Demand for Community Food Service

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ABSTRACT

This paper evaluates the development of an effective forecast for demand for meals at a community food service facility. Data was analyzed using time series models to identify cycles, trends or seasonality. Data was also analyzed to determine if weather or economic factors can be used to forecast demand for meals at the center. A quarterly forecast can be developed for food service. A monthly forecast can be developed for demand on the food pantry.

INTRODUCTION and PROBLEM STATEMENT

The ability to measure demand is a vital concern for any business, be it a service provider or goods manufacturer. A reliable measure of future demand enables a business to plan and utilize resources in order to successfully meet customer needs. Providers of community food service have a need to measure future demand.

This feasibility study examines the development of an effective forecast for demand for meals at a community food service facility. The center under study was established in the 1980s with the mission to unify community resources to help people. The center provides emergency food, transportation, utilities, rent and other services. The center further works with individuals and families to help move them toward self sufficiency. Among the many services the center offers, the subject of this study is the daily hot meals program and the food pantry.

An effective forecast for the center will enable staffers to better utilize available resources as well as plan for future staffing and food needs. Practical applications of a reliable forecast will enable the center to reduce staffing, meals prepared and food collection during times of lower expected demand. In times of higher expected demand, the center can then be fully prepared to increase staffing and meals needed Additionally, the center can increase food collection or solicitation of donors in advance of expected increased demand.

RESEARCH QUESTION

The purpose of this study is to determine an effective forecast for meals at a local community food service facility. To do that it is necessary to review historical data to determine whether there is a significant difference between meals served throughout the year.

The study hypotheses are formulated as follows:

1a) N_0: Quantity of meals served does not vary over time

1b) $N_{1:}$ Quantity of meals served varies over time

2a) N_0: Demand on the food pantry does not vary over time.

2b) N_1: Demand on the food pantry varies over time.

LITERATURE REVIEW

A search for studies of forecasting for community food service shows that little is available. Mainstream media reports that demand for community food service is rising rapidly, these articles attribute the rising demand to broad categories such as 'economic downturn' or 'increasing number of foreclosures' without any supporting data (Huus, 2009). Measures of economic indicators are lagging indicators for demand for community food service. In long cycles of economic upturns or downturns, these indicators can show a general long term trend, but provide little ability to measure monthly or seasonal demand that is useful at an operational level.

Trade journal articles forecasting demand in the for-profit food service sector also use economic indicators to forecast demand broadly (Lawn, 2002; Buzalka, 2003). These trade Journal articles emphasize marketing techniques and cost containment methods as opposed to forecasting future demand.

Studies done by governmental groups or groups that are engaged in providing community food service focus on the reasons people use community food service. These studies gather demographic information from clients based on surveys (see for example Conference of Mayors Report (2008 and Hunger in America, 2006 report). While these studies help to identify the makeup of the client base, they shed little light on measuring future demand.

Thompson, et al (1988) published a study that indicates community food service demand increases at the end of the month. Thompson correlates the increased demand to inadequacy of public assistance programs. Reschovsky (1991) measures the relationship of average income and population size to donors to community food service operations. This study offers some ability to quantify the supply side, but not the demand side of community food services.

STUDY DESIGN

This study is designed to be a quantitative study. Data on meals served by the center over time will provide the demand data. Demand data was examined to determine possible trends, cycles and seasonality. Additionally, the study examined leading indicator correlation of demand for meals at the center with extrinsic quantitative data. Published data on temperature, precipitation, local unemployment and housing costs was measured against demand data using time series (including regression analysis) statistical techniques.

METHODOLOGY

The center provided monthly data from January, 2002 through December, 2009 on two categories of food service; meals served in the hot meal center and meals provided by the food pantry (food that is consumed at the recipients home). Data on meals served at the center was provided for subcategories of breakfast and lunch. Data on meals provided by the food pantry was provided for subcategories of households of more than one and households of one (named 'individuals' in the data table). This data is contained in Appendix A.

The data from the center was paired with monthly temperature and precipitation data from the National Atmospheric and Oceanic Administration. Additionally the data was paired

with county wide unemployment data and statewide Consumer Price Index (CPI) data from the U.S. Department of Labor statistics (see Appendix B). Three additional columns were added: first, a column converting unemployment rates so that it would graph on a similar scale with the demand data; second, a calculated percentage change in unemployment rate; and third, a calculated percentage change in Consumer Price Index (CPI). The first month that breakfast was served at the center was June, 2005. For this reason, demand data from the center prior to June, 2005 was eliminated to normalize the data for the regression analyses.

