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BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF GOODMAN WATER CORPORATION, FOR (i) A DETERMINATION OF THE FAIR VALUE OF ITS UTILITY PLANT AND PROPERTY AND (ii) AN INCREASE IN ITS WATER RATES AND CHARGES FOR UTILITY SERVICE BASED THEREON.	**DOCKET NO: W-02500A-10-0382**

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Notice of Filing

James Schoemperlen, an Intervenor, hereby provides notice of filing his direct testimony in the above referenced matter.

Respectfully Submitted this 2nd day of May, 2011.

James Schoemperlen
Intervenor

Arizona Corporation Commission
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BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF GOODMAN WATER CORPORATION, FOR (i) A DETERMINATION OF THE FAIR VALUE OF ITS UTILITY PLANT AND PROPERTY AND (ii) AN INCREASE IN ITS WATER RATES AND CHARGES FOR UTILITY SERVICE BASED THEREON.	**DOCKET NO: W-02500A-10-0382**

REBUTTAL TESTIMONY OF

JAMES SCHOEMPERLEN

IN RESPONSE TO TESTIMONY FROM MR MARLIN SCOTT, JR AND MR JUAN C. MANRIQUE OF THE ARIZONA CORPORATION COMMISSION

(RATE BASE, INCOME STATEMENT AND RATE DESIGN)

May 2, 2011

Schedule – A ..... Projection of Actual Returns Based on Staff Adjustments

Schedule – B ..... Projected Return if Only Rate Base is Adjusted.

Schedule – C ..... Projection of Adjustment to Achieve 9% Ave. Returns

Schedule – D ..... SAS Analysis of Time Series Data

Q1. Please state your name, occupation and address.

A1. James Schoemperlen, Corporate Controller for Sargent Aerospace in Tucson, my home address is 39696 S. Horse Run Drive.

Q2. On whose behalf are you testifying?

A2. I am testifying on behalf of myself as an intervenor in this case.

Q3. Please describe your educational background and professional experience.

A3. I am a Certified Public Accountant; I am the Corporate Controller for Sargent in Tucson which is an Aerospace Company. I have a BBA in Accounting from the University of Wisconsin. I have a Master's of Science Management from the University of Wisconsin with concentration in Finance.

Q4. Briefly Summarize your work experience.

A4. Brief summary as follows:

As Corporate Controller for Sargent in Tucson I have prepared numerous analysis for large capital additions including a recent significant expansion for the Tucson operations and I have led our mergers and acquisitions efforts analyzing numerous potential targets , Prior to that I was a divisional controller for Walbro Engine Management in Tucson, Prior to that I was controller for Lear Corporation in Janesville Wisconsin where I participated in a major plant expansion using robotics and was successful in obtaining significant funding from the state of Wisconsin for that expansion, Prior to that I held various Controllership positions with Motorola in Chicago IL for 20 years and performed the analysis for major plant expansions both domestic and international , Prior to that I worked as an Auditor for KPMG, one of the largest audit firms in the world and had concentrated audit experience in both commercial manufacturing and health care.

Q5. What is the scope of your testimony here?

A5. I am testifying in opposition to positions taken by the Arizona Corporation Commission Staff (Staff).

Q6. Please summarize the areas where you have problems with positions taken by the Arizona Corporation Commission staff.

A6. I have two main objections to Staffs analysis of the GWC proposal. Required rate of return (i.e. Marginal Cost of Capital) and rate design under Excess capacity / Intergenerational rate inequity.

REQUIRED RATE OF RETURN

I believe there are problems with how staff has developed the overall recommended rate of return for Goodman Water Company (GWC). Although Staff uses methods which are somewhat different to what GWC used, their analysis suffers from the same significant fundamental problem which affects GWC, namely a biased selection of comparative companies because Staff has used the same set of comparative companies that GWC used. On pages 7 through 13 of my filing in opposition to the GWC rate increase, I noted that 5 of the 6 stocks picked were on the list of best Water Utility performing stocks for the last 5 years and outperformed the Dow Jones Water Utility Index for that period, which indicates the comparison stocks have been "Cherry Picked" rather than a true representative sample to reflect what is happening with the average utility company. In addition, Staff noted on Page 6, line 15 and 16 that the average capital structure for the sample water utilities was 52.6% debt and 47.4 percent equity also on line 12, they noted that GWC had an 18.3% debt and 81.7% and later accepted that as the capital structure for GWC with neither any downward adjustment in GWC required rate of return for carrying less debt (more on that later), nor any explanation for accepting the GWC capital structure.

