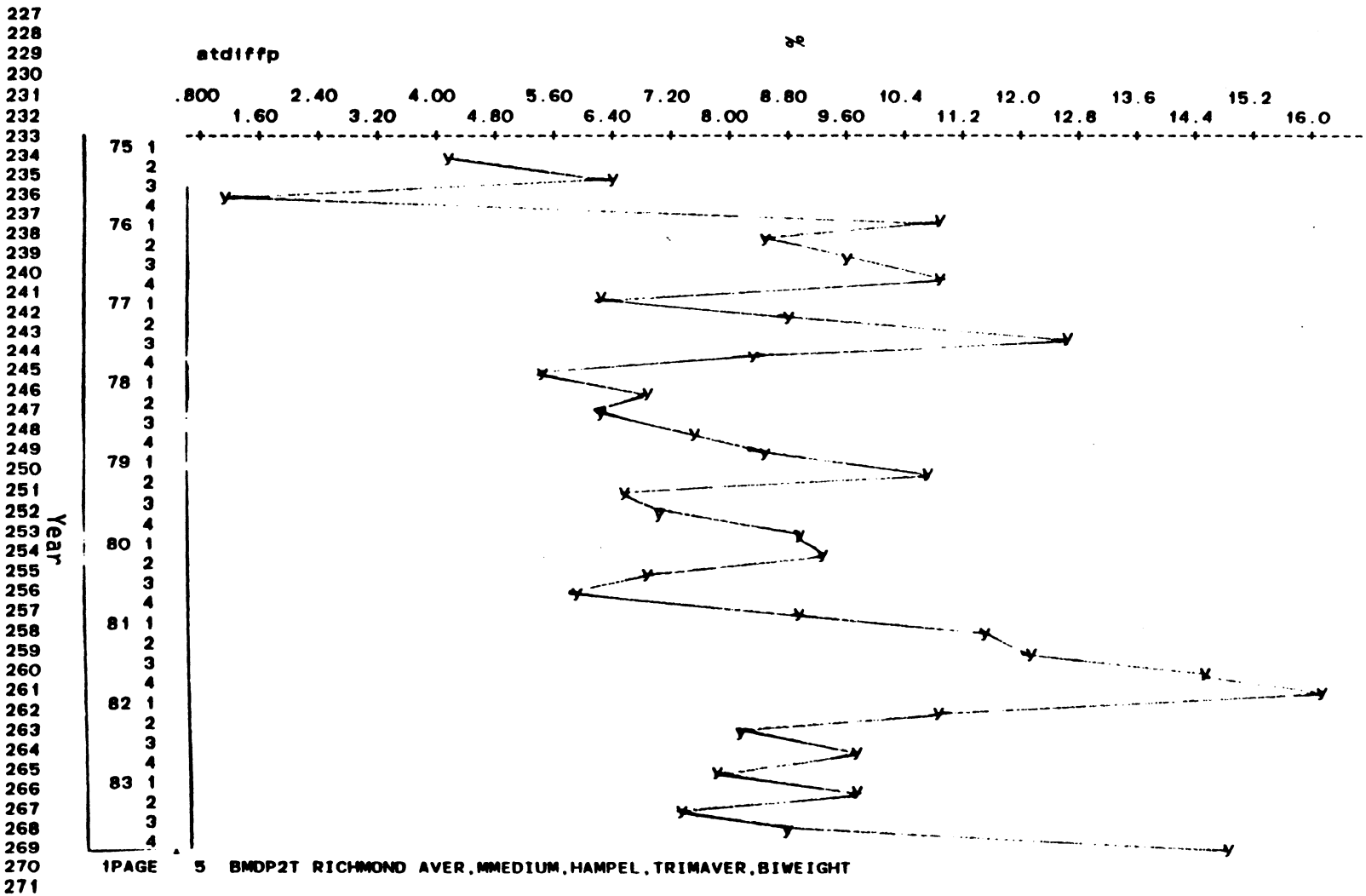


Exhibit 6.7 Richmond quarterly average and biweight housing price series in $'000's.