Regression analysis was performed on the demand data from center as the dependent variable. Each of the four categories (breakfast, lunch, food pantry households and food pantry individuals) was analyzed against independent variables of unemployment, weather variables and Consumer Price Index alone and in combinations. Combinations of breakfast and lunch (representing total hot food service) and households plus individuals (representing total demand from pantry) were analyzed against the same independent variables.

Finally, the data was analyzed using various time series models. Time series models were used to identify cycles, trends or seasonality based on historical demand data.

RESULTS

Regression analysis using demand data based on separate demand components and combined demand components against separate and combined independent variables (described in Methodology) showed that demand is not dependent upon any combination of independent variables tested in this study. Some of the analyses (particularly CPI) resulted in a p-value well below a statistically significant α of 0.05, in each case the Coefficient of Determination (r^2) did not explain more than 50% of the variance in the best case.

Time series analysis against historical demand yielded some positive results. Patterns identified in meal service differed from patterns in demand for pantry meals, so different techniques were used and unique results were obtained.

Demand patterns for meal service had large variability from month to month. However, demand patterns for quarters of the year revealed a measurable seasonal pattern. A seasonal index was applied to the data to develop a quarterly forecast for lunch service. For this analysis demand for lunch service was analyzed because data points are available for the period 2002 through present. Breakfast service was added in June, 2005. A graph of quarterly lunch service data, seasonal indices and forecast are contained in Appendix C.

Demand patterns for food pantry meals show less variability from month to month than demand for meal service. Using a three month moving average, an effective monthly forecast was developed for demand on the food pantry. A graph of a three month moving average mirrors demand for pantry food meals. Residuals follow a normal distribution, further establishing statistical validity for the forecast. This data is presented in Appendix D.

LIMITATIONS

The study did not seek long range cyclical trends. The purpose of the study is to identify a shorter range forecast for operational, not long range strategic planning. Additional studies in different time periods and different locations will be required to show if the results can be generalized more broadly.

January, 2009 data in all categories of food service at the center shows very high comparative demand. Whether this swing is an outlying data point or the beginning of a trend related to the current economic downturn cannot be determined from this data.

CONCLUSION and DISCUSSION

Both alternative hypotheses can be accepted based on analysis of demand data from the center. A quarterly forecast of lunches served can be developed for lunch service. A monthly forecast can be developed for demand on the food pantry.

A quarterly forecast for lunch service can assist the center in general planning for staff and non-perishable food items. A quarterly forecast will not assist the center in planning day by day to prepare the proper amount of food for the day. Based on some service at the center, the author knows that the center prepares for highest estimated demand and has a backup plan for quick food preparation in the event that demand exceeds the estimate. In the event that demand is lower than estimated, the center has cold storage available and very little is wasted.

A monthly forecast for demand on the food pantry will assist the center on a more timely basis and a more pragmatic basis. Being able to anticipate demand, the center can increase or decrease solicitations of donations in a timely manner. Additionally, staffing requirements can be anticipated with relative accuracy. This will increase the ability to serve client need while not allocating more resources than required.

This study points out that the needs of clients at the center are sensitive to factors not measurable by published and general statistics on weather, unemployment and CPI. The question then becomes “what factors have an effect on the client population of the center”. Is this client population more sensitive to local factors than can be measured by published data and statistics?