It is a fundamental financial fact of the risk/return relationship that if there is more debt, the shareholders will require a higher return (this means that any un-adjusted returns of the sample companies betas – expected return - will be much too high in comparison with GWC), yet Staff continued to use the Betas of these companies to determine the expected rate of returns without making any adjustment to reduce that return derived for the

difference in capital structure, nor do they adjust the GWC capital structure to represent the average of the sample.

Staff has also just accepted the GWC cost of debt of 8.5% as the proposed cost of debt in their capital structure. As I note on page 23 of my response in opposition to the GWC rate increase, GWC debt is held by EC Development and the President of EC Development is Alexander Sears who is also Chairman and CEO of GWC. Therefore the debt rate was not obtained based on an arm's length transaction and should not be allowed. As I indicated in my previous filing, current borrowing from WIFA is available at 3.68%.

I have already indicated that the Marginal Cost of Equity has been misstated by not adjusting for differences in capital structure but there is a further issue that the overall cost of capital will be reduced by a more appropriate mix of debt and equity. On page 23 of my response on the GWC rate request I show how the stable firm will minimize their cost of capital with a 50/50 mix of debt and equity. Staff has completely ignored the effect of an efficient capital structure in lowering the cost of capital. On page 25 of my response to the GWC rate request, I indicate how I have calculated an 8% Marginal Cost of Equity and an overall Marginal cost of capital of 7.16% using a more appropriate capital structure. It should be noted that although the difference between the 9% Staff calculates and the 7.16% I calculated sounds small, the effects of small changes are significant in the final rates determined.

Finally, I believe that when Staff performs their duty of proposing required rates of return they have the burden of proof in demonstrating that the rates are not biased and will not lead to biased results or unfair rate structures, that they are based on arms length transactions and employ an efficient cost of capital structure. I do not believe they have accomplished this here.

EXCESS CAPACITY THE RATE STRUCTURE AND INTERGENERATONAL RATE INEQUITIES.

Staff attempts to make calculations for excess capacity. I object to the calculations based on two issues, determination of excess capacity and statistical methods used.

Excess Capacity

In some places the calculations assume that if by 2014, the GWC plant will be used and useful, the entire cost should be included (Example the portion of the 530,000 tank capacity required included calculations out to 2014) and in other places, they consider whether or not the plant and equipment are actually connected and delivering service to customers (albeit no calculations were made there to calculate what portion of the CAPACITY of what is connected would be used by 2014). We clearly see this in calculation of the 530,000 gallon capacity plant used and useful under item E and calculation of water mains remove (page 5 and page 6). Obviously a system should be properly sized based on CAPACITY because excess capacity will lead to excess costs.

In addition, by removing excess capacity, based on what they expect to achieve in total customers by 2014, there is significant **intergenerational rate inequity** built into the rate design. Since as indicated there were 621 customers by year end 2009 (test year), who pays for the unused capacity until we get to 875 customers? **Also, if we are calculating total return (and therefore required rates) based on 621 current customers, this will inherently lead to excess returns in the future as I will demonstrate later.** Further, as I indicated in my original filing on page 5, Mr. Mark Taylor of Westland Resources Inc., has indicated that the waterworks is designed for approximately 1,291 equivalent housing units and ACC staff itself has

determined that the capacity of the GWC waterworks is approximately 1,800 equivalent housing units. In addition, Staff itself in their response has indicated the system could support up to 3,000 connections. Staff has not considered taking any of the excess capacity off between 875 units to 1,291 or 1,800 let alone 3,000 connections. The Staff proposed rate design indicates that it should include the capacity to 875 units (more on this later).Who pays for the capacity to 875 units until that is achieved? Staff proposes that would be current customers. **This is intergenerational rate inequity and it is significant as I demonstrated in my original filing.** This violates all the concepts of fair and just, or equitable service rates as covered by the Bluefield Water Works v Public Service Commission of West Virginia and Durant v. City of Beverly Hills.