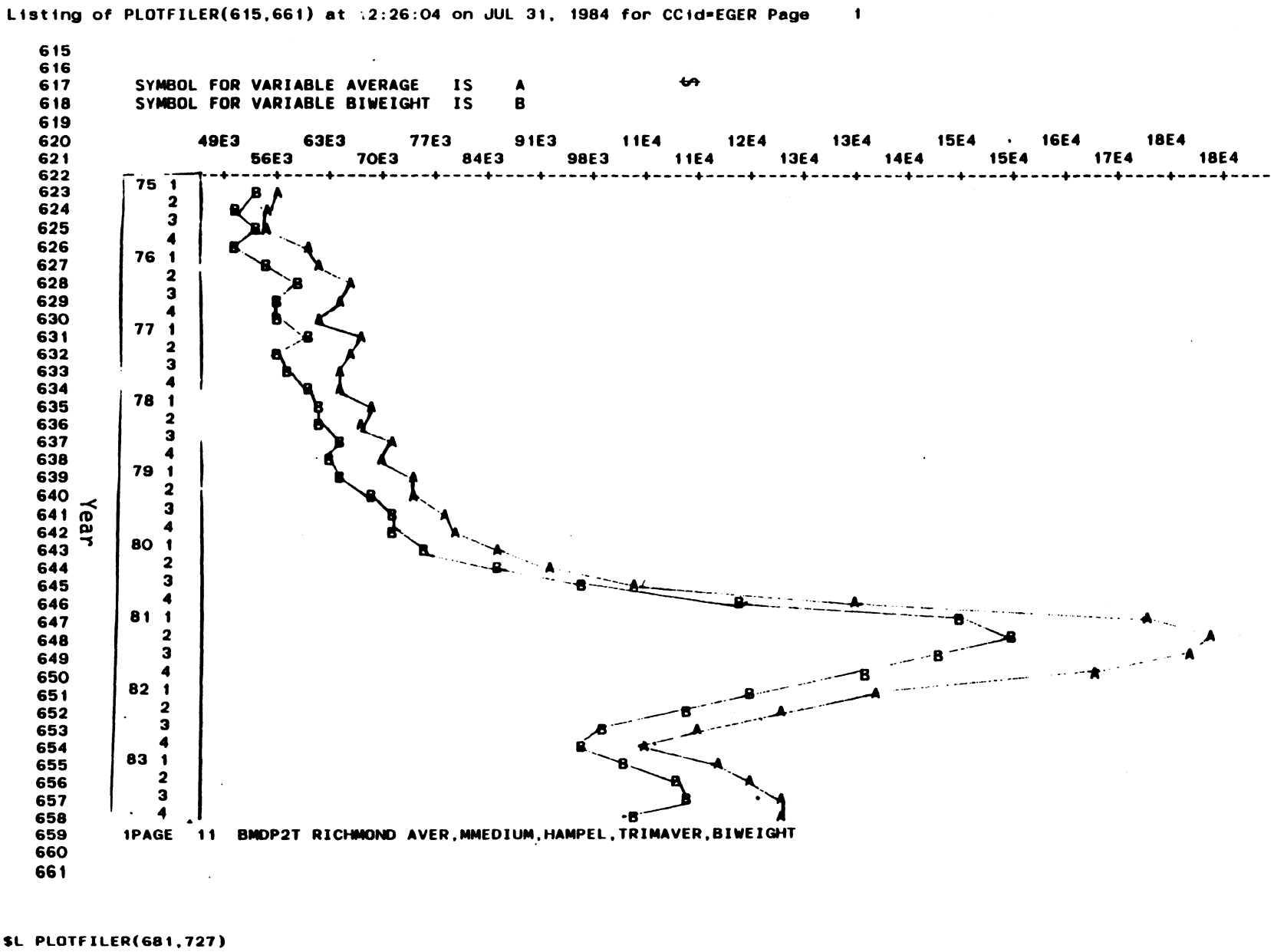
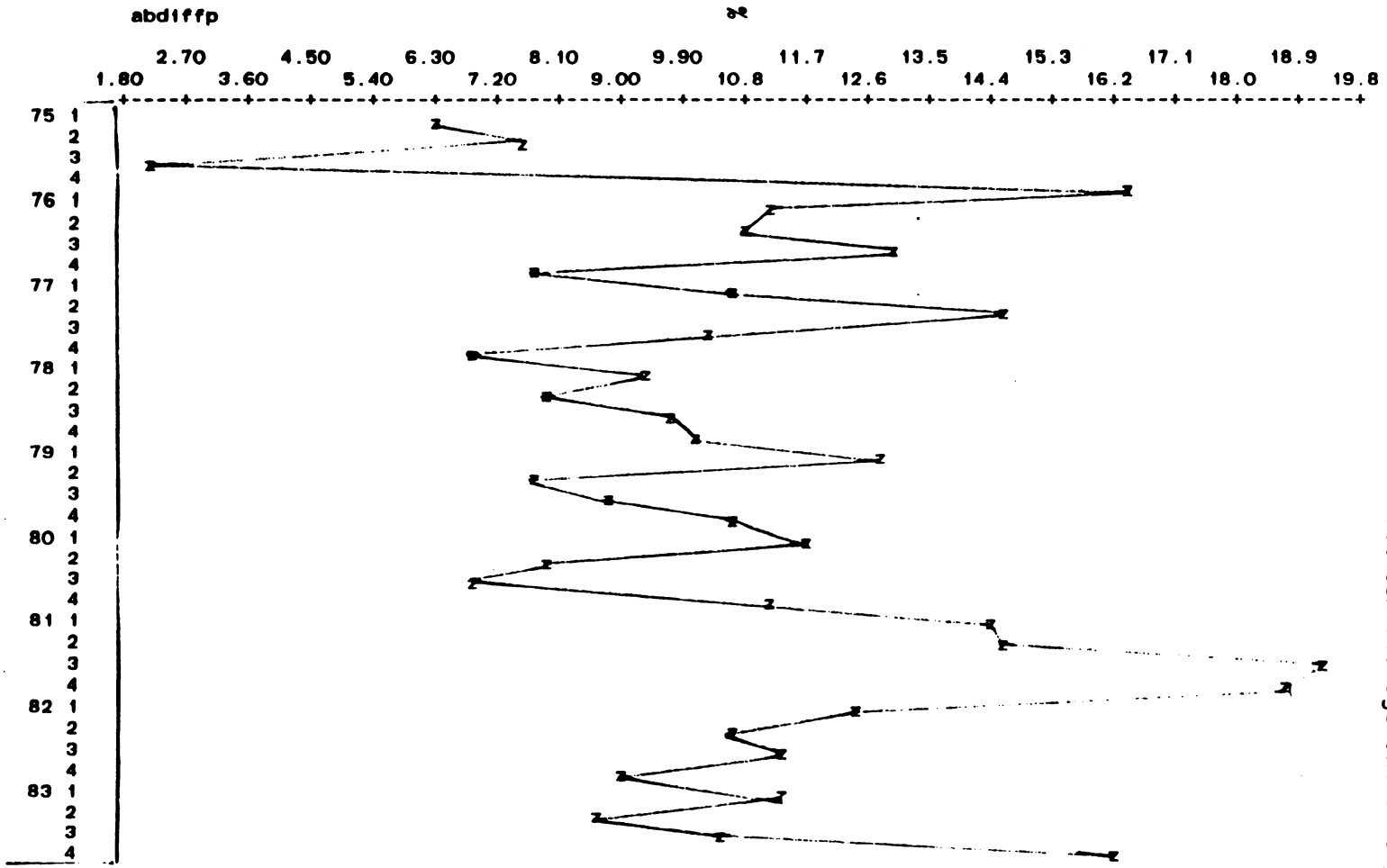


Exhibit 6.8 Richmond quarterly percentage difference between average and biweight.

Listing of PLOTFILER1(292,336) at 12:12:21 on JUL 26, 1984 for CCid=EGER Page 1



1PAGE 6 BMDP2T RICHMOND AVER,MMEDIUM,HAMPEL,TRIMAVER,BIWEIGHT

$L PLOTFILER1(356,402)

APPENDIX 2

Tests for population variances

(type 1, type 2, type 3)