APPENDIX A
Monthly Demand Data from center 2002 through January 2009

2001	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	**TOTAL**	**Prior Yr. Comparison**
Households													**9,468**	
No. of Lunches													**38,000**	
# Distributed													**400,000**	
2002														
Households	832	536	537	413	434	496	477	489	638	713	822	619	**7,006**	
Individuals	2,973	1,882	1,846	1,707	1,448	1,633	1,517	1,605	2,010	2,653	2,653	1,975	**23,902**	
No. of Lunches	3,936	3,052	3,929	3,481	3,465	3,297	4,128	4,183	4,341	3,999	3,667	3,928	**45,406**	
Inventory:														
# Received	23,786	38,664	13,675	18,503	23,635	11,052	26,736	22,490	20,946	25,813	29,816	28,309	**283,425**	
# Distributed	31,330	26,569	30,571	19,683	21,719	22,692	22,604	23,208	22,997	21,357	33,639	28,118	**304,487**	
2003														
Households	834	742	870	860	566	553	918	944	979	1,168	987	1,086	**10,507**	
Indviduals	2,526	1,554	2,672	3,483	1,689	1,715	2,728	2,860	2,779	3,610	3,014	3,313	**31,943**	
No. of Lunches	4,382	3,811	3,478	3,278	3,580	3,639	4,037	3,744	3,684	4,260	4,991	4,119	**47,003**	
Inventory:														
# Received	19,363	28,889	22,329	23,270	25,513	41,431	58,271	70,443	39,215	52,199	82,305	67,884	**531,112**	
# Distributed	24,419	23,976	23,642	24,081	20,483	34,112	28,703	42,773	34,615	53,939	53,970	63,345	**428,058**	
2004														
Households	1,099	1,101	1,262	1,100	936	1,064	932	1,033	961	966	1,100	965	**12,519**	
Individuals	3,326	3,277	3,709	3,104	2,642	2,956	2,554	3,013	2,705	2,716	3,057	2,616	**35,675**	
No. of Lunches	4,337	4,076	5,283	4,788	4,374	5,155	5,158	5,641	5,043	4,821	5,673	5,272	**48,194**	
Inventory:														
# Received	56,863	51,696	67,821	49,597	40,737	42,354	45,003	54,612	49,853	47,507	65,786	63,710	**635,539**	
# Distributed	55,979	49,638	63,750	48,908	42,430	49,710	48,483	49,727	43,948	43,660	50,117	45,949	**592,299**	
2005														
Households	1,012	820	988	936	1,045	1,036	922	1,094	1,036	1,076	1,193	898	**12,056**	96%
Individuals	3,472	2,108	2,656	2,576	2,503	2,584	2,441	3,111	2,870	2,978	3,266	2,543	**33,108**	93%
No. of Lunches	5,169	4,559	4,906	4,215	4,415	4,887	4,268	4,053	4,735	5,371	6,186	4,720	**45,164**	94%
No. Breakfasts						2,255	2,267	2,738	2,428	2,835	2,770	2,548	**17,841**	
Inventory:												meals =	**63,005**	131%
# Received	36,447	30,477	46,056	36,228	59,664	36,825	41,600	51,615	44,650	34,295	50,836	51,344	**520,037**	82%
# Distributed	41,969	43,063	44,719	40,894	45,283	42,750	35,429	48,700	44,726	38,517	51,366	35,221	**512,637**	87%

2006	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	**TOTAL**	
Households	1,035	819	1,007	764	872	893	876	976	766	993	1067	867	**10,935**	91%
Individuals	2,863	2,174	2,563	2,064	2,359	2,593	2518	2762	2189	2847	3200	2356	**30,488**	92%
No. of Lunches	7,181	4,575	6,227	4,981	4,396	4,899	4519	4963	4475	4830	5280	4644	**60,970**	135%
No. Breakfasts	4,245	2,636	3,263	2,539	2,612	2,754	2334	2707	1993	2460	2132	1981	**31,656**	177%
Inventory:											(1000TH)	meals =	**92,626**	147%
# Received	35,680	48,701	50,372	43,545	41,163	37,473	66200	49922	35733	44891	47841	44718	**546,239**	105%
# Distributed	45,603	49,100	49,993	39,694	44,183	46,713	72186	54953	41319	53884	53383	35034	**586,045**	114%

2007	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	**TOTAL**	06/07 comp.
Households	1,061	879	951	955	1,017	918	870	953	860	1002	931	740	**11,137**	102%
Individuals	2,990	2,361	2,731	2,621	2,350	2,414	2381	2419	2290	2766	2852	2570	**30,745**	101%
No. of Lunches	4,969	4,492	4,436	4,711	4,888	5,299	6797	5347	5090	5791	5839	5160	**62,819**	103%
No. Breakfasts	2,139	2,237	2,532	2,737	2,568	2,698	2581	2713	3109	2744	2394	2046	**30,498**	96%
Inventory:											(300THK)	meals =	**93,317**	101%
# Received	47,275	53,449	52,663	49,880	62,175	47,288	51968	45988	30180	56526	50435	47463	**595,290**	109%
# Distributed	55,672	39,589	55,576	42,900	41,031	39,463	41418	42900	36340	39677	45200	41362	**521,128**	89%