Imagine if an Entrepreneur built a hotel for 1,200 customers monthly in a market that normally had only 620 customers but said to those customers I'm going to increase your hotel bill to cover 1,200 customers. Do we think this Entrepreneur would stay in business very long? This in effect is what has been proposed. The only reason the water company could do it is because they have a monopoly and the regulating body responsible allows it.

What happens if the housing depression continues and we never get to 875 customers? Then of course we would have excess capacity that has not been identified as such in this analysis.

Schedule A attached shows the effect of the rate adjustments if only those proposed by Staff are made. In this schedule I start with GWC proposed return in base year as GWC adjusted it (I included the Salary increase and Property tax increase although I believe they are unreasonable). I included the Staff recommendation of 9% return in base year and the $290,613 rate base adjustment as proposed by Staff (Net rate base of $1,739,712 which assumes the capacity if only 875 customers). The analysis shows that

although we start with 9% rate of return, as you add customers (assume 7% customer growth to uniformly get to the 875 by end of 2014), **the *yearly* return grows to 16.4% by the end of the period and that *average annual return* grows to a return of 12.1% over the rate period by the end of 2014.** So how does this happen? It's because they are setting a 9% return based on 621 customers. **When you add customers to get to 875, your return must grow!** In addition, no adjustment is made based on what Staff proposes for the effect of fixed and variable costs (i.e. costs do not grow proportionally to revenue) **and the 621 customers are expected to pay the costs for all 875 customers initially**. All of this as the calculations demonstrate **adds up to major Intergenerational Rate inequity and an unfair and discriminatory rate structure which is unfair and unjust in its consequences since it will result in rates among the highest in all of Arizona as demonstrated in my initial response to the GWC request.** It should also be noted that even if excess capacity is taken off based on percentage of customers between 621 customers and 875 over the years until the 875 customers are achieved (See attached Schedule –B, $1,739,712/875*621 = $1,234,698), the average return will still be **11.2%** over the period. It is not until the starting average return is adjusted to **5.8%** that the **overall average rate of return achieved will become 9%** over the period (See attached Schedule – C). **Instead of concentrating on initial return, the Staff should concentrate on average rate of return over the period, here starting with a 5.8% cost of capital and removing excess capacity properly. Also Staff needs to take the excess capacity off between 875 equivalent units AND the 1,291 equivalent units already admitted by GWC.**

Statistical Methods Used

Staff indicates that they are using linear regression analysis to come up with 875 customers by the end of the rate period 2014. It should be noted that the data they are trying to forecast is "Time Series" data. In Schedule – D, I have included an article from the developers of SAS software which is recognized as the premier tool in the market for all types of forecasting purposes. They state in part "In regression analysis, if error terms are not independent *(autocorrelated),* the efficiency of the ordinary least-square (OLS) parameter estimates is adversely affected and the standard error estimates are biased. **This happens frequently with time series data** (emphasis added). Ordinary regression analysis assumes that the error variance is the same for all observations. When the error variance is not constant, the data are said to be *heteroscedastic,* and ordinary least-squares estimates are inefficient." Translation, Staff used an incorrect method statistically to try to forecast the 875 customers at the end of 2014. Clearly, just based on validity of the method used there is no proof that there will be 875 customers at the end of 2014. However, just using common sense, since we are in the throes of the largest single meltdown in housing, it is not clear that we will see 875 customers in the development any time in the foreseeable future and the capacity developed for that build out is clearly excess.