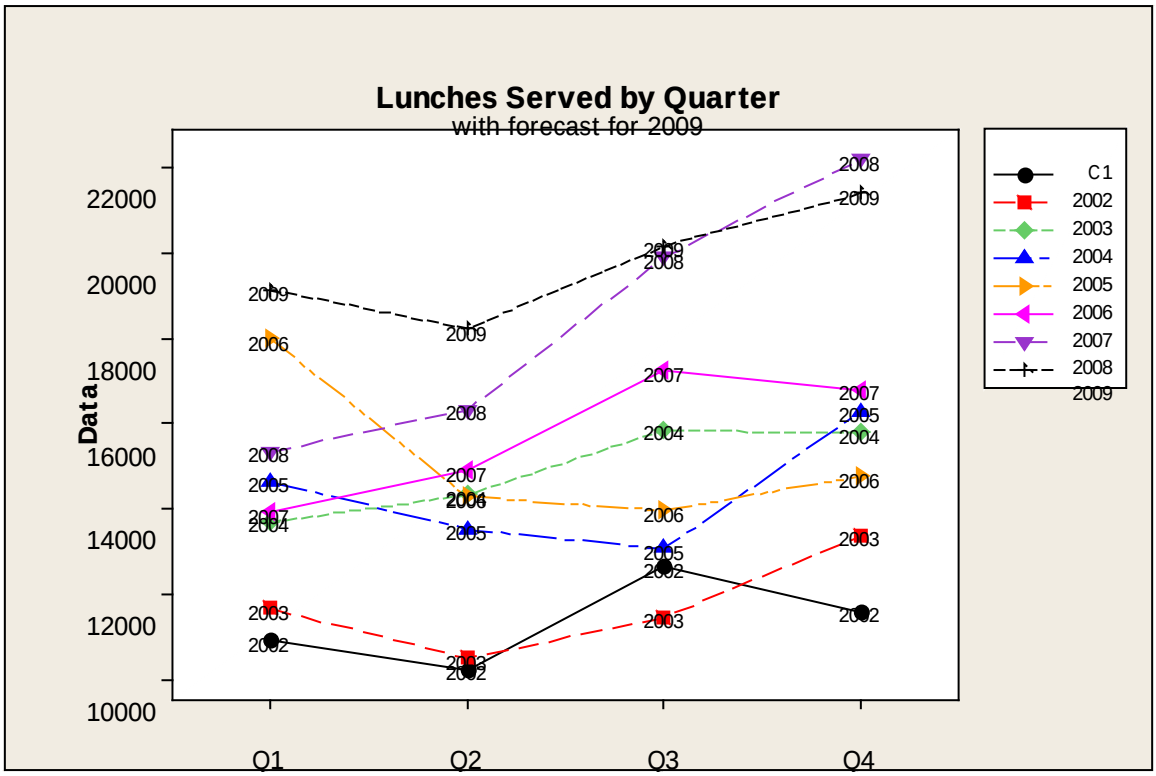
2008	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	**TOTAL**	07/08 comp.
Households	983	831	865	956	871	839	1018	1224	1070	1177	1126	1375	**12,335**	110.76%
Individuals	2,829	2,172	2,308	2,714	2,324	2,388	2930	2665	3097	3286	3245	3601	**33,559**	109.15%
No. of Lunches	5,398	4,545	5,378	4,967	5,279	6,070	6450	6615	6816	7478	7437	7256	**73,689**	117.30%
No. Breakfasts	2,077	1,706	1,838	1,753	1,908	2,025	2675	2324	2115	2280	2008	2281	**24,990**	81.94%
Day Shelter									425	290	270	403	**1,388**	
Warming Center										28	70	400	**498**	
Inventory:											(Thnk=540	TOTAL	**100,565**	107.77%
# Received	39,270	41,369	65,564	32,215	50,964	32,391	54937	40640	50439	59155	67011	63668	**597,623**	100.39%
# Distributed	46,060	31,392	41,643	42,814	36,738	34,551	46371	47025	57006	58286	60420	72015	**574,321**	110.21%

2009	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	**TOTAL**	08/09 comp.
Households	1,238												**1,238**	125.94%
Individuals	4,600												**4,600**	162.60%
No. of Lunches	7,484												**7,484**	138.64%
No. Breakfasts	2,465												**2,465**	118.68%
Day Shelter	916												**916**	
Warming Center	282												**282**	
TOTAL meals	11,147												**11,147**	
Inventory:														
# Received	50,866												**50,866**	129.53%
# Distributed	69,317												**69,317**	150.49%

APPENDIX B

Month	Lunches	Breakfasts	Lunch +	Household	Individual	Total	Total_1	Unemployr	Temp F	Precip	Unemp X 1	% change u	CPI	% Change C
06/2005	4887	2255	7142	1036	2584	3620	10762	4.9	81.1	3.99	4900	0.11	194.5	0.0005
07/2005	4268	2267	6535	922	2441	3363	9898	4.6	94.5	0.27	4600	-0.06	195.4	0.0046
08/2005	4053	2738	6791	1094	3111	4205	10996	4.4	86.4	1.34	4400	-0.04	196.4	0.0051
09/2005	4735	2428	7163	1036	2870	3906	11069	4.3	83.2	0.07	4300	-0.02	198.8	0.0122
10/2005	5371	2835	8206	1076	2978	4054	12260	4	65.4	2.16	4000	-0.07	199.2	0.0020
11/2005	6186	2770	8956	1193	3266	4459	13415	4.2	57.5	0.48	4200	0.05	197.6	-0.0080
12/2005	4720	2548	7268	898	2543	3441	10709	4	43.1	0.35	4000	-0.05	196.8	-0.0040
01/2006	7181	4245	11426	1035	2863	3898	15324	4.3	51.6	0.28	4300	0.08	198.3	0.0076
02/2006	4575	2636	7211	819	2174	2993	10204	4	46.1	0.15	4000	-0.07	198.7	0.0020
03/2006	6227	3263	9490	1007	2563	3570	13060	4.1	52.3	0.56	4100	0.02	199.8	0.0055
04/2006	4981	2539	7520	764	2064	2828	10348	3.8	68.1	0.67	3800	-0.07	201.5	0.0085
05/2006	4396	2612	7008	872	2359	3231	10239	3.7	76.5	0.94	3700	-0.03	202.5	0.0050
06/2006	4899	2754	7653	893	2593	3486	11139	4.2	89.6	0.12	4200	0.14	202.9	0.0020
07/2006	4519	2334	6853	876	2518	3394	10247	4.1	90.7	1.37	4100	-0.02	203.5	0.0030
08/2006	4963	2707	7670	976	2762	3738	11408	3.9	87.2	1.13	3900	-0.05	203.9	0.0020
09/2006	4475	1993	6468	766	2189	2955	9423	3.5	73.2	0.84	3500	-0.10	202.9	-0.0049
10/2006	4830	2460	7290	993	2847	3840	11130	3.2	62.6	1.03	3200	-0.09	201.8	-0.0054
11/2006	5280	2132	7412	1067	3200	4267	11679	3.3	54.8	0.34	3300	0.03	201.5	-0.0015
12/2006	4644	1981	6625	867	2356	3223	9848	3.1	42	1.21	3100	-0.06	201.8	0.0015
01/2007	4969	2139	7108	1061	2990	4051	11159	3.7	31.8	0.55	3700	0.19	202.41	0.0030
02/2007	4492	2237	6729	879	2361	3240	9969	3.4	40.3	0.36	3400	-0.08	203.49	0.0053
03/2007	4436	2532	6968	951	2731	3682	10650	3.3	59.2	0.57	3300	-0.03	205.35	0.0091
04/2007	4711	2737	7448	955	2621	3576	11024	2.9	59.9	2.65	2900	-0.12	206.68	0.0065
05/2007	4888	2568	7456	1017	2350	3367	10823	2.8	71.4	1.79	2800	-0.03	207.94	0.0061
06/2007	5299	2698	7997	918	2414	3332	11329	3.5	85.3	0.52	3500	0.25	208.35	0.0020
07/2007	6797	2581	9378	870	2381	3251	12629	3.5	91.6	0.43	3500	0.00	208.29	-0.0003
08/2007	5347	2713	8060	953	2419	3372	11432	3.4	89.8	2.76	3400	-0.03	207.91	-0.0018
09/2007	5090	3109	8199	860	2290	3150	11349	3.3	80.1	0.54	3300	-0.03	208.49	0.0028
10/2007	5791	2744	8535	1002	2766	3768	12303	3.2	68.2	3.03	3200	-0.03	208.93	0.0021
11/2007	5839	2394	8233	931	2852	3783	12016	3.4	55.6	0.2	3400	0.06	210.17	0.0059
12/2007	5160	2046	7206	740	2570	3310	10516	3.7	38.2	0.6	3700	0.09	210.36	0.0009
01/2008	5398	2077	7475	983	2829	3812	11287	4	40.1	0.08	4000	0.08	211.08	0.0034
02/2008	4545	1706	6251	831	2172	3003	9254	4	47.5	0.18	4000	0.00	211.69	0.0029
03/2008	5378	1838	7216	865	2308	3173	10389	4	53.2	0.17	4000	0.00	213.52	0.0086
04/2008	4967	1753	6720	956	2714	3670	10390	3.6	61.6	0.32	3600	-0.10	214.82	0.0061
05/2008	5279	1908	7187	871	2324	3195	10382	3.6	70.7	1.56	3600	0.00	216.63	0.0084
06/2008	6070	2025	8095	839	2388	3227	11322	3.9	83.9	0.73	3900	0.08	218.81	0.0101
07/2008	6450	2675	9125	1018	2930	3948	13073	4.6	93.7	0.24	4600	0.18	219.96	0.0053
08/2008	6615	2324	8939	1224	2665	3889	12828	4.6	85.1	4.03	4600	0.00	219.08	-0.0040
09/2008	6816	2115	8931	1070	3097	4167	13098	4.2	76	1.04	4200	-0.09	218.78	-0.0014
10/2008	7478	2280	9758	1177	3286	4463	14221	4.5	66.2	1.44	4500	0.07	216.57	-0.0101
11/2008	7437	2008	9445	1126	3245	4371	13816	4.8	57.3	0.18	4800	0.07	212.42	-0.0192
12/2008	7256	2281	9537	1375	3601	4976	14513	4.8	41	0.24	4800	0.00	210.22	-0.0104
01/2009	7484	2465	9949	1238	4600	5838	15787					-1.00	211.14	0.0044