Goodman Water Co
Projection of Actual Returns Based on Staff Adjustments
Schedule - A

		1 Dec-10	2 Dec-11	3 Dec-12	4 Dec-13	5 Dec-14	
	Revenue	700,939	750,603	803,653	861,218	987,635	
	Total Cost Before Inc. Taxes	475,765	487,012	499,027	512,063	540,693	
	Income Taxes	68,600	85,215	102,964	122,222	161,771	
	Total Cost**	544,365	572,228	601,990	634,286	702,464	
	Operating Income	156,574	178,375	201,663	226,932	285,172	$ 184,409.08
	Net Rate Base*	1,739,712	1,739,712	1,739,712	1,739,712	1,739,712	
	Total Customers	621	665	712	763	875	
	Revenue per Customer	1,128.73	1,128.73	1,128.73	1,128.73	1,128.73	
	Return on Rate Base	9.0%	10.3%	11.6%	13.0%	16.4%	
	∑ of Returns	1,048,716					
	Average Annual Return	12.1%					

* Plant and Equipment supports 825 customers
** Assume total cost per GWC Test Year Adjust w/ adjust for reasonable Prop tax and Wages, Fixed / Variable per below

			Fixed	Variable
Fixed	Salaries and Wages	$ 40,000.00	$ 40,000.00	
	Purchase Water			
Variable	Purchased Power	$ 27,066.00		$ 27,066.00
	Chemicals			
Variable	Repairs and Maintenance	$ 7,746.00		$ 7,746.00
Variable	Office Supplies and Expanse	$ 14,855.00		$ 14,855.00
Variable	Outside Services	$ 102,925.00		$ 102,925.00
Variable	Water Testing	$ 2,783.00		$ 2,783.00
	Rents			
	Transportation Expenses			
Fixed	Insurance - General Liability	$ 9,669.00	$ 9,669.00	
	Insurance - Health and Life			
Fixed	Regulatory Commission Expense - Rate Case	$ 20,000.00	$ 20,000.00	
Variable	Miscellaneous Expense	$ 378.00		$ 378.00
Fixed	Depreciation Expense	$ 228,853.00	$ 228,853.00	
Variable	Taxes Other Than Income	$ 2,988.00		$ 2,988.00
Fixed	Property Taxes	$ 18,502.00	$ 18,502.00	
	Sub Total	***$ 475,765.00***	***$ 317,024.00***	***$ 158,741.00***
			$ 0.67	$ 0.33
direct Calc	Income Tax -Marginal rate at	$ 68,600.06		$ 68,600.06
	Total Expenses before Interest	$ 544,365.06	$ 634,048.67	$ 386,082.40
			66.6%	33.4%

Tax Calc's							
	Revenue	$ 700,939.00	$ 750,602.95	$ 803,653.09	$ 861,218.13	$ 987,635.47	
	Operating Expenses	$ 475,765.00	$ 487,012.35	$ 499,026.56	$ 512,063.26	$ 540,692.88	
	Synchronizzed Interest	$ 27,835.00	$ 27,835.00	$ 27,835.00	$ 27,835.00	$ 27,835.00	
	Arizona Taxable Income	$ 197,339.00	$ 235,755.61	$ 276,791.52	$ 321,319.86	$ 419,107.59	
	Arizona State Income Tax Rate	6.9680%	6.9680%	6.9680%	6.9680%	6.9680%	
	Arizona Income Tax	$ 13,750.58	$ 16,427.45	$ 19,286.83	$ 22,389.57	$ 29,203.42	
	Federal Taxable Income	$ 183,588.42	$ 219,328.15	$ 257,504.69	$ 298,930.30	$ 389,904.17	
0.15	50,000	$ 7,500.00	$ 7,500.00	$ 7,500.00	$ 7,500.00	$ 7,500.00	
0.25	75,000	$ 6,250.00	$ 6,250.00	$ 6,250.00	$ 6,250.00	$ 6,250.00	
0.34	100,000	$ 8,500.00	$ 8,500.00	$ 8,500.00	$ 8,500.00	$ 8,500.00	
0.39	335,000	$ 32,599.48	$ 46,537.98	$ 61,426.83	$ 77,582.82	$ 91,650.00	
0.34	10,000,000	$ -	$ -	$ -	$ -	$ 18,667.42	

Goodman Water Co
Projection of Return if Only Rate Base is Adjusted.
Schedule - B

		1	2	3	4	5
		Dec-10	Dec-11	Dec-12	Dec-13	Dec-14
	Revenue	620,848	664,838	711,826	762,814	874,786
	Total Cost Before Inc. Taxes	475,765	487,012	499,027	512,063	540,693
	Income Taxes	33,960	48,121	63,248	79,662	115,708
	Total Cost**	509,725	535,134	562,275	591,725	656,401
	Operating Income	111,123	129,704	149,551	171,088	218,385
	Net Rate Base*	1,234,698	1,322,181	1,328,146	1,336,099	1,739,712
	Total Customers	621	665	712	763	875
	Revenue per Customer	999.76	999.76	999.76	999.76	999.76
	Return on Rate Base	9.0%	9.8%	11.3%	12.8%	12.6%
	∑ of Returns	779,852				
	Average Annual Return	11.2%				

* Plant and Equipment supports 825 customers
** Assume total cost per GWC Test Year Adjust w/ adjust for reasonable Prop tax and Wages, Fixed / Variable per below

				Fixed	Variable
Fixed	Salaries and Wages	$	40,000.00	$ 40,000.00	
	Purchase Water				
Variable	Purchased Power	$	27,066.00		$ 27,066.00
	Chemicals				
Variable	Repairs and Maintenance	$	7,746.00		$ 7,746.00
Variable	Office Supplies and Expanse	$	14,855.00		$ 14,855.00
Variable	Outside Services	$	102,925.00		$ 102,925.00
Variable	Water Testing	$	2,783.00		$ 2,783.00
	Rents				
	Transportation Expenses				
Fixed	Insurance - General Liability	$	9,669.00	$ 9,669.00	
	Insurance - Health and Life				
Fixed	Regulatory Commission Expense - Rate Case	$	20,000.00	$ 20,000.00	
Variable	Miscellaneous Expense	$	378.00		$ 378.00
Fixed	Depreciation Expense	$	228,853.00	$ 228,853.00	
Variable	Taxes Other Than Income	$	2,988.00		$ 2,988.00
Fixed	Property Taxes	$	18,502.00	$ 18,502.00	
	Sub Total	***$***	***475,765.00***	***$ 317,024.00***	***$ 158,741.00***
				$ 0.67	$ 0.33
direct Calc	Income Tax -Marginal rate at	$	33,960.46		$ 33,960.46
	Total Expenses before Interest	$	509,725.46	$ 634,048.67	$ 351,442.80
				66.6%	33.4%

Tax Calc's

	Revenue		$	620,848.32	$	664,837.58	$	711,826.10	$	762,813.64	$ 874,786.29
	Operating Expenses		$	475,765.00	$	487,012.35	$	499,026.56	$	512,063.26	$ 540,692.88
	Synchronizzed Interest		$	27,835.00	$	27,835.00	$	27,835.00	$	27,835.00	$ 27,835.00
	Arizona Taxable Income		$	117,248.32	$	149,990.23	$	184,964.53	$	222,915.38	$ 306,258.41
	Arizona State Income Tax Rate			6.9680%		6.9680%		6.9680%		6.9680%	6.9680%
	Arizona Income Tax		$	8,169.86	$	10,451.32	$	12,888.33	$	15,532.74	$ 21,340.09
	Federal Taxable Income		$	109,078.46	$	139,538.91	$	172,076.21	$	207,382.63	$ 284,918.32
0.15		50,000	$	7,500.00	$	7,500.00	$	7,500.00	$	7,500.00	$ 7,500.00
0.25		75,000	$	6,250.00	$	6,250.00	$	6,250.00	$	6,250.00	$ 6,250.00
0.34		100,000	$	8,500.00	$	8,500.00	$	8,500.00	$	8,500.00	$ 8,500.00
0.39		335,000	$	3,540.60	$	15,420.17	$	28,109.72	$	41,879.23	$ 72,118.14
0.34		10,000,000	$	-	$	-	$	-	$	-	$ -