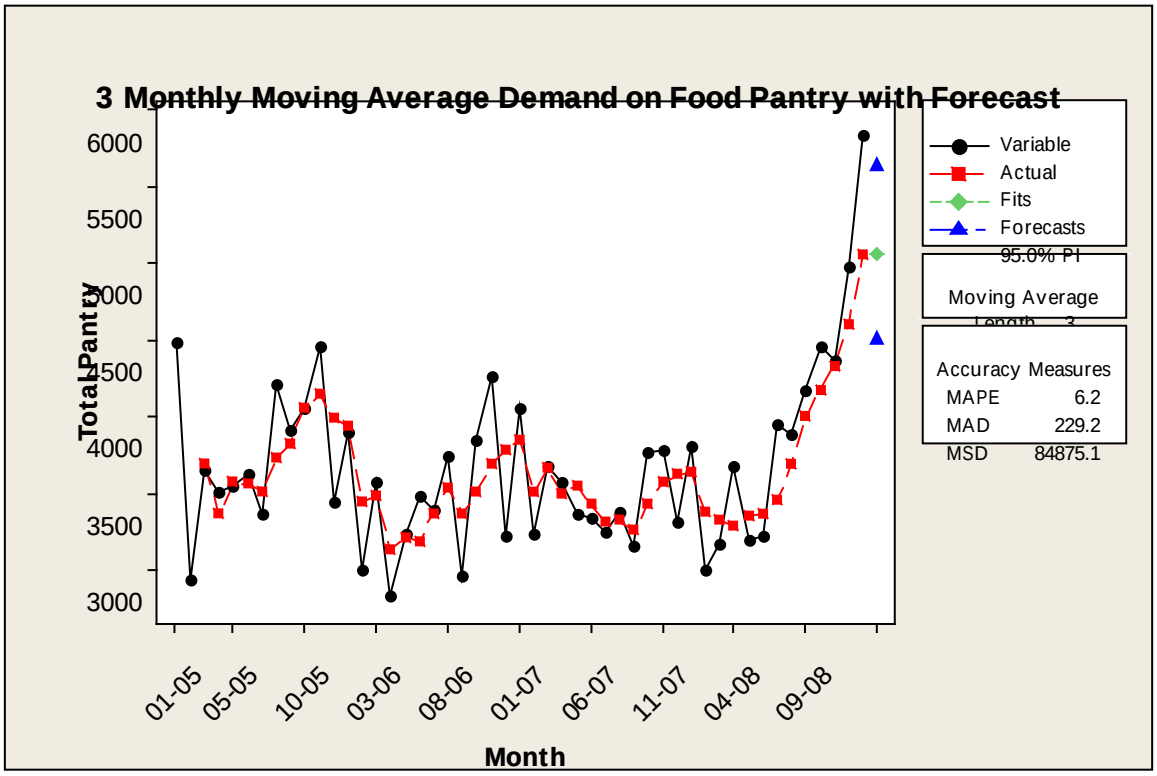
APPENDIX C

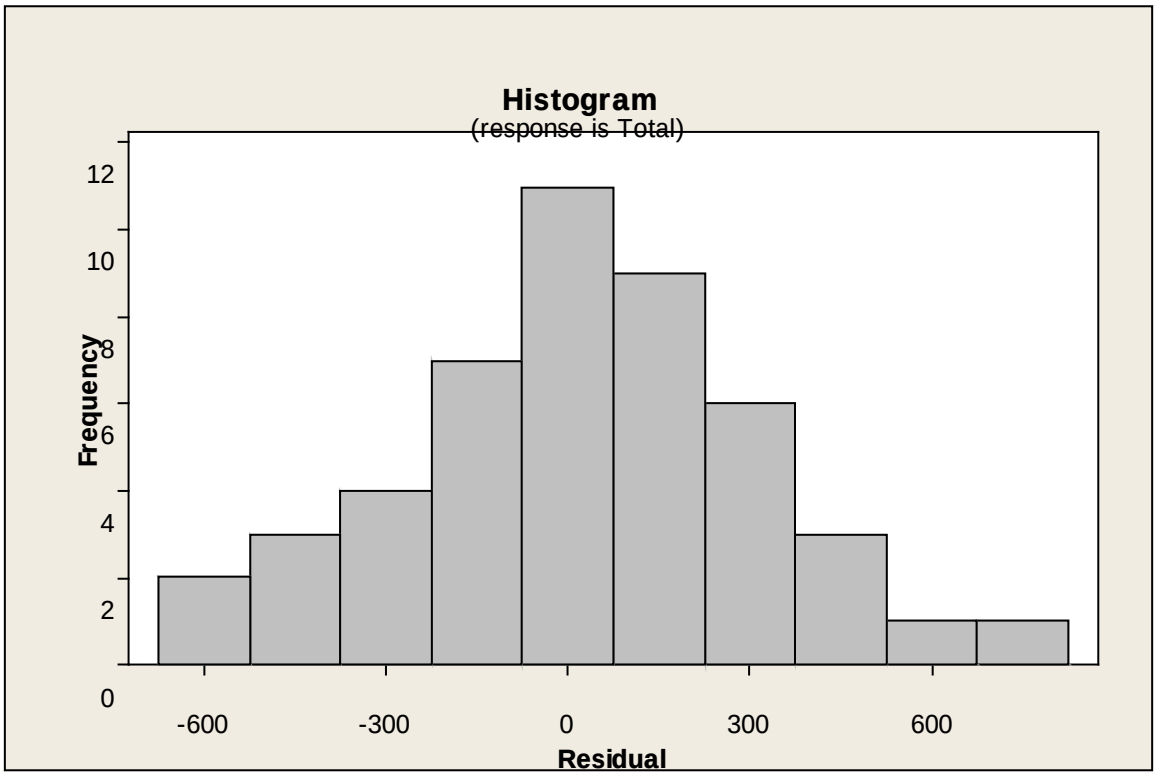


	Q1	Q2	Q3	Q4	Total	Growth		Index Q1	Index Q2	Index Q3	Index Q4	
2002	10,917	10,243	12,652	11,594	45,406			0.24	0.23	0.28	0.26	1.00
2003	11,671	10,497	11,465	13,370	47,003	0.03		0.25	0.22	0.24	0.28	1.00
2004	13,696	14,317	15,842	15,766	59,621	0.21		0.23	0.24	0.27	0.26	1.00
2005	14,634	13,517	13,056	16,277	57,484	-0.04		0.25	0.24	0.23	0.28	1.00
2006	17,983	14,276	13,957	14,754	60,970	0.06		0.29	0.23	0.23	0.24	1.00
2007	13,897	14,898	17,234	16,790	62,819	0.03		0.22	0.24	0.27	0.27	1.00
2008	15,321	16,316	19,881	22,171	73,689	0.15		0.21	0.22	0.27	0.30	1.00
	14,017	13,438	14,870	15,817	406,992	0.07		0.24	0.23	0.26	0.27	1.00