Goodman Water Co
Projection of Adjustments to Achieve 9% OVERALL returns
Schedule - C

		1	2	3	4	5
		Dec-10	Dec-11	Dec-12	Dec-13	Dec-14
	Revenue	558,900	598,500	640,800	686,700	787,500
	Total Cost Before Inc. Taxes	475,765	487,012	499,027	512,063	540,693
	Income Taxes	11,715	20,539	30,189	32,479	37,508
	Total Cost**	487,480	507,551	529,216	544,542	578,201
	Operating Income	71,420	90,949	111,584	142,158	209,299
	Net Rate Base*	1,234,698	1,322,181	1,328,146	1,336,099	1,739,712
	Total Customers	621	665	712	763	875
	Revenue per Customer	900.00	900.00	900.00	900.00	900.00
	Return on Rate Base	5.8%	6.9%	8.4%	10.6%	12.0%
	∑ of Returns	625,410				
	Average Annual Return	9.0%				

* Plant and Equipment supports 825 customers
** Assume total cost per GWC Test Year Adjust w/ adjust for reasonable Prop tax and Wages, Fixed / Variable per below

				Fixed	Variable
Fixed	Salaries and Wages	$	40,000.00	$ 40,000.00	
	Purchase Water				
Variable	Purchased Power	$	27,066.00		$ 27,066.00
	Chemicals				
Variable	Repairs and Maintenance	$	7,746.00		$ 7,746.00
Variable	Office Supplies and Expanse	$	14,855.00		$ 14,855.00
Variable	Outside Services	$	102,925.00		$ 102,925.00
Variable	Water Testing	$	2,783.00		$ 2,783.00
	Rents				
	Transportation Expenses				
Fixed	Insurance - General Liability	$	9,669.00	$ 9,669.00	
	Insurance - Health and Life				
Fixed	Regulatory Commission Expense - Rate Case	$	20,000.00	$ 20,000.00	
Variable	Miscellaneous Expense	$	378.00		$ 378.00
Fixed	Depreciation Expense	$	228,853.00	$ 228,853.00	
Variable	Taxes Other Than Income	$	2,988.00		$ 2,988.00
Fixed	Property Taxes	$	18,502.00	$ 18,502.00	
	Sub Total	***$***	***475,765.00***	***$ 317,024.00***	***$ 158,741.00***
				$ 0.67	$ 0.33
direct Calc	Income Tax -Marginal rate at	$	11,714.98		$ 11,714.98
	Total Expenses before Interest	$	487,479.98	$ 634,048.67	$ 329,197.31
				66.6%	33.4%

Tax Calc's							
	Revenue	$ 558,900.00	$ 598,500.00	$ 640,800.00	$ 686,700.00	$ 787,500.00	
	Operating Expenses	$ 475,765.00	$ 487,012.35	$ 499,026.56	$ 512,063.26	$ 540,692.88	
	Synchronizzed Interest	$ 27,835.00	$ 27,835.00	$ 27,835.00	$ 27,835.00	$ 27,835.00	
	Arizona Taxable Income	$ 55,300.00	$ 83,652.65	$ 113,938.44	$ 146,801.74	$ 218,972.12	
	Arizona State Income Tax Rate	6.9680%	6.9680%	6.9680%	6.9680%	6.9680%	
	Arizona Income Tax	$ 3,853.30	$ 5,828.92	$ 7,939.23	$ 10,229.14	$ 15,257.98	
	Federal Taxable Income	$ 51,446.70	$ 77,823.73	$ 105,999.21	$ 136,572.59	$ 203,714.14	
0.15	50,000	$ 7,500.00	$ 7,500.00	$ 7,500.00	$ 7,500.00	$ 7,500.00	
0.25	75,000	$ 361.67	$ 6,250.00	$ 6,250.00	$ 6,250.00	$ 6,250.00	
0.34	100,000	$ -	$ 960.07	$ 8,500.00	$ 8,500.00	$ 8,500.00	
0.39	335,000	$ -	$ -				
0.34	10,000,000	$ -	$ -				

SCHEDULE - D, Time Series Analysis

SAS/ETS Software

Time Series Analysis

Regression with Autocorrelated and Heteroscedastic Errors

In regression analysis, if the error terms are not independent (*autocorrelated*), the efficiency of the ordinary least-square (OLS) parameter estimates is adversely affected and the standard error estimates are biased. This happens frequently with time series data.

Ordinary regression analysis assumes that the error variance is the same for all observations. When the error variance is not constant, the data are said to be *heteroscedastic,* and ordinary least-squares estimates are inefficient.

The AUTOREG procedure estimates and forecasts linear regression models for time series data when the errors are autocorrelated or heteroscedastic. The autoregressive error model is used to correct for autocorrelation, and the generalized autoregressive conditional heteroscedasticity (GARCH) model and its variants are used to model and correct for heteroscedasticity.

The AUTOREG procedure supports the following variations of the GARCH model:

- generalized ARCH (GARCH)
- exponential GARCH (EGARCH)
- integrated GARCH (IGARCH)
- GARCH-in-mean (GARCH-M)

The procedure can also analyze models that combine autoregressive errors and GARCH-type heteroscedasticity. The maximum likelihood method is used for GARCH models and for mixed AR-GARCH models. Four estimation methods are supported for the autoregressive error model:

- Yule-Walker
- unconditional least squares
- iterated Yule-Walker
- exact maximum likelihood

Details of the AUTOREG Procedure

ARIMA (Box-Jenkins) and ARIMAX (Box-Tiao) Modeling and Forecasting

The ARIMA procedure analyzes and forecasts equally spaced univariate time series data, transfer function data, and intervention data using the autoregressive moving-average (ARMA) model or the more general autoregressive integrated moving-average (ARIMA) model. An ARIMA model predicts a value in a response time series as a linear combination of its own past values, past errors, and current and past values of other time series.

The ARIMA procedure provides a comprehensive set of tools for univariate time series model identification, parameter estimation, and forecasting. It offers great flexibility in the kinds of ARIMA or ARIMAX models that can be analyzed. The procedure supports seasonal, subset, and factored ARIMA models; intervention or interrupted time series models; multiple regression analysis with ARIMA errors; and transfer function models of any complexity.

Details of the ARIMA Procedure

Polynomial Distributed Lag Regression

The PDLREG procedure estimates regression models for time series data in which the effects of some of the regressor variables are distributed across time. The distributed lag model assumes that the effect of an independent variable, X, on a dependent variable, Y, is distributed over time. If the value of X at time t changes, Y experiences some immediate effect at time t, and it also experiences delayed effects at times $t + 1$, $t + 2$, and so on up to time $t + p$, for some limit p.

The distribution of the lagged effects is modeled by Almon lag polynomials. The coefficients of the lagged values of the regressor are assumed to lie on a polynomial curve.

Regression models supported by PROC PDLREG can include any number of regressors with distribution lags and any number of covariates (simple regressors without lag distributions).

You can specify a minimum degree and a maximum degree for the lag distribution polynomial, and the procedure fits polynomials for all degrees in the specified range.