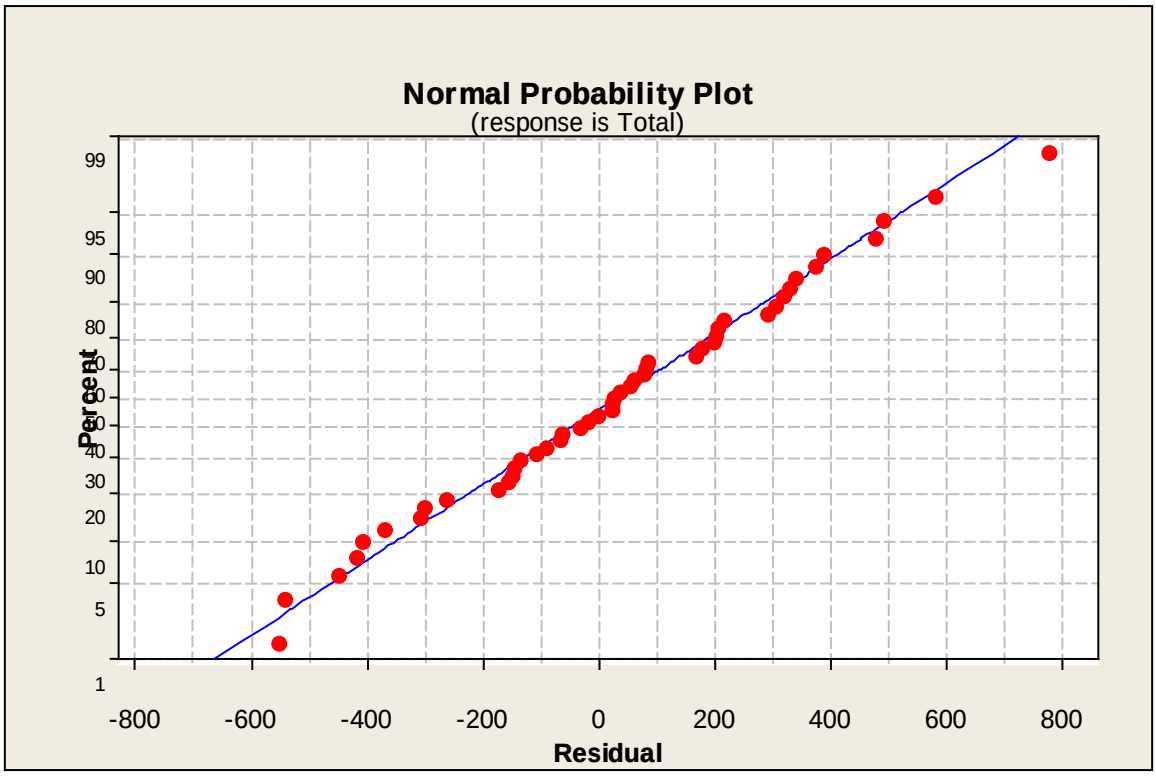
78847.23	2009 Forecast using mean 7% growth factor
19116.09	Forecast Q1 2009
18212.73	Forecast Q2 2009
20144.95	Forecast Q3 2009
21373.47	Forecast Q4 2009

APPENDIX D


3 Monthly Moving Average Demand on Food Pantry with Forecast
Total Pantry
6000
5500
5000
4500
4000
3500
3000
01-05
05-05
10-05
03-06
08-06
01-07
06-07
11-07
04-08
09-08
Month
Variable
Actual
Fits
Forecasts
95.0% PI
Moving Average
Length 3
Accuracy Measures
MAPE 6.2
MAD 229.2
MSD 84875.1


Histogram
(response is Total)
Frequency
12
10
8
6
4
2
0
-600
-300
0
300
600
Residual

APPENDIX D continued



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