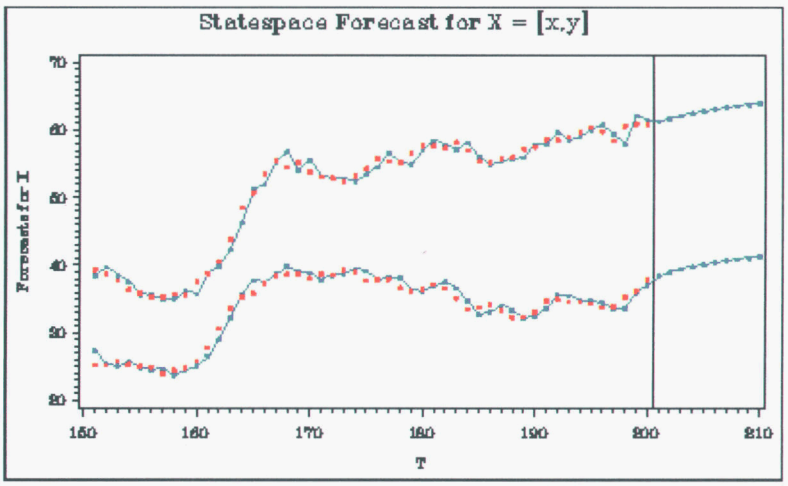
The PDLREG procedure can also test for autocorrelated residuals and perform autocorrelated error correction using the autoregressive error model. You can specify any order autoregressive error model and several different estimation methods for the autoregressive model, including exact maximum likelihood.

Details of the PDLREG Procedure

State Space Modeling and Forecasting

The STATESPACE procedure is useful for automatic modeling and forecasting of several interrelated time series with or without a feedback relationship.

The procedure analyzes and forecasts multivariate time series using the state space model. It is appropriate for jointly forecasting several related time series that have dynamic interactions. By taking into account the autocorrelations among the whole set of variables, the STATESPACE procedure may give better forecasts than methods that model each series separately. By default, the STATESPACE procedure automatically selects a state space model appropriate for the time series, making the procedure a good tool for automatic forecasting of multivariate time series.



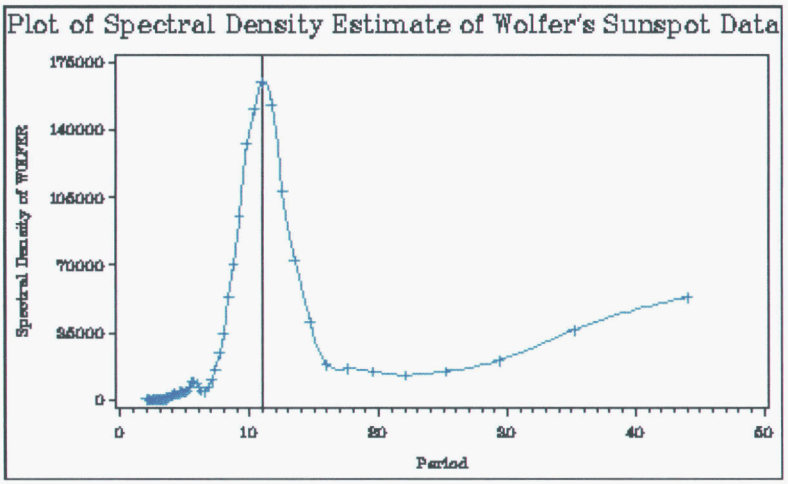
Use the STATESPACE procedure to forecast and fit statespace models.

Details of the STATESPACE Procedure

Spectral Analysis

Spectral analysis is a statistical approach to detecting regular cyclical patterns, or periodicities, in transformed time series data.

The SPECTRA procedure produces estimates of the spectral and cross-spectral densities of a multivariate time series. Estimates of the spectral and cross-spectral densities of a multivariate time series are produced using a finite Fourier transform to obtain periodograms and cross-periodograms. The periodogram ordinates are smoothed by a moving average to produce estimated spectral and cross-spectral densities. PROC SPECTRA can also test whether the data are white noise.



The SPECTRA procedure performs spectral and cross-spectral analysis of time series.

Details of the SPECTRA Procedure

Time Series Cross-Sectional Regression Analysis

The TSCSREG procedure analyzes a class of linear econometric models that commonly arise when time series and cross-sectional data are combined. The TSCSREG procedure analyzes panel data sets that consist of multiple time series observations on each of several individuals or cross-sectional units. The performance of any estimation procedure for the model regression parameters depends on the statistical characteristics of the error components in the model. The TSCSREG procedure estimates the regression parameters in the preceding model under several common error structures, including one and two-way fixed and random effects.

Details of the TSCSREG Procedure

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